UNIVERSITY OF SOUTHAMPTON

AGRICULTURAL CHANGE IN LATER PREHISTORIC AND ROMAN BRITAIN

by Victoria Mary Crosby

Master copy

Thesis submitted for the degree of Doctor of Philosophy.
Department of Archaeology, University of Southampton.
August 1989.

CONTENTS

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF ARTS

ARCHAEOLOGY

Doctor of Philosophy

AGRICULTURAL CHANGE IN LATER PREHISTORIC AND ROMAN BRITAIN

by Victoria Mary Crosby

This thesis has the dual aim of examining the agriculture of the later prehistoric and Romano-British period and investigating the ways in which agricultural systems and agricultural change can be described and explained in an archaeological context. It is argued that a broader approach will enable more useful information to be extracted from the increasing volume of data available.

An eight part framework is used as the basis for a discussion of some classes of evidence for agriculture. The framework encompasses socio-economic factors as well as aspects of agricultural practice. It is argued that an agricultural system is defined by its organisation as much as its practices, and that it can only be understood in its socio-economic context. Conversely, agriculture discussed in this way becomes a source of information on social, economic and political organisation.

Patterns of change are identified, and it is suggested that the essentially static picture of later prehistoric agriculture prevalent in much of the literature is erroneous and hinders understanding. The areas of fertility maintenance and the organisation of land use are particularly emphasised. The use of historical and experimental data to estimate productivity of past agricultural systems is discussed.

Problems in drawing social inferences from the remains of agricultural activity are considered, and it is suggested that considering the organisation of agriculture as an element in a society provides a key to these difficulties. Some relationships between agricultural and social organisation in the Iron Age are suggested.

Acknowledgements.

This thesis is the result of part-time study over seven years, and it is a pleasure to acknowledge the help I have received from many people during that time.

My mother Mrs. June Crosby paid my fees for three years, and my grandmother Mrs. Hilda Rew gave me a wordprocessor which made the final stages of preparation much easier. Numerous friends have helped with both encouragement and in practical ways; I would especially like to thank Margaret Jenness and Gwenda Baker. The support of my husband David Bull has been vital throughout. Our son Thomas Bull has been very good, allowing me to work in peace most of the time. I would also like to thank Dr. C. Swann for her support.

Staff and postgraduate students in the Department of Archaeology have made many useful comments on the work while it was in progress. Tim Champion has been a valuable source of advice and information.

I would particularly like to thank my supervisor Stephen Shennan for his continuing help and advice.

Chapter 1.
Introduction.

1.1. Aims and approach.

The aim of this thesis is to devise methods for recognising, describing and ultimately explaining agricultural change, in the context of later prehistoric and Roman Britain. The main theme is that if a consistent framework can be drawn up for defining an agricultural system, for examining its component elements, and for considering what constitutes change in the system, it will then be possible to extract more information from the increasingly available data on the agriculture of this period. An important subsidiary theme is that the evidence for the practices and organisation of agriculture forms an important source of evidence on past societies and their economies. But once again a method for using this information is needed, and some aspects of current ways of looking at agriculture tend to obscure possibilities in this area.

The view taken here is that the causes and motivations for agricultural change should be sought primarily within the areas of social and economic change, rather than relying on factors which are either external to the agrarian societies under discussion (notably climate) or considered to be independent variables (as population is in the Boserup model of agricultural change). Both these factors are potentially crucial in understanding agricultural societies: but the response to climatic change will be determined by social and economic conditions, and population itself is a socio-economic variable. Agricultural systems also have their own intrinsic dynamics and limitations, and understanding these is also essential to understanding the process of change.

There is thus a dual aim, both to increase understanding of later prehistoric and Roman Britain agriculture and to investigate the ways in which agricultural systems and agricultural change can be described and explained in archaeological contexts.

A number of discussions of paleotechnic agriculture have resulted in systems of classification based on a single criterion, frequency of cultivation (notably Boserup 1965, 1981). Other aspects are therefore relegated to secondary importance. Boserup (1981, Preface) defends her use of a partial model (her classes are also evolutionary stages), but reliance on her model might be considered in odd contrast to the emphasis on complexity and multicausality in many other areas of archaeological explanation. In addition, the archaeological evidence does not readily lend itself to describing agricultural systems in terms of frequency of cultivation. The importance of being able to maintain fertility receives little attention in her model, where the availability of industrial fertilisers is assumed, and the model has been criticised for, among other things, failing to consider environmental factors. This is another key problem with using it archaeologically.

The principal tool of cultivation (digging stick, hoe or plough) has also provided a basis for classifying agricultural systems, but Bronson (1972,203) concluded that there is no clear correlation between technology and intensity of cultivation, citing several examples of intensive systems based on simple tools. But in any case it would not provide an adequate criterion for distinguishing between different agricultural systems in British prehistory.

Because of the problems of developing criteria for distinguishing agricultural systems which are useful and operational in archaeological terms it could be argued that past agricultural systems should be defined purely in terms of the archaeological record itself. However the nature of the available archaeological evidence could then lead to the virtual exclusion of some less tangible aspects of agriculture. An accumulation of lists of exploited species or plans of field boundaries does not constitute a description of an agricultural system, but there seems at present to be no consensus as to what such a description should comprise. There are a number of different emphases apparent in the literature, notably landscape reconstruction, estimates of productivity and experimental approaches, and the recovery of details of agricultural practice, such as crop processing techniques and herding strategies. The suggestion made here is that, despite much interesting work, the lack of a clear concept of what constitutes an agricultural system and of a framework for analysis of agriculture within its economic context is limiting the information which can be drawn from the available data.

The assumption here is that an agricultural system must be defined as a package of agricultural practices occurring together and often closely interdependent. There may be substantial variations within this package, reflecting for example local environmental conditions, and yet its basis remains recognisably constant despite these differences. A key element may be the way in which the fertility of the soil is maintained; on archaeological timescales, this factor achieves a discernible importance which may be less obvious in contemporary studies of non-industrialised agriculture. The ways in which agriculture is organised and its social and economic context are also important components of the agricultural system.

One key question is the scale at which an agricultural system is to be defined, and whether for instance it would be acceptable to discuss the agricultural system of an individual farm. I think that to do so is misleading, and confuses system with practices. The recognition of considerable variation in excavated agricultural settlements within a limited area and timespan suggests that the definition of an agricultural system based on a single site would be inadequate. Satisficing models of agricultural decisions (see section 1.3.1.iii below) also predict variability in agricultural practices due to individual preferences, in addition to variation reflecting localised environmental factors. This distinction between variability within a single agricultural system and variation between different agricultural systems is a key problem in arriving at useful definitions.

So the initial question must be how an agricultural system can be defined in archaeologically recoverable terms. This is approached here by distinguishing eight aspects of an agricultural system which it seems necessary to detail if the system is to be adequately described and defined. These are:-

1. Technology; tools and the ways in which they are used.
2. The plant and animal species exploited.
3. Fertility maintenance methods, including the organisation of land use.
4. Population levels and labour requirements.
5. The levels and types of investment in agricultural production.

6. The relationship between subsistence and surplus production.
7. Economic demands or constraints: rents, taxes and the autonomy of the productive unit.
8. The decision framework.

The eight part framework for describing agricultural systems has deliberately not been based on the categories of archaeological evidence available. The aim is to allow more constructive integration of the data, and to prevent the availability of data from unduly channelling the discussion. Yet to be useful, the framework must allow description in archaeologically recoverable terms, and the balance between these two considerations is important.

These categories form the framework for the discussion of the archaeological evidence which follows. So far there is no attempt here to define an agricultural system beyond proposing this list of eight components, which together are taken to describe it. It is the combination of these elements and especially the ways in which they are interrelated and interdependent which uniquely describes an 'agricultural system'. The usefulness of this approach is evaluated in Chapter 11.

The categories are different in kind, particularly in the directness with which they can be recovered from the archaeological evidence. Some are, at least potentially, directly recoverable from the results of excavations of agricultural settlements, and others may be less directly inferred from the results of excavation and fieldwork. Others depend on assessment of a wider range of social and economic evidence from a variety of sources. The different natures of the categories reflect two underlying premises of this work - that an agricultural system is defined by its organisation as much as its practices, and that it can only be described adequately if it is described with reference to its social and economic context.

The eight elements of agricultural systems have been treated in two ways. The first three, the basic elements of agricultural practice and organisation, have been discussed in detail (Chapters 3-7). The emphasis is on arable production, with discussion of livestock restricted to aspects which are closely interrelated to the needs of cultivation. These subjects have been discussed in greater detail than originally intended; this is because existing syntheses of work in these areas mostly did not consider the questions considered important here, or else failed to provide an adequate basis for doing so.

The remaining elements form themes in the discussion of the details of agricultural practice, and in the discussion of the social and economic context of later prehistoric and Romano-British agriculture in Chapters 8 to 10. Again this is a reflection of the nature and quality of the evidence. It is difficult to relate agricultural developments to their economic context when there is still no consensus on such fundamental aspects as the economic role of hillforts or the development of the market economy. For the eighth category, the decision framework, fitting decision models to inadequate data seemed to be of doubtful value in terms of the insights into the functioning of agricultural systems which might be obtained. In addition, models of agricultural decision processes based in the individualistic context of peasant economies or in the context of contemporary industrialised agriculture seemed inadequate for the complexities of later prehistoric societies, where the evidence begins to suggest a hierarchy of decision making at individual and community levels may often have been characteristic. Yet some decision models provide useful insights into the problems of resource allocation faced, and for that reason they retain a place in this discussion.

The treatment given to the fourth aspect, population and labour, requires further comment. The population levels supportable and the labour inputs required are clearly important characteristics of an agricultural regime. And population growth can be both a cause and a result of agricultural change. But rather than consider population and labour as a separate topic in the same way as the three categories of agricultural practice, the present work instead draws attention to them as issues where they arise.

The reason for this is the rejection of a simple model of continuous population pressure as a 'prime mover' in agricultural change. If population pressure is to be invoked, it must be demonstrated to exist. This implies that a detailed reconstruction of population trends in later prehistoric and Roman Britain would be needed before discussion of the relationships between agricultural change and population densities for the period could be useful.

Although population growth is often taken as a major independent variable affecting agricultural systems (not least because of the influence of Boserup's (1965) model of agricultural change), the view taken here is that population itself is a variable dependent on socio-economic conditions. For population pressure to be taken as a major element in explaining agricultural change, population growth must first be demonstrated (and, indeed, explained).

This view is based on a number of factors which can only be briefly outlined here. Firstly, there is considerable evidence that human populations can and do limit their numbers when conditions demand. Much of this evidence derives from hunter-gatherer societies, and the higher birthrates seen in many agrarian societies have led writers (eg. Neel and Chagnon 1968,688) to suggest fundamentally different natality and mortality schedules for the two types of society. But as Dumond notes, it is not certain that unacculturated agriculturalists not subject to commercial and governmental pressures have similar high birthrates (1975,718).

Current high birthrates amongst agricultural communities in developing countries have to be seen in terms of the economic realities facing poor peasant farmers. The labour of children is often essential to family survival, as shown for example by White's work in Java (1975). Children may also be their parents' only hope of a secure old age (George 1976,59-61). This is the reason for the 'failure' of many family planning projects (Mamdani 1973).

A comparison of two agricultural societies in Thailand by Kundstadter (1972) provides an interesting example, suggesting that differences in the social organisation of agriculture led to a fertility differential. The Lua' live in permanent villages, and rights to cultivation are inherited and enforced; cultivation involves a fixed fallow scheme and re-use of the same areas in turn, with plots in use at a particular time grouped together. The Karen live in villages which often split to form new settlements, land rights are less rigidly controlled, and both new and isolated plots are frequently used. Although the two groups coexist within the same area, and until recently there was no real land shortage, the Lua' system of land use and rights leads to the perception that land is limited. The Lua' population is stable (achieved in part by migration) while the Karen population is growing. The average number of births is markedly different, 6.8 for Karen and 4.8 for Lua' women.

In the archaeological context, Cowgill has surveyed some estimates of population trends in pre-industrial food-producing populations, and concluded that they experienced considerable variation in growth rates, with long periods of "extremely slow or negligible growth, or even population decline, ... interspersed with surges of relatively rapid growth" (1975,511). He concluded that "steady population growth, or an insistent tendency towards growth, cannot be taken for granted" (ibid,513)

Hence an assumption that population growth formed a continuous backcloth to the later prehistoric and Roman period in Britain is unacceptable. For a detailed assessment of the role of population dynamics in later prehistoric and Romano-British agricultural development, a reliable estimate of population trends for the period would be essential. Although estimates of population sizes for individual sites are now an almost compulsory part of excavation reports, and estimates exist for a number of areas, the basis for a confident population profile of later prehistoric and Roman Britain still seems inadequate. One attempt to estimate prehistoric population levels (by Mercer, 1981) is discussed in Chapter 2. In the absence of data from burials due to the discontinuity in the later prehistoric burial record and the use of cremation in the later Iron Age and much of the Romano-British period, population estimates would need to be based on the settlement evidence. As excavated sites with good population size estimates accumulate and as the results of survey allow greater confidence to be placed in the recognised density of settlements of different periods and in comparisons between areas with different factors affecting site recognition, attempts to reach conclusions on population trends will become increasingly realistic and worthwhile. But to do so in the depth necessary to make a useful contribution to the debate about the role of population growth in agricultural change is beyond the scope of this thesis.

1.2. The chronological and geographic scope.

The initial intention was to concentrate on the period 100 BC to AD 100 in Britain, a period when agricultural change has either been assumed to have occurred as a direct result of the Roman Conquest (eg. Wacher 1978,106-7) or might be expected to have occurred because of economic changes during the period, possibly but not necessarily coincident with the Roman invasion.

The intention was however modified. The timespan has been greatly extended for a number of reasons. For some types of evidence, the scarcity of examples dated to the within the shorter period imply that a longer time scale is needed if change is to be recognised, and equally that evidence must at times be sought from a wider geographic area within northwest Europe. This is, for example, the case with ploughs and ploughing.

But the main reasons relate to the nature of change in the period. Despite recognition of agricultural changes in the later Iron Age and indeed a trend towards identifying changes previously assumed to be associated with 'Romanisation' as late Iron Age innovations, there remains an otherwise largely static picture of agriculture in the first millenium BC. This is because a number of important agricultural practices - notably the use of extensive field systems and systematic manuring - have been given an early date and then assumed to have continued virtually unchanged throughout. It seemed necessary to understand the nature of agricultural practice and organisation during the first millenium BC in order to evaluate the evidence for change towards its end. It is surely an important question whether changes identified in the later Iron Age followed 1500 years of essentially unchanging agricultural practice or should be seen in the context of an agricultural tradition incorporating experiment, modification and development.

At the other end of the timespan, during the Romano-British period, it seems possible that one major economic change, the development of a market economy, did not occur until around 200 AD (Hodder 1979; Crawford 1970). A number of the technological changes in Roman agriculture (as illustrated by finds of new tool types) similarly cannot be securely dated before the third or fourth centuries, at least at first sight. Concentration on the first century AD might therefore exclude much of the evidence for agricultural and socio-economic change in Roman Britain.

Detailed considerations of the evidence for agricultural practice - tools,crops, fertility maintenance and field systems - all suggest processes of development and change as features of the agriculture of the later prehistoric period. Changes in both practice and organisation may have significantly increased the productive potential of agriculture during this time (contra, for example, the static picture of agricultural potential envisaged by Mercer 1981). Some of these changes are more firmly attested in the evidence than others; the evidence is uneven and differing in nature, making comparisons difficult. The limited range of contexts from which the evidence derives, whether in chronological, geographic or social terms, is a recurring point.

This view of Iron Age agriculture and some of the conclusions reached also imply changes in the way earlier (Bronze Age) agriculture should be assessed, and this in turn has implications for reconstructions of Bronze Age populations, societies and economies. But this is beyond the scope of the present work.

1.3. Some models of agricultural decision and innovation processes.

This section outlines some simple models of the processes of decision making and innovation in the context of agricultural communities. The intention is to suggest some questions about later prehistoric and Romano-British agriculture and agricultural communities which may provide an insight into their functioning and the changes which occur in them.

1.3.1. Models of decision making in pre-industrial agriculture.

A variety of criteria can be used to reach decisions about the allocation of agricultural resources. Each results in a different pattern of use of the available land, labour and other inputs. Assessment of the criteria applicable in different situations can therefore be a key factor in understanding agricultural systems; it can also provide an indication of the potential for change within the existing context of land, technology, and labour. Three positions can be distinguished.

(i). The aim is to maximise profits. This is often stated more cautiously: pre-industrial traditional farmers behave as if they were maximising profits.

This view carries the assumption that continuity and tradition ensure that traditional agriculture is almost totally efficient, and knowledge virtually perfect ("the state of the arts is in fact known, established and given"). This equilibrium is disturbed only following major change, and the nature of traditional agriculture as defined implies the change originates externally to the agricultural system, for example resulting from economic or political upheaval, or natural disasters (Schultz 1964,30-2,36-41).

Decisions on this criteria can be modelled using Games Theory (Gould 1963,291-4), but although the solution derived should ensure long-term profit, the model does not take into account whether the farmer can withstand the effect of one or more disastrous years.

<u>(ii). The aim is to maximise security.</u> Here the best possible worst outcome to the farmer is selected.

This criterion is ultradefensive; where weather conditions and other uncertainties are fairly predictable, agriculturalists who could risk an occasional bad year would not need to be this conservative. The implications of security maximising differ greatly from those of profit maximising, as long-term overall production is not maximised, and may fall well short of the level achievable under the profit maximising criterion. If security can be provide by other means (storage or redistribution of food) there may be a substantial potential for increased production within existing technological and organisational constraints.

The security maximising criterion can also be modelled using Games Theory and the Wald minimax/maximin strategy (Found 1971,113-8).

(iii). Decisions are satisficing within bounded rationality.

Simon's (1957) model suggests that decisions are rational only in respect to simplified models of real world problems. Choices are also made within decision premises related to the individual's social role. Simon sees the decision maker, rather than estimating uncertainties, as taking corrective action in response to events. It can be suggested that this approach is readily applicable to societies where economic and non-economic behaviour are not necessarily closely differentiated. Unlike the first two criteria, this model does not result in a definitive solution, a single optimal decision. The question therefore arises as to whether it can be effectively implemented.

The satisficing model was developed further by Lipton in a discussion of Indian peasant agriculturalists. He concluded that each farmer tried to achieve a satisfactory outcome on several counts, and thus developed an individual "survival algorithm" - "a group of practices, a group of decisions about allocating farm resources, which allows him just tolerable levels of profit, security and status" (1968,438). Some important implications follow. There will be considerable and continuing differences in the way different farmers employ different resources, as although a problem has only one maximising solution, many learned or inherited survival algorithms can give satisfactory outcomes. In addition, individuals will attach different weight to security, status and profit in reaching their decisions. Once a set of practices providing a secure and tolerable outcome is reached, it will be highly stable, but even relatively small piecemeal changes could unbalance the whole. Farmers will therefore often be reluctant to risk innovation.

(iv). Some implications of these models.

The profit-maximising model and Schultz's comments on the nature of traditional agriculture seem to fit easily with the essentially static view of later prehistoric agriculture referred to above. This is perhaps especially so in the tendency to see change as a response to factors external to the agricultural sector, such as climatic change or 'Romanisation'. Well-documented cases of agricultural development originating within agrarian communities would suggest this model was not appropriate. Without provision for overcoming the effects of a disastrous harvest, fluctuations in food supply would have seriously affected social and population stability.

In contrast, one implication of the security maximising model is that there is potential for increased productivity within existing technological constraints. Ultradefensive security maximising criteria can be relaxed, if the need for security can be met on other ways. The introduction of effective long-term storage, or means of redistributing food to counter scarcity, would allow increased productivity. This could accommodate population growth or provide a greater surplus for use in other ways. Similar points apply to the security element in Lipton's satisficing model.

One strength of the satisficing model is its ability to allow for variation. Where differences can be recognised in the subsistence bases of agricultural settlements within a region and time period beyond those accountable for in terms of local environmental conditions, the concept of individual survival algorithms seems potentially very useful. It can also be applied to agricultural settlements of different social and economic status. Considering the differences in priority attached to the three criteria of status, security and profit might prove to be an important way of investigating variation between the agricultural regimes of different settlements, and the social and economic organisation of agrarian communities.

1.3.2. Models of innovation in agricultural societies.

The modelling of innovation processes has been usefully summarised by Spratt (1982). Innovation processes are described using both thermodynamic (describing the incentives) and kinetic models (describing the speed of the process and the factors controlling it). Spratt (ibid, 90-1) gives some examples of their application to technological innovation in agriculture. Two aspects of innovation processes are particularly interesting.

(i). Most innovations are initially 'uneconomical'.

There is an initial "negative cash flow", a period in which labour and resources invested outweigh the returns. Spratt (ibid,85) discusses the applicability of this concept to prehistory, and in particular distinguishes innovations which would consume few resources and whose labour needs could be met without detracting from normal subsistence activities from those innovations where the effort and resources put into development would interfere with subsistence activities. Understanding the factors which make the "negative cash flow" acceptable is important in understanding the innovation process. Even when a tool is introduced (imported) in a developed form, there can still be a period of investment in establishing production when there is a negative cash flow.

Spratt's discussion concentrates on returns to the producer rather than the advantages obtained by the user. But a new tool may have a similar period of poor return on investment for its user. Three reasons can be identified. It can be difficult to learn the use of a new tool. When first introduced, a tool may not be fully efficient; Further modification and improvement may be required. It may be possible to realise the potential advantages of a new tool only if other changes, in technology or the organisation of labour, can accompany it. All three factors are seen in, as a well described example, the adoption of the scythe for wheat harvesting in the nineteenth century AD (Perkins 1977,54-5,57,112-3,127,129, 130-1: Collins 1969,459). Similarly, Salisbury (1973,92) noted that four major technological innovations adopted after European contact in New Guinea were initially inefficient. Only a period of "political ferment" which masked this inefficiency, allowed them to continue in use until change in social organisation allowed them to be used efficiently.

An important implication is that many innovations cannot be seen in isolation. Their use forms part of a package of practices, some forming essential prerequisites for adoption, others following as consequences. These include changes in the organisation and socio-economic context of agriculture as well as its practices.

The use of these models is not restricted to tools; similar reasoning should be applicable to the development of agricultural techniques, if adequate evidence for the stages of their development and adoption can be identified. The question of the conditions under which a period of experimentation, risk and probable initial inefficiency and negative returns becomes acceptable or unavoidable may be fundamental in understanding agricultural change.

(ii). The social context of agricultural innovation.

It is probably unrealistic to expect that the six production-based stages of innovation specified by Spratt

(1982,80) will be readily identifiable in the archaeological record. One example is provided by van Ardsell's (1986) identification of five phases in the development of the manufacture of potin coins. However, Spratt (1982,90) noted the difficulty in establishing an adequate data base for studying innovation in prehistoric agricultural tools. It seems more realistic to aim to distinguish a phase of small-scale manufacture and trials and establishment of facilities and techniques of production during which a tool or technique might show signs of modification and development (corresponding to Spratt's development and investment phases) from a subsequent phase of general production, distribution and use of an established tool type or of widespread application of a technique. An unsuccessful innovation would not reach the second stage.

Cancian (1967) distinguished two user-based phases in the adoption of innovations which are perhaps broadly equivalent to these. In the first stage, innovation is risky to the user, as the costs and benefits are not fully understood. In the second stage of a successful innovation, the experience and knowledge obtained by stage one users means that the risks involved in adoption are greatly reduced.

Using seven studies of various kinds of innovation in agricultural communities, Cancian studied the relationship between social stratification and innovation, in terms of inclination to risk taking. He suggested two contrasting effects of wealth: an inhibiting effect, as the rich have more to lose, and a facilitating effect, as the rich can afford to acquire tools and skills. These produce opposite predictions of the relationship between wealth and innovation. Cancian's data however suggested that the relationship is not simple or linear.

Individuals in his high status group had a greater than expected tendency to innovate, which Cancian suggested could be seen as either because they need to innovate to maintain rank, or because they are high-ranking because of a continuing disposition to innovate. In the two middle rank groups, the inclination to risk was inversely proportional to wealth. The higher middle groups were conservative in the initial stages of innovation, but when risks were lowered, they were seen to adopt innovations at a greater rate than the facilitating effect alone would predict. For this group, wealth had an inhibiting effect in stage one and a facilitating effect in stage two.

The lowest ranking individuals were unlikely to risk innovation. Cancian suggested that while higher and middle ranking individuals risked loss of rank if innovation failed, the low ranked group faced "economic extinction" (1969,925).

Spratt (1982,86) considered that the means of communication of knowledge was not a significant factor impeding the spread of early innovations, such as the diffusion of ploughs in neolithic Europe. But at the level of the individual adopter, the ability to assess actual experience of earlier users appears to be a necessary feature of widespread adoption, at least among middle ranking social groups. As noted above, an innovation may require other technological or organisational change to render it fully efficient, and the introduction of these by early users will be an additional factor in reducing risks and increasing benefits to stage two adopters.

If from archaeological evidence, the introduction of new techniques, tools or crops can be associated with particular types of sites, this may provide an insight into the relationships between agricultural settlements and their relative status. Looking for other changes which might have reduced the risk implications or increased the efficiency of an innovation may also be valuable in explaining agricultural change.

1.3.3. Boserup's model of agricultural innovation.

In recent archaeological work, the most influential model of agricultural change has been Boserup's (1965) discussion of of the relationship between population and agricultural growth. Countering the Malthusian view that population size depends on the level of agricultural output (ie. on the food supply), she stressed the possibility of expanding agricultural production by increasing labour inputs (ibid,14). By defining the frequency of cultivation as the key element in agricultural systems (ibid,12-3), she asserts that it is "unrealistic" to view cultivation systems as "adaptations to different natural conditions". They "can be more plausibly explained as the result of differences in population densities" (ibid,117).

As population increases (and the causes of this are explicitly excluded from her discussion: ibid,14), the land must be cultivated more frequently. Initially labour inputs increase and its productivity diminishes, but the changed system of land use leads to developments in tools (land use systems and technology being closely inter-related; ibid,23) and in fertilising techniques (ibid,25). Displacement of activities previously carried out in fallow areas also creates "additional activities for which new tools and other investments are needed" (ibid,14). Ultimately productivity is improved by these developments. The availability of industrial inputs, especially chemical fertilisers, can be a key factor in allowing this where conditions would otherwise demand more extensive land use systems (ibid,114). Similarly, developments in non-agricultural activities allowing improved makes of tools to be obtained are crucial in realising the full potential of the changes (ibid,26-7,76).

There are some important criticisms of and limitations to Boserup's model. By excluding the causes of population growth from discussion, she overlooks the point that the labour demands of agriculture can form an important stimulus to population growth. This is particularly the case where the labour of children is essential to the survival of the household, as in many peasant agricultural societies (White 1975; Clark 1970, 226-7; Mamdani 1973,14,127). In a period of agricultural stress and population growth, it may not be clear which is cause and which effect; the two may reinforce each other in a circular process.

Other work, concentrated mostly in the humid tropics (Geertz 1963; Brookfield 1972: Vasey 1979), suggests Boserup's model is deficient because it fails to consider the constraints imposed by environmental factors. Vasey (1979,269) has suggested that intensification is "best understood in terms of ecologically optimal strategies at different population densities". A particular emphasis can be placed on the elasticity of agricultural systems - that is, on the variation in input levels they can tolerate, from the minimum needed to keep them running to the maximum where marginal returns are falling to zero (Brookfield 1972,34).

Another important aspect is Boserup's emphasis on the availability of industrial inputs, especially manufactured tools and fertilisers. Increased frequency of cultivation may not be viable, at least beyond the short term, without artificial fertilisers, especially as reducing the uncultivated land available for grazing may reduce the manures available. Without the availability of improved tools, agricultural development may not progress beyond the initial stage of increased labour inputs (1965,75-6,114). Agricultural change is thus linked to other socio-economic change, seen by Boserup in terms of the importance of developing urbanisation and improvements in administration and manufacturing technology, which she suggests may in turn result from increased population densities.

In the context of prehistoric societies, environmental constraints and the availability of techniques for maintaining fertility will require more specific consideration than is incorporated in Boserup's model, with its basis in present day world development issues.

Brookfield's discussion of intensification in Pacific agriculture offers an important extension to the consideration of these issues. Criticising the "long-lived calorific obsession" (1972,46) of many writers, he proposed that "a disaggregation of production into subsistence production, social production and trade or cash production" allows a "refinement of population-based theory" (ibid,31). He distinguishes a "surface" of subsistence needs, related closely to population levels, from the "superimposed surface of social needs" which may "deviate very substantially" from it (ibid,39). Social production will vary between cultures, and also between individuals depending on the priority they attach to seeking status and prestige (ibid,38: cf Lipton's survival algorithm, discussed in section 1.3.1.iii above.)

Cowgill (1975,514) suggests that agricultural development is more likely to occur in response to opportunities rather than the result of food scarcity, particularly because those most acutely affected by food scarcity are unlikely to be able to innovate (cf Cancian's discussion, see section 1.3.2.ii above). This response to opportunity is most likely when food can be converted into "something else", whether material goods or services, or "less tangible prestige or status or authority" acquired through the accumulation and redistribution of food or other items food can be used to acquire (ibid,516).

1.3.4. Intensification and agricultural change.

It is important to realise that not all agricultural innovation should be described as intensification. Intensification is best described as the substitution of inputs of capital, labour and skills for land (Brookfield 1972,31). Nor does all intensification involve innovation: increasing application of labour need not involve new techniques. Brookfield (1972,33-4) has contrasted the two approaches to stress: the continuing process of innovation described by Boserup and the cul-de-sac of agricultural involution described by Geertz (1963).

There seems to be value in distinguishing two types of agricultural change:

(i) Input intensification involves increasing the quantity of inputs, especially of labour, into an otherwise unchanged farming system. The system is then pushed towards its maximum inputs level (see discussion of Brookfield's flexibility concept above). Productivity is less important than overall production; increasing labour is implied but marginal returns diminish. It can be seen as the result of stress; population pressure would offer one explanation, but any increase in the productive demands made on agriculturalists (such as demands for payment of rents or taxes) in situations where expansion of the area cultivated was not an option would produce similar stresses. Agriculturalists in this position would be disadvantaged, and unlikely to be able to risk innovation.

In Boserup's model the adoption of more frequent cropping in response to stress is an example of input intensification. The development of improved techniques of fertility maintenance may follow the increased cropping (1965,25); but the initial change is a simple increase of inputs.

An archaeological example of input intensification could be the stress inferred by Cunliffe in the agriculture of downland areas in middle Iron Age Wessex, linking increasing population, the need to expand cultivation and increasing reliance on sheep for manuring in the face of soil deterioration (1984b,31). There is no suggestion of accompanying development of agricultural techniques, and the stress on the system therefore continues to grow.

(ii) Organisational change may involve change in the practice (tools or techniques) or the organisation of cultivation. It is a change in the nature of the agricultural system. It can be seen as a response to opportunity in situations where producers, or those taking the productive decisions, control the level of production. The changes may constitute intensification (increasing the productivity of land), but this is not necessarily the case. The innovations can be either labour-saving or output increasing, but labour-demanding (Simon 1978,167). Bronson (1972, 200-1) suggested that output-increasing innovations are more likely to be attractive where agricultural decisions are not taken by those actually doing the work; but where individuals can benefit from their increased productivity (cf. Cowgill 1975, 514-6, see section 1.3.3. above) they will also be an attractive. It is a key question whether this kind of change can also be an outcome of stress; Boserup's model clearly implies that significant change of this type follows on from input intensification.

Archaeologically, an example of this might be the introduction of extensive field systems. This clearly represents a change in the practice and organisation of agriculture, but their functioning is not well enough understood to say whether this represented an intensification of land use.

1.4. Models and questions.

These sections have outlined some models of agricultural decision making and innovation which it is hoped provide some insights into the functioning of later prehistoric and Romano-British agricultural systems and examining change in them. 'Agricultural practice' is the sum of innumerable decisions taken by individual farmers and farming communities, and the ways in which changes in circumstances affect the allocation of resources compose the relationship between cause and effect.

Questions relating to the role of security, status and profit recur in several of the models discussed above, in deciding the allocation of agricultural resources, determining levels of production, and in the ability and motivation to innovate. It can therefore be suggested they will be important issues in assessing the archaeological evidence for agriculture.

Security can be sought through both agricultural practice (risk-spreading agricultural decisions) and social mechanisms. While Colson (1979,21) has suggested that in general storage serves only to even out imbalances in food availability during the year, the evidence for large-scale and centralised storage during the Iron Age (Gent 1983) suggests it may have come to play a more significant role in providing security against annual fluctuations in yields. Gent's interpretation however suggests the appearance of centralised storage represents a response to stress rather than an increase in potential; he inferred that grain, "mobilized from subordinate settlements", was a "critical commodity if rising populations and climatic change combined to increase the risk attached to the cereal harvest" (ibid,243). His explanations can therefore be seen as either external to or independent of the social and economic basis of the Iron Age. The question whether storage is a response to stress or an increase in the potential of agricultural systems is surely crucial to understanding both Iron Age agriculture and Iron Age society in general.

Another question is the extent to which status derived from participation in or control over agricultural production or organisation. Cancian's work suggests this may be important in understanding innovation. The need to retain rank in agricultural societies where status relates to agricultural participation may be a spur to innovative practices. The higher than expected response in Cancian's second stage amongst the higher middle group may reflect their need to maintain status as new practices become established. The existence of extensive field systems and the concentration of storage on defensible sites in the later prehistoric period imply organisation of some form at the community rather than individual level. The nature of this organisation and its implications must be regarded as a key factor in understanding the agriculture practised in them.

This is a different question from that of profit; as the individual's opportunities for converting produce into money or valuables increase, the status derived from agriculture may in contrast diminish. The wealthier or more successful producers (or those able to mobilise the production of others) may cease to apply their surplus (product or labour) to acquiring status by meeting social obligations towards the needs of others (discussed in Chapter 8). This in turn has implications for security, if the unsuccessful can no longer expect aid from the successful. The successful have an incentive to increase their production further; the unsuccessful may be pushed towards increasingly conservative and security conscious farming. Haselgrove's (1982) suggestion that in the later Iron Age of southern Britain status derived from the manipulation of prestige goods implies this may have become an issue before the Roman conquest.

These questions of security status and profit are all closely related to the practice of agriculture through their effect on the numerous decisions which compose it, but they are inseparable from its social and economic context. The issues are developed in more detail in Chapters 8 to 10 below. These and the models discussed above were introduced here to help establish the theme running through the following discussion of agricultural practice, that is, that agricultural systems are defined by their organisation as well as their practice, and can only be adequately understood in their social and economic context.

Chapter 2.

Estimates and experiments: inferences about prehistoric agriculture.

Estimates of agricultural productivity and of population levels supportable have become a regular feature of excavation reports. The high yields achieved in experimental work at Butser have produced an optimistic approach to these questions; the contrast between these and the inferences of population stress and declining fertility and yields drawn by Cunliffe (1984b) is noted in Chapter 4. This chapter considers some of the estimates made and the conclusions drawn from the experimental data, and examines the way in which they were reached. The problems in using experimental and historical data in such assessments are discussed.

There are two main themes in this discussion. One is that assumptions about agricultural practice are often built into the estimates without being made explicit, and without the extent to which the archaeological evidence supports them being assessed. The second argues that the approach taken by writers such as Mercer (1981) tends to result in prehistoric agriculture being viewed in an essentially static way. This is perhaps a consequence of the first; where assumptions about aspects of agricultural practice are made but not defined, the possibility of change in those aspects is as a result effectively excluded from consideration.

2.1. Estimates of crop productivity.

2.1.1. The productivity of the 'celtic' field systems.

Mercer (1981) combined experimental results from Butser with data from a late nineteenth century agricultural notebook and other historical figures to derive a "brief indication of the volume of production within likely prehistoric farming systems" (ibid,231). He concluded, perhaps somewhat defensively, that

"... it will be possible to quarrel in detail with every figure ... either on specific grounds or on the general basis that a nineteenth-century source is not likely to reflect at all accurately upon prehistoric circumstances. However it would seem unlikely that any of the figures can be so badly awry that they will alter the order of magnitude of the conclusions." (ibid,236).

There are two reasons for considering Mercer's paper in detail here. There are some problems with the figure used, or more particularly in some of the assumptions underlying their use. The second reason is that the paper sidesteps some important questions about agriculture and agricultural changes, because of the essentially static way in which it views prehistoric agriculture. In doing so it loses the insights which could be derived from quantifying the possibilities.

Mercer's estimates are based on the farming of a field system "of apparently Middle Bronze Age date" near Segsbury. A area of fields of around 9km square is interpreted as five farms of 400-500 acres each, and it is the productive potential of one of these which is discussed. Recent work on these field systems has shown them to be predominantly Romano-British in date (Ford et al 1988); however this need not affect the present discussion.

Cereal crops are the first aspect considered, and Mercer assumes that two thirds of the land is under cultivation each year, with emmer. It is probably unlikely that only one crop would be grown, but in terms of these estimates, it has little effect on the conclusions. Clearly some assumption about the annually cultivated area is necessary, but this is itself an important variable in an agricultural system, and one which might well vary within the period of use of a field system. Changes in the way fertility is maintained, such as more or less reliance on manuring, fallowing or folding, could increase or decrease the relative proportions of cultivated and fallow land.

Mercer then uses the Butser emmer yields (from Reynolds 1981,Table 1) to calculate the average overall yield, the quantity of seed corn to be stored, and the quantity of grain available as food. The total yield is about 250 tonnes, which he reduces to 200 tonnes to allow for "spillage, rotting, disease etc.". The Butser average yield per seed for emmer is 30:1, and Mercer reduces this to 20:1, to allow for losses in storage. However by taking one twentieth of the 'after losses' yield as the basis for this calculation, Mercer in fact reduces the margins he has allowed for loss. If yield/seed figures are to be used for calculating the seed corn needed, the proportion must be taken of the total crop. 12.5 rather than 10 tonnes should be kept for seed. If the Butser yield figures are used, it seems more obvious to use the Butser sowing rate to calculate the seed corn needed for the area to be sown, and then allow for loss in storage.

Use of yield/seed figures can be misleading in other ways. An increase in seeding rate will, within limits, increase the yield/area achieved. But it usually simultaneously decreases the yield/seed. So if yield/seed figures are quoted, there will be an apparent decrease in productivity, although there has been an actual increase in production.

In addition, change in the techniques of cultivation may allow seeding rates to be reduced without cutting yields. In these circumstances, halving the seed could double the yield/seed ratio, but there need be no increase in production and the only gain might be the relatively small quantity of seed corn saved. This is important in using the figures achieved at Butser, because Reynolds applies highly intensive sowing and cultivation techniques (1981,108). If the seed had been broadcast instead of hoed in, even if yields were not reduced, the extra quantity of seed required would have at least halved the yield/seed ratio (Morton 1855,Vol.2,1146-7). Mercer's statement that McConnell's Agricultural Notebook gives a rate of 1 bushel per acre for broadcast wheat in October appears to be incorrect [Mercer cites the 1885 edition; I have checked the 1883 and 1904 editions]. It is explicit that this rate is for drilled crops. The figure for broadcast crops is 3 bushels/acre. In the mediaeval periods, when sowing rates were often too low for productive efficiency (Mate 1985,25-6; Brandon 1972,406-410), rates under 2 bushels/acre were still unusual (Brandon 1972,T.2).

The implications of this are that either sowing was labour intensive, as assumed in the Butser work, or that seeding rates were higher than Mercer assumed. The differences in labour inputs are substantial. Nineteenth century figures suggest an acre could be sown broadcast in 40 minutes (one sower, kept supplied with seed) and the seed covered by harrowing in an hour; hoeing seed into drills took 3½ to 4 man-days (10 hour day) per acre (McConnell 1883,31; Morton 1855, Vol.2,182). The time allowed by Columella for ploughing or harrowing in the sown seed is a quarter of a day per iugerum (ie. 2.5 acres or 1.0 ha per day), perhaps doubling in harder soils (XI.II.46; II.IV.8). With labour inputs at the level implied by hoeing-in, sowing (and the ploughing preceding it) would become as crucial a labour peak as harvesting, which Mercer (1981,233) takes to be the period determining the minimum population levels. Reynolds' assumption that sowing was this intensive may well be correct; but it is only an assumption, and its labour implications must be accepted. Practice may have changed during later prehistory, perhaps particularly if there were changes in the scale of cultivation (cf. Brandon's comments on an example of intensive small-scale cultivation in mediaeval France, utilizing low sowing and high manuring rates; 1972,407,410,).

If alternatively the seed was broadcast, good yields would have required the sowing rate to be at least tripled, and the amount of seed corn stored to be increased correspondingly.

Mercer's discussion of storage is interesting, not least because the produce of "apparently Middle Bronze Age" fields are stored, one page later, in Iron Age pits and 'four posters' (1981,231-2). The point is not frivolous; Mercer's comments on storage reflect his approach and the assumptions built into it. He is making, often implicitly, some specific assumptions on methods and intensity of cultivation. These are then related to the entire timespan from the middle Bronze Age (or even, his concluding paragraphs suggest, from the end of the Neolithic) to the end of the Iron Age. Mercer phrases his figures in terms of the 'potential' of farming practice, but affirms that the population figures he infers are "a logical sequitur" from the start of "widespread field system construction (c.2000 bc)" (ibid,236). The assumption that potentials must have been reached seems to underlie his comment that "extensive and consistent beef eating is the only possible route to a low population model for any period in British farming prehistory" (ibid,235).

It is the application of one set of production parameters in this way which is unsatisfactory. A comparison of intensive and less intensive systems would have more value is assessing the range of productivity within farming systems. It would also get away from the idea that there is _a_ prehistoric agriculture. The approach misleads because it does not suggest looking for development in the functioning of the agricultural systems, and in the technological and social contexts in which they operated.

The paper makes the apparent but implicit assumption that potential agricultural productivity is the major, and perhaps only, factor influencing population levels. Mercer estimates population levels by dividing the 190 tonnes of grain available as food by the average annual food requirement of a person. This produces a figure of 600 people, which would be reduced by other demands on the grain produced (eg. feeding livestock) and increased by the availability of other sources of food (such as animal products) (ibid,233). However, "a single year of disease or crop failure" would cause "widespread disease and death". Communities would therefore be volatile, and could decline within a single year (ibid,236).

To infer population levels which are supportable only in years of average or better yield seems unwise. Sharp population declines due to harvest failure would have social consequences as well as purely demographic ones. It is necessary to consider whether the understanding of later prehistoric society gained from other sources is compatible with volatile and hence inherently unstable communities.

2.1.2. Poor harvests and their implications.

One possible approach to this is to attempt to estimate the scale of the problem due to harvest fluctuations. The yield data from the mediaeval Winchester manors was used to examine the pattern of harvest failures. The data and discussion are given in the Appendix to this chapter. It is not suggested that yield figures etc are applicable to prehistory; crop species, technology and social conditions all vary. Climatic change will also affect the occurrence of harvest failures (see comments on the "Little Ice Age" of 1550-1700 in the Appendix). Nevertheless, the data give a pattern of yields, of average, abundant and poor harvests, in the context of pre-industrial agriculture in Britain.

Figure 2A.5 summarises the yields from four of the Winchester manors. The yield group in which the average yield falls is indicated. It is clear that there are a large number of years in which yields fall below average. 37% of the recorded harvests fell into groups defined as below average. A population which depended on average yields to feed itself would thus experience a shortfall almost two years in five. The yield data show a marked drop in the frequency of yields at what could be described as a 'cut-off' level (discussed in Appendix, section 2A.2). This concept could be used to distinguish harvests which were broadly satisfactory from those where serious shortage would result.

Rather than basing population estimates on average yields, using the 'cut-off' level as indicating the divide between adequate and inadequate harvests seems more realistic. The 'cut-off' level for the Winchester manors considered was close to 75% of the average yield/acre obtained. Unless a society is considered to have been very susceptible to food shortage, with the effects this must imply for its social and demographic stability, taking this figure as the distinction between satisfactory harvests and those causing considerable hardship seems more reasonable. The latter occurred in around 15% of harvests (one in seven years); two or more such failures in a row occurred about once in thirty years. It is not claimed that these proportions applied in later prehistory, but they probably give an indication of the likely scale of the problem. The question raised is how societies coped with these periodic harvest shortfalls.

Some factors related to agricultural practice would allow some measure of insurance against bad harvests. The Winchester yields allow some estimation of their likely effectiveness. Cultivation of more than one crop, particularly a spring and a winter sown variety, provides some insurance from below average harvests. But barley yields attained average levels in only a quarter of the years where wheat yields were below the 'cut-off' level. Cultivating legumes may have provided a greater degree of insurance; examination of price series data for the later fifteenth century showed that legume prices were average or lower in roughly half the years wheat prices were high (reflecting poor wheat harvests).

It seems that the capabilities of these methods are limited; cultivation of more than one cereal crop was not an effective defence against the very bad harvests, although legumes may have been more useful.

Comparing the occurrence of poor harvests on the four Winchester manors analysed suggests that some compensation for moderately poor harvests by exchange with other communities should often have been possible, but that the very poor years usually affected yields on all four manors.

Insurance against bad years may therefore have been largely dependent on social organisation rather than agricultural practice. An obvious possibility is storage of surplus product from years of abundance. Mercer's discussion of storage concentrated on the 5% of the grain required for seed, which he suggests was stored in pits (1981,232-3). Experimental work on pit storage has tended to emphasize their use for seed corn, with germination rates being a major concern (Reynolds 1974). It is therefore interesting to contrast this with Fenton's summary of ethnographic evidence from Africa, America and Central Europe. He concluded that:

"There is nowhere in the more recent literature a suggestion that seed-grain was stored in this way."

Pits were used as "a means of securing surplus crops for long periods", and also of concealing them (1983,586).

If this interpretation of pit storage was applied to later prehistory, its introduction would clearly be an important changing parameter in the relationship between agricultural productivity and population. Large-scale grain storage in pits would allow societies to cope with the years of inadequate harvests for which the insurance (risk-spreading) practices of the agricultural system itself were not sufficient. This sort of factor is central to considering population potentials; the difference between a society suffering severe food shortage once in every seven or so years and one which has the social and technological framework to overcome this must be important in demographic terms, as well as in terms of the social dislocation which would result.

This illustrates an important point about Mercer's estimates. For productive or population 'potentials' to be reached, certain conditions have to be met, and for estimates of this kind to be useful, these conditions need to be specified.

2.1.3. The use of experimental yield data: the figures from Butser.

Interpretation of the Butser figures also requires caution. Accepting Reynolds view of the labour intensive nature of Iron Age agriculture, there are still some factors which imply that the yields seen at Butser may not have been regularly achieved under real conditions. An important point is the question of scale. For good results, ploughing and sowing must take place when soil and weather conditions are right and in time for good germination and growth. This is easily accomplishable for a few experimental plots each season, but for a larger cultivated area it may be less possible. Ploughing and sowing may take place under less than ideal conditions, or at a later than optimum time. Additional seed may be needed to compensate, and yields may suffer. These factors are not necessarily readily assessed in experimental conditions.

A second point relates to recovery after bad seasons. Reynolds (1981,110) noted that spelt and emmer yields recovered entirely in 1980 after the bad harvest of 1979. But examination of the Winchester yields showed a detrimental effect on subsequent harvests. This could result from poor seed quality, reduction of sowing rates in response to shortage of grain, or indeed poor physical condition of workers and draught animals after a period of food shortage. Experimental work would not be likely to reflect such factors.

Determining how long adequate yield levels can be sustained is of course one of the major aims of the Butser experiments (Reynolds 1981,108-9). It is a problem which is sometimes underestimated in the 'optimistic' approaches to prehistoric agriculture. The Butser yields themselves have shown no sign so far of decline, fluctuations in yields of spelt and emmer for the continuously cropped Field II being attributable to weather conditions (Reynolds 1981,109). Yields in 1986 exceeded the averages for the period 1973-80 (Reynolds 1987,25). This field produced no crop due in 1987 to severe winter weather (Reynolds 1988,56). However the yield data are not yet fully published for the entire period of the experiment, and a longer run of years will probably be needed to isolate long-term trends.

Results of long-term experiments at Woburn and Rothamsted have also been influential, for example leading Rowley-Conwy (1981,90-1) to discount the importance of decline in cereal yields under continuous cultivation. However, although these experiments show that fields can continue to produce viable cereal crops over long periods, they also show quite clearly that yields do decline. It therefore seems useful to look at the ways in which yields change, under continuous cultivation and fallowing regimes.

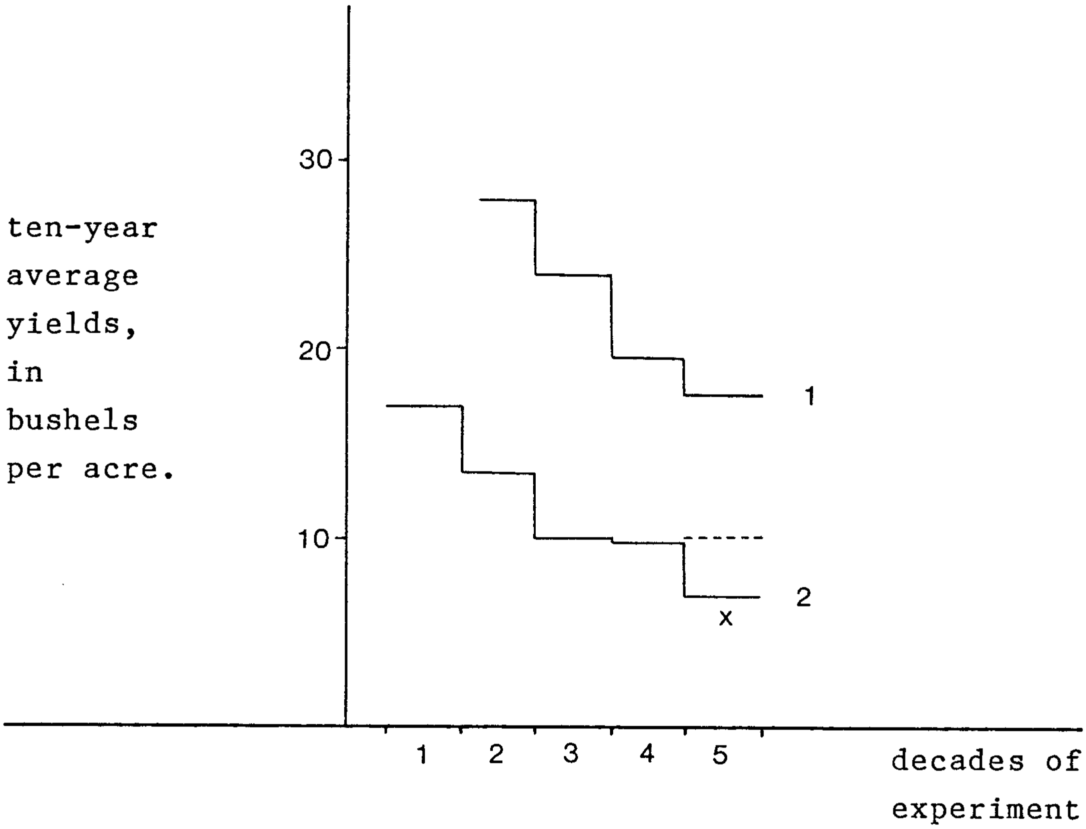
2.1.4. Long-term agricultural experiments.

(i). Continuous cropping.

Figure 2.1 summarises the result of long term experiments at Woburn. For the unmanured wheat plots, the yields fell over the first two decades, and then declined little further. They remained at around 60% of their original levels (Russell and Voelcker 1936,28-9). The barley also showed a similar pattern. Assessment of the results on manured plots was hampered by changes in the manuring rate during the experiment. Over the first thirty years, application of farmyard manures at 8 tonnes/acre prevented decline in yields (ibid, 148-9,256). Subsequent decline could have resulted from either soil change or reduced manuring; yields still remained good. The sentence quoted by Rowley-Conwy (1981,90) that yields can be maintained carries the qualification that "freedom from disease, suitable manuring and sufficient cultivation to keep down weeds" are essential (Russell and Voelcker 1936,237). It can be noted that chalk soils were singled out as areas where experiments in continuous cropping with wheat have proved unsuccessful because of disease levels (ibid,236-7).

Figure 2.1. Continuous cropping experiments at Woburn.

(a). Wheat.



Notes:

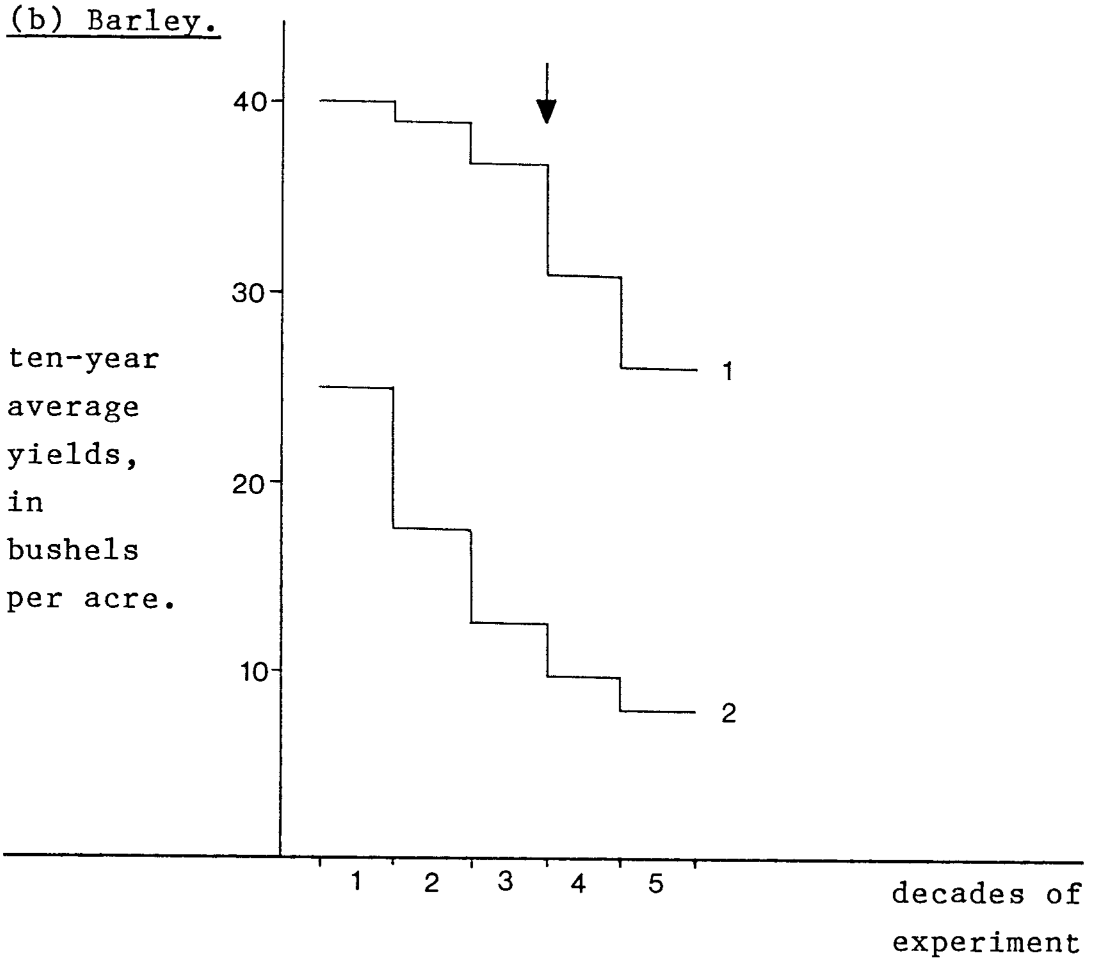
Notes:	1	Treated with farmyard manure.
	2	Unmanured.
	x	Sudden decline attributed to run of bad harvests, 1921-6.
	-----	Average yield for other years of fifth decade (ie. excluding 1921-6).
		Decrease in manuring rate.

Source: Russell and Voelcker 1936, 28-9,42-4.

(continues)

Figure 2.1. (continued).

(b) Barley.



Notes: 1 Treated with farmyard manure.

2 Unmanured.

↓ Decrease in manuring rate.

Source: Russell and Voelcker 1936, 46,52.

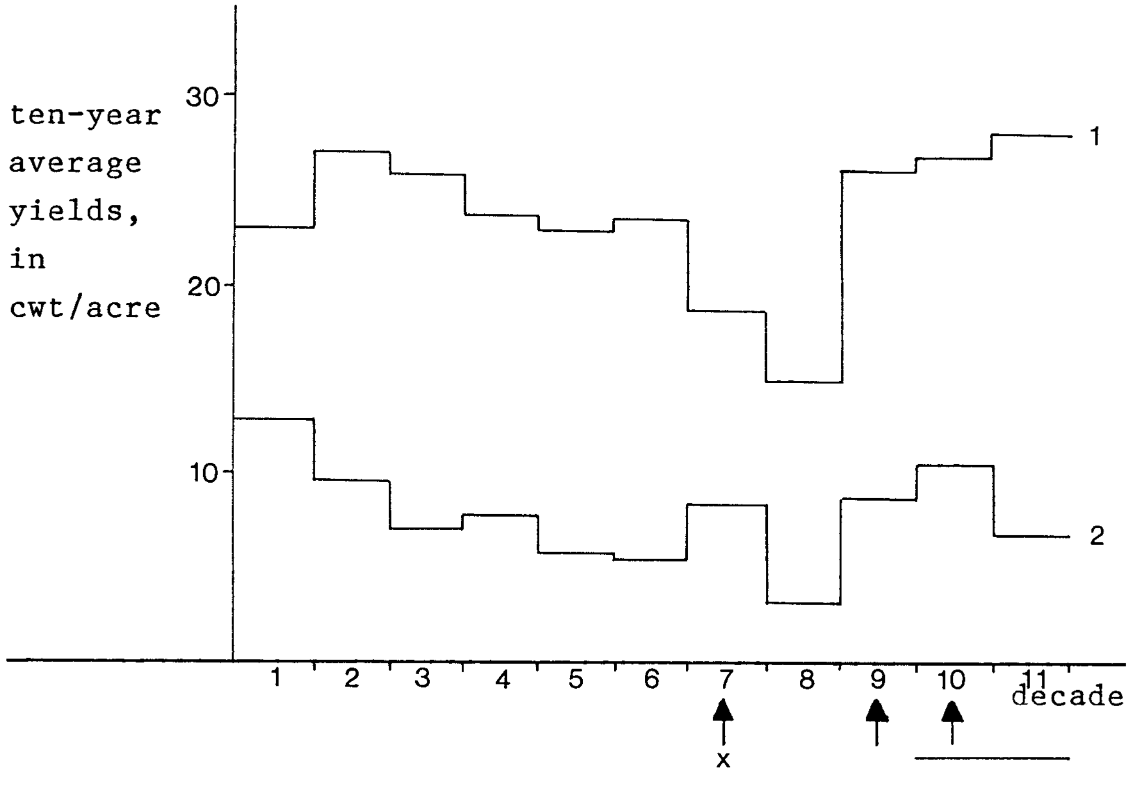
Weed control was a major problem in the experiments at Rothamsted. The continuous barley experiment at Hoosfield quoted by Rowley-Conwy may achieve its highest yields in its eleventh decade, but the introduction of chemical weedkillers and occasional fallow years was needed to bring this about. Even after a prolonged period of cultivation, a fallow year produces a marked increase in the subsequent year's yield (Russell and Voelcker 1936,249). It is only on the heavily manured plots (14 tons/acre) that the later yields exceed initial levels, although the effect on the unmanured plots of the fallow years and weed control is also marked (Rothamsted Experimental Station 1970,19-22; see Figure 2.2). The barley variety had been changed during the seventh decade.

The wheat experiment at Broadbalk was changed from continuous cropping to a fallow cycle largely because of weed control problems. The yields under continuous cultivation declined significantly. Regression analysis (used to avoid distortion of underlying trends by the occurrence of poor years due to annual weather variations etc.) showed that over 80 years the yields dropped to 80% and 50% of their initial levels on the manured and unmanured plots respectively (Rothamsted Experimental Station 1968, 41-2; see Figure 2.3). The decline in manured yields occurred despite manuring at the 14 tons/acre rate.

(ii). Fallow systems.

Although the classical Rothamsted experiments and many of those at Butser are based on continuous cultivation, cultivation systems incorporating some form of fallow or grass ley period are probably as important in agricultural prehistory. This is of course an assumption; early fields could have been in continuous use until either yields did decline disastrously, disease or weed infestation forced their abandonment, or non-agricultural factors intervened.

Figure 2.2. Continuous barley cultivation: The Hoosfield experiment, 1852-1961.

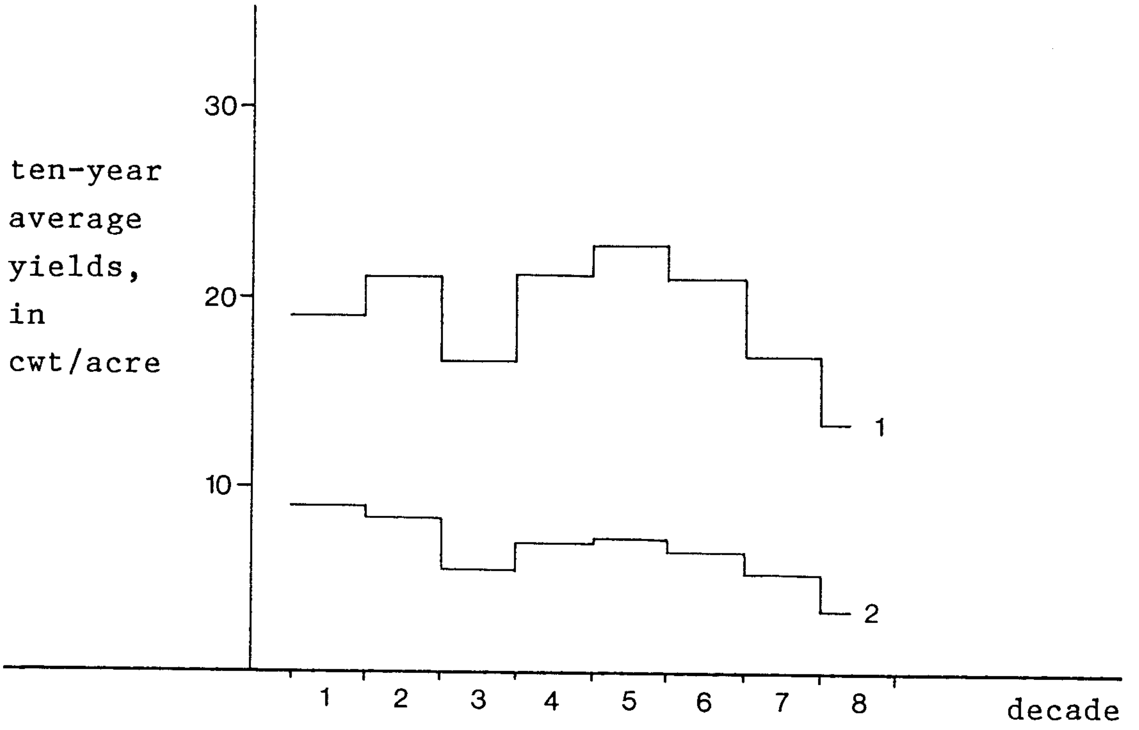


Notes:

1	farmyard manure at 14 tons/acre.
2	unmanured.
↑	decade include one year bare fallow.
——	use of chemical weedkillers.
x	change in barley variety grown.

Source: Rothamsted Experimental Station 1970, 19-22.

Figure 2.3. Continuous wheat cropping: the Broadbalk experiment 1852-1925.



Notes: 1 farmyard manure at 14 tons/acre.
2 unmanured.

Decline in yields: regression analyses.

Slow declines in yields were identified, based on calculations of linear regressions on time.

Treatment	Average yields: 1852-61	1922-5
manured	21.0	17.0
unmanured	8.6	4.4

The average yields in the last period of cultivation were therefore equivalent to 81% (manured plots) and 51% (unmanured plots) of those in the first period.

Source: Rothamsted Experimental Station 1968, T.3.16, 41-2

Fallowing is a specific agricultural technique, and the date of its introduction is unknown.

The Broadbalk wheat experiment was changed from continuous cropping to a five year fallow cycle. Yields increased markedly, by around 100% in the first and 50% in the third and fourth years after fallow (Rothamsted Experimental Station 1968,38-9,T.3.12). The yields in this thirty years were similar to those achieved in the first ten years of the continuous cropping period, and there was little evidence suggesting slow long-term changes in yields (ibid,42). In fact, results for the first three decades of fallowing showed a rise in average yields in each decade, perhaps not surprising as they followed after 80 years of continuous cultivation.

For one decade yields under fallow and continuous cropping (with herbicides) can be directly compared, as continuous cultivation was re-established in part of the field. The fallowed plots (unmanured and farmyard manure treatments) produced average yields of between 10 and 20% more than the continuous cultivation plots. However, because of the two fallow years, the per acre production of the continuous cultivation plots was from 2 to 9% more than that of the fallowed plots (ibid,40-1,T.3.14).

While the data on fallowing is not extensive, the Rothamsted results show that use of a fallow cycle enables yields to be kept high, with first year yields remaining close to initially achieved levels. While long-term decline was not detected, the fallow experiment followed 80 years continuous cultivation, and in other situations the result might have differed. The yields under continuous cropping in the decade where direct comparison was possible differed little from the yields of the fourth year of the fallow cycle. It seems possible that while fallow maintains first year yields close to original levels, any pattern of long term decline will be seen in the subsequent years of the cycle.

(iii). Grass leys.

Grass leys - periods in which cereal cultivation ceases and the land put to grass - are another means of maintaining fertility, and are presumably what Mercer meant when he suggested that the "fallow" portion of the land in his model could provide grazing for cattle. There have been ley-arable experiments at Rothamsted, but they offer little useful information in the present context. Leys were found to improve grain yields little in the subsequent year, compared with standard arable rotations (Boyd *et al* 1961). However, they were probably of greater value on soils less robust than those at Rothamsted, and in the absence of rotations including root crops. They are also valuable in reducing crop diseases (ibid,179), and in limiting soil erosion (Hodges and Arden-Clarke 1986,13-5).

The limited experimental data are disappointing because the nineteenth century sources are firm that "laying down land to grass is a means of improving its fertility, and of rendering it again fitted for the production of corn" (Sproule 1844,436). This was to be done before the soil was exhausted. Stevenson (1812,190-90) describes practice in Dorset. Winter wheat followed a summer of bare fallow, and was followed by one year of barley or oats, or by two years of barley then oats, before being sown with grass. The length of the ley depended on soil conditions, ranging from two to six years.

The ley was not usable continually for grazing. The grass was often intersown with the last cereal crop, and the stubble was lightly depastured by calves or sheep. Livestock were removed during the winter months to prevent damage to soil or plants. The grass was often cut for hay in its first season and depastured subsequently, though the last summer was usually bare fallow to control weeds.

2.1.5. Sustaining yield levels.

The long-term experimental data clearly indicate that yields must be expected to decline under continuous cultivation. On unmanured plots the figures suggest long-term yields of around half initial levels. Prehistoric crop varieties may prove to be more robust, and a longer run of data from Butser will be informative. Fallowing will allow yields to be kept close to initial levels in the first year of cultivation, but there may be gradual decline seen in the later years of the cycle. Grass leys will also maintain fertility, but will further reduce the proportion of time for which the land is cropped.

Manuring allowed the maintenance of yield levels, although a long-term decline was seen at Broadbalk. The heavy levels required (14 tons/acre) must be noted; the evidence for manuring discussed in Chapter 6 and for the management of livestock (Chapter 5) nowhere suggests that routine manuring at this level was achieved in later prehistoric or Roman Britain.

2.2. Estimating the role of livestock in the arable economy.

Mercer's model of agricultural productivity incorporated two notional herds of cattle, based on beef and dairy production, and assessed their fodder and grazing needs and food productivity. He notes that his "dairy/beef model based on an area of 150 acres could be run alongside the cereal economy ... on the ⅓ of the land left fallow ..." (1981,235). However a fallow field is not unimproved grassland and it certainly is not a hayfield. Stubble will provide some grazing, but livestock cannot be allowed to graze an arable field all winter because damage to soil will usually result. The discussion of grass leys above reinforces the point that establishing grass for grazing requires care. The likely need for bare fallow prior to sowing also limits the use of the fields for grazing. Without deliberate sowing and care of the grass, any grazing is likely to be poor.

The agricultural model could however provide fodder, as the straw of spelt and emmer are acceptable to livestock (Reynolds 1981,117). Chaff was regularly used as fodder in Roman Italy where hay was not available (Columella, VI.III.3) and straw if the chaff ran out (Pliny XVIII.LXXII). Because of the lower protein level of straw compared to hay, only a 'maintenance' diet would be available without some additional foodstuffs. Straw alone is insufficient for a cow in milk or a working ox (based on data given by McConnell 1904,266-277,281). There may be no need to 'balance' all the elements of the agricultural system within the area defined by fields; grazing land may have been available outside it.

The two aspects of livestock husbandry most directly related to the arable economy are draught power and the provision of manures.

2.2.1. Manure production.

Mercer commented that it is "quite clear ... that manuring was a consistent practice from at least the end of the third millenium bc.", and notes that the Butser results imply that yield levels might have been almost doubled by this practice (1981,233). The manuring rate at Butser is 10 tons/acre, below the 14 tons/acre needed to maintain yields at Woburn, but still a rate for which there is no strong evidence in prehistory. Translated into cows, the Butser rate implies each acre needs the product of about 1.4 animals, kept in a stall or yard throughout a six month period. [Nineteenth century figures suggest that with a good allowance of litter, cattle could be expected to produce seven or eight tons of manure a head over six months: McConnell 1896,66.] Mercer himself notes the "consistent and, perhaps significant, failure" to identify cattle shelters (1981,235); in this context, the potential yields under heavy manuring regimes are surely irrelevant. If increased recognition of cattle housing results from the use of techniques such as phosphate analysis, the position would be altered (see Chapter 5). But at present the best evidence for extensive housing (eg. at Cats Water), interestingly, comes from sites where cereal cultivation does not appear to have been an important element in the economy.

Scarcity of cattle housing is not confined to the Iron Age. Barker and Webley (1977,198) reconstructed an "integrated economy" dependent on the manure of 1000 head of cattle for the late Romano-British villa at Gatcombe, without any provision for housing or penning the livestock for manure collection being recognised. The cattle were assumed to be overwintered on ten smaller settlements on the wider villa estates - settlements whose contemporary existence "remains to be verified" (Branigan 1977,205-7). Accommodation on this scale (housing for 100 head of cattle) on small rural settlements would be unparalleled in Roman Britain. Elsewhere in southwest England, the scarcity of livestock housing at the rural settlement at Catsgore is one of the factors interpreted as indicating its dependency on a nearby villa (Leech 1982,36-9: see Chapter 5.3.2.ii). The assumptions of overwinter cattle housing and heavy manuring based on it cannot at present be justified from the evidence available.

A more detailed estimate of manuring practice, based on an interpretation of buildings in terms of livestock housing, is derived by Applebaum (1975) in his analysis of the economy of the Bignor villa. He used the manure production figures given by Columella as the basis of his estimates. Noting the high manure production figures for cattle (10 loads a month) he argued that load (vehes) implies a stretcher load of around 83 pounds rather than a cart load of around half a ton (ibid,127). Applebaum reached this figure by calculating the annual solid dung production of a cow, ignoring any litter component. This is erroneous on two counts; dung is not farmyard manure, and Pliny explicitly comments that if the 10 loads/month figure is not reached, "it would look as if the farmer had been slack in providing litter for his stock" (XVIII.LIII). [Both Columella (II.XIV.8) and Pliny adopt a high moral tone in discussing manure].

Columella is in fact specific that a vehes of manure contains 80 modii (XI.II.86). The figure is entirely consistent with other references to manuring rates in his work, such as the descriptions of muck spreading (II.V.1., II.XV.1,XV.II.86). There is no reason to prefer Applebaum's figure. The mosaic referred to by Applebaum (illustrated by White 1970, Fig.30) shows a stretcher load being carried out of a building; if it was manure,it was probably being carried from the stalls to the dungheap nearby (cf. Varro I.XXXVIII). In the nineteenth century a one horse cart load of manure was around 750 kg (McConnell 1904,70), and there is no reason to think a two ox cart could not carry 500 kg in the Roman period. Potts (1807,sv.'ox') notes that one ox with a light cart could pull a load of 750-1000 kg.

Columella's figures both for manure production and spreading rates are both very high. He argues strongly in favour of manuring, explicitly countering the "mistaken belief" that the earth had become barren with age, asserting it was rather due to "our own lack of energy that our cultivated lands yield us a less generous return" (II.I.2,7). However animals fed on bulky low grade fodders do produce more but poorer quality dung (Morton 1855,Vol.2,317-8), and shortage of animal manures may have led to the incorporation of a range of less valuable materials into the manures used (White 1970,129-133; Pliny XVIII.VI.54). Slicher van Bath noted that high manuring rates historically used in Silesia were due to the poor quality, and the large amount of added straw (1963,259). However it seems likely that Columella's figures are exaggerations, or perhaps statements of rarely attained ideals. Calculation of manure production rates is not straightforward (cf. McConnell 1896,65-6)

Applebaum used the figure of 83 lb a load and his estimated capacities for the livestock buildings to estimate the manure available for a year at Bignor. The quantities reached are 985 loads from sheep, 1,440 from oxen, 2,750 from cows and 12,000 from humans, from an estimated population of 100 people. In a footnote, Applebaum notes that colleagues had expressed doubts at the use of human sewage. There seems no reason to doubt this; it is recommended by Columella (II.XIV; I.VI.24) and Pliny (XVII.VI.51). What is surprising is the sheer quantity involved. A figure of Columella's is again the source: 10 loads per person per month is also to be expected. This works out at 28 lb. a person per day, again assuming Applebaum's 83 lb. load. [A 500kg load would imply 167 kg or 368 lb.] The figure is clearly wrong. In any case Applebaum has ignored Columella's statement that the ten loads/month include yard and building sweepings as well as excreta (II.XIV.8). Pliny, writing later than Columella and probably here as elsewhere in his work using Columella's writings as a source, omits this figure from his discussion of manuring (XVIII.LIII). In Applebaum's estimates, human excreta accounts for over two-thirds of the manure available at Bignor, so the error is important.

Three points can be made. First, Applebaum's calculations on manuring rates are based on a figure which is clearly incorrect, and should surely have been recognised as such. The arithmetic is meaningless unless the basic assumptions are sensible.

The second point relates to manuring levels. Applebaum derived an average manuring rate (28.3 cwt/acre; 1975,127) which is very low - probably so low as to be almost insignificant. Yet his approach, based on the evidence he infers for livestock housing, is inherently reasonable. The location of the buildings in an outer yard (ibid,Fig.1) supports their interpretation in this way (see Chapter 5; Bignor is exceptional in its evidence for livestock housing). The limited availability of animals manures calculated on the basis of the capacity of the buildings is notable; it totalled 5175 loads, or, at 500 kg a load, 2588 tonnes. Taking Applebaum's figures for annual acreage cultivated (400 to 500 acres), and his estimate of a load, the quantity is negligible, 191 tons or less than half a ton an acre annually. On the basis of a 500kg load, the total becomes 5 to 6½ tons/acre. The quantity is useful, but well below recently used levels, and it must be remembered that Columella's figures for manure production are almost certainly considerable overestimates. Recent and historical data suggest around 1 to 1.3 tons/month as likely rates for cattle (McConnell 1896,66; Slicher van Bath 1963,293), although Slicher van Bath cites one case where 3 to 4 tons per animal was recorded (ibid,256). Sheep produce about one tenth of the quantity (ibid,294), the same ratio as cited by Columella. Using Applebaum's figures (197 sheep housed for 7 months, 24 oxen housed all year, and 55 cows housed for 5 months) and these manure production figures gives an approximate total yield of between 800 and 900 tons/annum. This is barely two tons per acre.

The third point is the need to look critically at the source material (as of course Applebaum does in his reassessment of the vehes). Columella was optimistically advocating manuring, and countering views that soil decline was inevitable. The stress laid on the exploitation of a range of sources for animal and plant products for incorporating into manures (see Columella II.XIV.1-7; Pliny XVIII.V-VI.) itself suggests that obtaining an adequate supply was not easy. Although the high plant content of the manures - more properly described as composts (White 1970,129-133) - used in Roman Italy and the diet of the livestock may explain some of the discrepancy between Columella's targets and recent figures, there seems little doubt there was considerable exaggeration.

2.2.2. Draught animals.

Mercer noted that the need to transport the harvest "might well imply the existence of draught animals as, of course, might the initial task of ploughing" (1981,234). But while he estimates the value of herds as producers of beef and milk, their role as draught animals is unassessed. Given the nineteenth century figures of two to three man-weeks to dig even recently moved soil with iron spades (and twice as long for old grassland), the absence of draught animals would have an impressive effect on labour figures.

There are several ways in which the number of draught animals, presumed to be cattle, can be estimated. The three main ones are using recent historical data, using figures given by the Roman agronomists, and using recent experimental results.

(i). Recent historical figures.

Much of this relates to horses rather than oxen. Comparisons of the work rates of the two are available, although the picture is complicated by eighteenth and nineteenth century improvements in plough technology and the breeding of draught horses, which were not matched by improvement in draught oxen (Complete Farmer 1807, sv.'ox','plough'). The performance differential was therefore increasing during this period. The data relates to the use of heavy ploughs with teams of four or six oxen, which are slower to turn than experimental ards (taking 45 rather than 10 seconds: McConnell 1883,30; Fowler 1967,25).

An important point is that there were recognised limits to the length of day the oxen could work, and the number of weeks heavy working could be sustained for. A four ox team could plough an acre a day, and maintain this for 6 weeks. 200 acres of arable required 8 to 12 oxen (Dickson 1805,1131-2). An ox could work a seven hour day; this was sometimes split into two yokings (Naismith 1795,69-70).

(ii). Roman literary sources.

The Roman data relate to specific conditions of soil and climate different to those in Britain, and probably also to a different type of ard. The cattle in use may also have been larger; Columella (II.II.24) describes using smaller oxen and equipment as a false economy, as "the revenue in fruitfulness of crops outweighs the expense of buying heavier draught animals". Roman agricultural practice also meant that the land had already been broken and ploughed at least once prior to the pre-sowing ploughing (eg. Columella, II.IV.8,11; II.XII.8). During the limited sowing season when time and labour are critical, the ploughing would have been relatively easily performed. Nevertheless, the figures given do relate to real agricultural experience and a simple technological level, and they are valuable comparative data available for that reason.

The conventional figure given by the agronomists is that a 200 _iugera_ farm required 2 yokes of oxen, although it was recognised this varied with soil conditions (Varro XIX). This was for an entire farm under a variety of crops, and not an annual arable acreage of 200 _iugera_ (50 ha). The area of arable one yoke could be expected to prepare for cultivation in a year was given as 50 _iugera_ autumn sown (half for wheat and half, with less preparation needed, for legumes) and 15 _iugera_ of spring sown crops (Columella II.XII.7-8;II.XI.3) or 40 _iugera_ of easy land and 30 _iugera_ of hard land (Pliny XVIII.XLVIII.173). The figures are similar, allowing 65 to 70 _iugera_ (16.25 to 17.5 ha) per yoke per annum, split between the spring and winter sowing seasons. The time taken to plough one _iugerum_ was one to two days for the first ploughing, and two thirds to one day for reploughing.

There is clear concern for the limitations of the oxen; Pliny's specification of a fair days work explicitly states that work in excess of this is unfair to the oxen (XVIII.LXIX.178). It also limits the length of the furrow; Pliny (XVIII.III.9) and Columella (II.II.27) both state that any furrow length greater than 120 feet is harmful. This is a conventional figure, though it presumably derives from real practice. 120 feet is one _actus_, and a _iugerum_ is a rectangle with sides of one and two _actus_. It is interesting that an _actus_ is 35.5 m, and that a square field with this as its side would be 0.126 ha in area, very close to the 0.13 ha which Reynolds (1979,52) gives as the average size of a 'celtic field'. The capabilities of cattle may be an important limitation on field size.

(iii). Experimental data and estimates.

It has often been suggested that a typical prehistoric field could be cross-ploughed in one day. This conclusion was reached by both Fowler (1967,24-6) and

Lindquist (1974,29). The problem is that while Fowler's typical later prehistoric field was 0.4 ha in area, Lindquist's (based on the size of excavated fields in Gotland) at only 0.06 ha was only one sixth of the size.

Each estimate combines experimental speeds with patterns of excavated ploughmarks. It should be noted that Reynolds (1982,149-150) has asserted that these do not reflect normal ploughing practice, but 'rip-ploughing' to break grassland. However Nielsen (1970,1986) has identified ploughmarks at different levels in the soils at Store Vildmose, presumably representing the need for periodic deeper ploughing, and there seems to be no suggestion that differences in technique or spacing were identified.

Lindquist's rate appears to be too slow; he quotes a time of 2 minutes to plough a furrow 21 to 28 m long and to turn the plough, citing Hansen's experiments. However, Hansen states that a 30 m furrow took 25 to 30 seconds, without giving a turning time. Fowler (1967,25) gives an experimental turning time for an ard of 10 seconds, and a nineteenth century plough could be turned in 45.

Direct experimental work by Reynolds (1982,141-2) has shown that "given the right conditions for work" a "celtic type field" of about 0.2 ha (ie. the size Fowler regards as a typical later prehistoric field; 1981,214) can be ploughed in under 3 hours (on light chalk soils, with Donnerupland type ard). The average speed of the draught cattle was similar to that reached by contemporary Spanish cattle ploughing with a sole ard (the type probably used in Roman Italy). The cattle could work for 5 hours without a significant break for rest.

Questions unanswered by experimental work are those of scale (how long the work rate might be maintained) and the effects of adverse conditions during the ploughing seasons, or of food shortage on the animals.

(iv). The work rate of draught animals.

The figures derived experimentally can be compared with the Roman records. Reynolds' figures allow the ploughing of two 0.2 ha fields in a day, and applying Fowler's figures to a field that size produces a time of about 3.75 hours, and hence a similar daily total. This exceeds the Roman figures of 0.13 to 0.25 ha/day for the initial ploughing. But the experimental figures quoted relate to light sandy or chalk soils. The Roman figures relate to actual farming experience under a range of soil and other conditions and the Mediterranean climate. The difference could reflect the greater efficiency of the bow ard compared with the sole ard (although not all writers agree that the sole ard was used in Roman Italy; see Chapter 3).

Columella's figure of 50 iugera for the winter sown crops one yoke could plough for suggests that up to 50 days work was expected of the ox team at that season, the initial breaking having been carried out earlier. The early nineteenth century figure of 6 weeks sustained heavy work is similar, despite differences in plough type and team size. This can probably reasonably be taken to indicate the length of time a yoke could have been heavily worked in later prehistoric Britain. Assuming 40 to 50 days work, and 0.4 ha a day, one yoke could perhaps cultivate 16 to 20 ha in the winter season. On heavier soils, this must probably be halved.

Returning to Mercer's model, 330 acres sown in winter only would require 16 to 21 yoke of oxen, half as many if sowing was split between spring and summer. Using the Roman agronomists overall figures for the areas which could be cultivated annually using a single yoke of oxen (ie. ignoring the daily work rates etc. where differences have been shown to exist), the requirements would be very similar, at 19 to 20 yokes. Despite differences in conditions and techniques, the similar figures may reflect the similar capabilities of the working animals.

Mercer's notional farmers must therefore feed a minimum of 16 draught cattle, and the herd needed to ensure their replacement. Both his beef and dairy herds could produce 16 or more animals of three years or older. There is no reason why cows cannot plough; in fact Reynolds (1979,50) notes that cows are widely used for draught, and it was a common Roman practice (White 1970,278). Keeping non-breeding stock such as oxen is perhaps an indicator of the economic status of the farmer, and it would be interesting to know when this practice appeared, and if it can be linked to other aspects of the agrarian economy. But heavily worked cows cannot be expected to produce and rear successfully a calf a year (a optimistic figure anyway ?) or to keep good milk yields. The Roman agronomists recognised that a working cow had "the double burden of work and pregnancy" and recommended that working cows should calve only every second year, especially if fodder was scarce (Columella VI.XXIV.4; White 1970 277-8). A more realistic model for a herd of cattle that size in the context of an arable economy would be based on the need to ensure the availability of draught animals.

2.3. Conclusions.

This chapter has examined a few of the published estimates of the productivity of prehistoric and Romano-British agricultural systems, and in particular the estimates of the productive capacity of 'celtic' field systems derived by Mercer (1981). The importance of the Butser results in assessing the potential of prehistoric (and Romano-British; Scott 1983) agriculture is obvious. But their use is not straightforward, and an understanding of the constraints of real as opposed to experimental conditions and the likelihood of long-term changes is essential. The future full publication of the Butser results to date may begin to clarify the latter question, but a much longer series of results is likely to be needed before it is satisfactorily resolved.

The ability to sustain yield levels relates closely to the techniques used to maintain soil fertility. Caution is clearly needed in reaching estimates of the extent of Iron Age and Romano-British manuring practices, an issue also discussed above in Chapters 5 and 6. A realistic assessment of the quantity of manure an agricultural system could have generated is required before a rate of application is assumed. In terms of experimental evidence, the effects of different manuring regimes, especially at levels below recent recommendations, and of different fallowing or ley cycles, remain fundamental outstanding questions.

With manuring, as with other aspects of agricultural practice, the question is not simply one of potential, but also whether the conditions necessary to realise that potential were, or could be, met. The answer to this must be sought in the archaeological evidence for agricultural practice and organisation. Any quantification involves assumptions about agricultural practice, and these must be at the least specified, and their implications indicated, even (perhaps especially) if at present the evidence does not allow confidence in their validity.

Mercer concluded by asserting:

"Farming practice in British prehistory had the potential to support massive populations (... from at least the end of the Neolithic). ... As soon as we find our selves in the presence of widespread field system construction (c.2000bc) it would appear to the writer that these inferences or something of their order are a logical *sequitur*." (1981,236).

This conclusion should be viewed with some scepticism. Farming practice encompasses more than crops, and field systems can be a framework for a variety of agricultural and fertility maintenance regimes. Key factors, notably in the area of fertility maintenance and cropping regimes, remain poorly understood. And they form a crucial element in determining the potential of agricultural systems.

It has been argued in Chapter 7 that the extensive coaxial arable fields systems of the chalk downlands date from no earlier than the Iron Age, and recent work by Ford *et al* (1988) has shown the Segsbury systems themselves to be at least mostly Romano-British in date. The early coaxial systems are all interpreted as being concerned with the management of pasture, with early (middle Bronze Age) arable fields consisting of small groups clustered round settlements. The extensive arable systems appear to be a later (early Iron Age) development. This in itself casts doubts on the value of Mercer's conclusions, but the main argument against them is more fundamental.

By applying a single set of production parameters, Mercer's method effectively excludes the possibility of investigating change in the period. As evidence for agricultural practice is of little importance in his consideration of potentials, most changes in agricultural practice, however far reaching, would not affect his conclusions. Attempts to quantify the productivity of prehistoric and Romano-British agricultural systems and to assess the constraints under which they operated are undoubtedly valuable. But later prehistoric agriculture was not static - attempts at quantification which do not take this into account are unrealistic, and ultimately will tend to obscure the important questions about agricultural and population dynamics.

Chapter 2, Appendix.
The pattern of poor harvests: inferences from mediaeval yield data.

Estimates of prehistoric population sizes are often based on estimates of agricultural productivity under average yield conditions, and accompanied by caveats of the type "a single year of disease or crop failure ... would spell appalling hardship heralding widespread disease and death" (Mercer 1981,236). It is therefore of obvious interest to consider how the occurrence of harvest failures might be taken into account. To do this it is necessary to investigate the pattern of crop failures in pre-industrial agriculture, and to see if any generalisations can be made.

The most appropriate data seem to be English mediaeval yield figures. Although there are reasons for not using actual yield figures from this period as bases for estimates of prehistoric productivity, the pattern of good and bad years may still be informative, and the data are arguably the most relevant available.

Two sets of figures are examined. The first is an analysis of harvest qualities from the late mediaeval period, 1465-1634, by Harrison (1971). These have the disadvantage that they are derived from recorded prices, and there is therefore difficulty in interpreting them in terms of actual yields. As the figures used were average annual prices, regional variations will be concealed, and the patterns may well differ from those experienced by individual agricultural communities. However the period includes part of the "Little Ice Age" of 1550-1700, and therefore offers the opportunity to consider the effect of climatic deterioration on harvest patterns.

The second series is the yields of the Winchester manors for 1209-1349 (Titow 1972). As these are yields for individual manors, they may allow the identification of patterns which would be masked in national or regional averages. They are also actual yield figures, although it must be remembered that they originate solely in one particular sector of the mediaeval agricultural economy.

2A.1. English harvest qualities, 1465-1634.

Harrison (1971) used average annual grain prices to estimate the quality of harvests for wheat, oats, barley and all grains taken together. The criterion used was the percentage difference between the annual price and the 31 year moving average price, which was taken as the price which would have applied if yields had been average in that year. The harvests were classed into six groups: abundant, good, average, deficient, bad, and dearth.

In this discussion the harvest qualities and the effects of climatic change are considered first for the all grains classification, and then some comparisons between the grains are made. There is a large gap in the price series for barley; this is particularly unfortunate since barley was the main bread grain of the poorer people (Everitt 1967,450)

The all grains harvest qualities were summarised by Harrison (ibid, T.II) and are shown in Figures 2A.1 and 2A.2. Roughly 2/5 of the harvests were classed as above average, 2/5 as average and 1/5 as poor (below average). There were nine groups of poor harvests (defined as being separated by five or more years of average or better harvests). These consisted of two single years, three small runs (of two or three years) and four longer periods where the poor harvests were separated by up to three years of average or better harvests. These groups contained 3/4, 6/9, 7/12 and 8/16 poor years respectively.

Figure 2A.1.

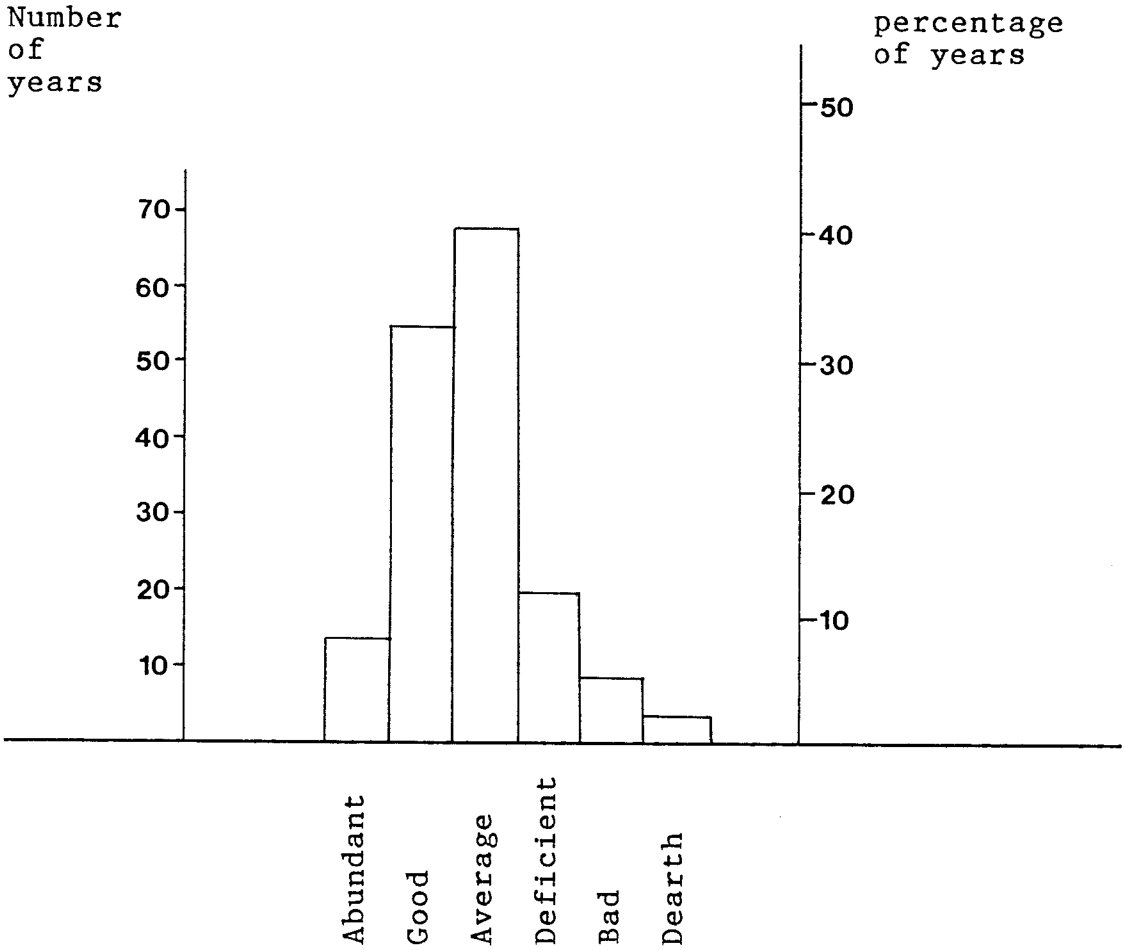
Harvest qualities, 1465-1634: All grains.

Data from Harrison 1971, Appendix II.

Figure 2A.2.

Harvest qualities 1465-1634: all grains.

Source: Harrison 1971, Appendix II.



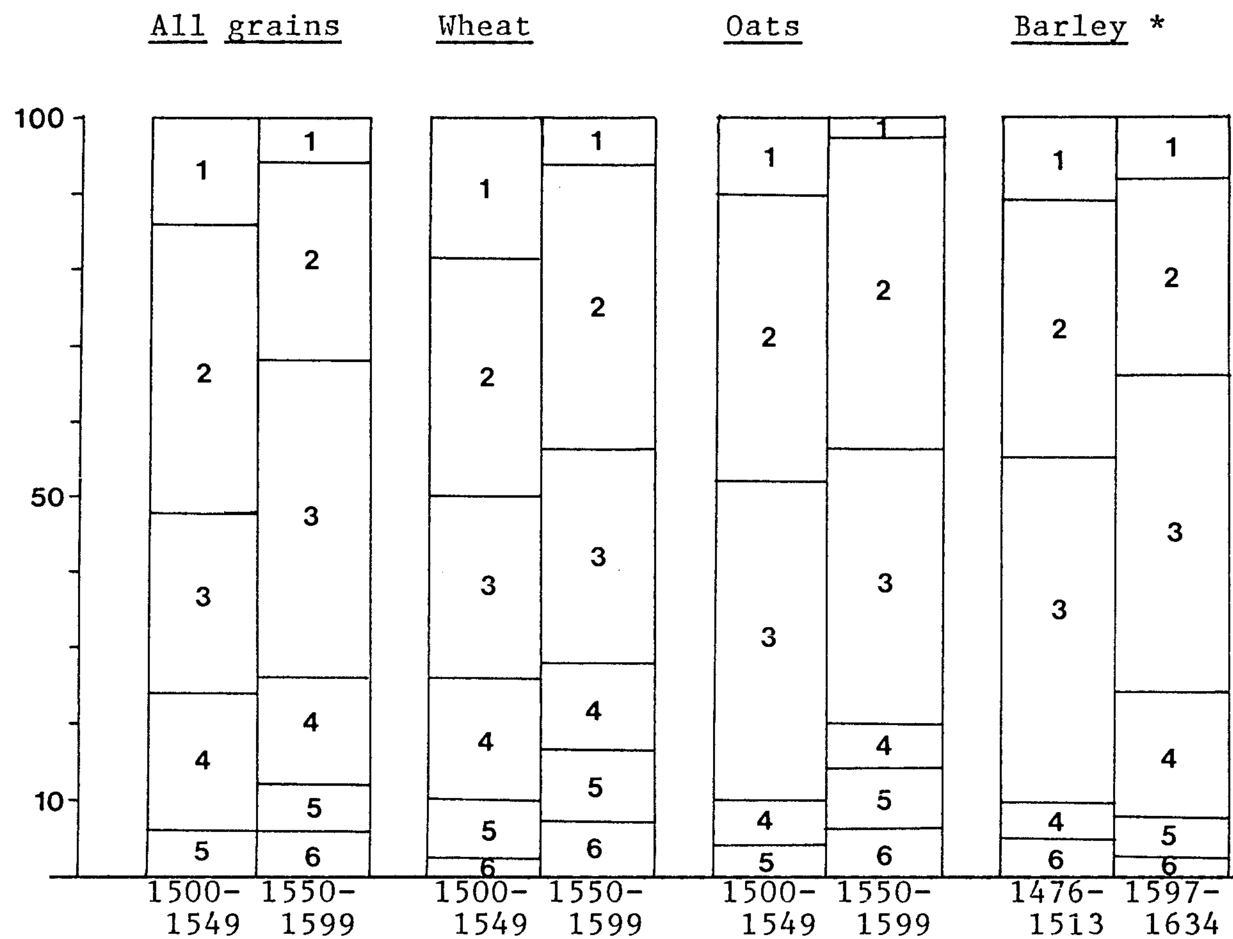
Harrison (ibid,144) used a comparison of all grains harvests from 1480 to 1549 and 1550 to 1619 to see if any effects on yields attributable to the "Little Ice Age" could be detected. This period is believed to have seen a decline in average temperatures. Although overall rainfall was less, the dryness was noted especially in winter, and summers tended to be wetter. The period 1500 to 1550 was in contrast apparently one of mild winters (Lamb 1966, 181-3,192). Although Titow (1972,24) has drawn attention to the danger of circular argument in using climatic records derived from documentary sources (as Lamb's are) to explain yield variations, ice core analysis also indicates a period of declining temperatures from the mid sixteenth century (Johnsen et al 1970).

Analysis of wheat yields by Hoskins (1964,30) had failed to show any evidence for worsening climate, and he suggested that there was increased perception of worse harvests in the later sixteenth century due to the political situation. But Harrison's analysis of the all grains harvest qualities did give "some support" to the climatic change theory.

Figure 2A.3 compares the two halves of the sixteenth century, for all grains and the three crops separately. For the all grains harvests, there are two main features. A marked drop in above average harvests, especially 'abundant' ones, was accompanied by a corresponding increase in 'average' years. There was no significant increase in poor years, but the number of 'dearth' years increased; that is , although there were no more poor years, these tended to be worse than in the previous half century.

For the grains separately, the results interestingly are different. For wheat and oats the increase in 'dearth' and decrease in 'abundant' categories are similar to the all grains. But the sharp decline in above average

Figure 2A.3. Harvest classification and the "little Ice Age". Percentage of harvests in each quality classification, 1500-1549 and 1550-1599.



* there are no harvest quality estimates for barley for 1514 to 1596

Abundant	1
Good	2
Average	3
Deficient	4
Bad	5
Dearth	6

<u>Source of data:</u>
Harrison 1971, Appendix II.

harvests did not occur. Wheat, like all grains, showed little increase in below average harvests, but for oats and barley the number of these doubled. This may reflect the practice of growing oats and barley in poorer soils (Thirsk 1967). The decline in yields identified on the Winchester manors in the later thirteenth century was also more marked in oats and barley, and Titow (1972,32) quotes Rothamsted experiments which indicated that barley reacted more rapidly than wheat in conditions of soil impoverishment. This might underlie Pliny's comment that if the land cannot be manured, wheat should be cultivated in preference to barley (XVIII.LII.192).

The different pattern in the all grain data may be due to economic factors (it must be remembered that the harvest classifications are based on prices not yields) or to agricultural factors such as the extent to which yields of one grain crop can compensate for poor harvests in another.

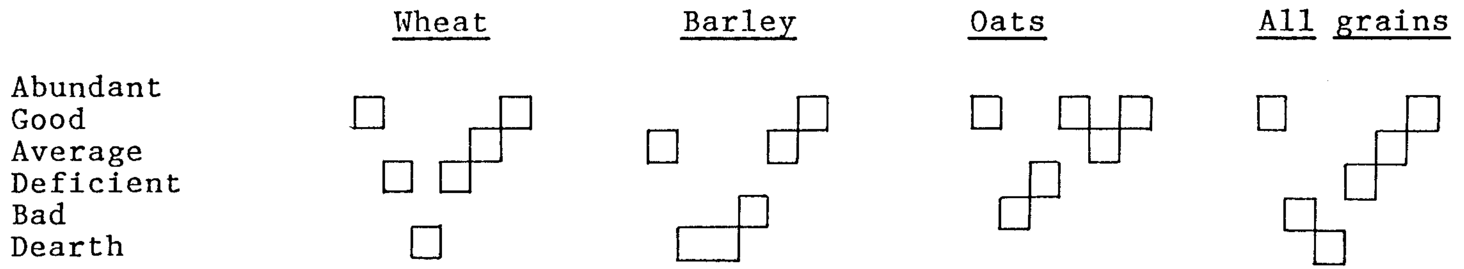
Because the estimates are based on price, the classifications for different grains will not be wholly independent, as a shortage in one grain can be expected to result in raised prices for the others as well as itself. However, Harrison (1971,188) concluded Hoskins (1964,40, Fig.III) was wrong in assuming that wheat prices closely reflected other food prices, and the extent of the interdependence of the grain prices remains unclear.

Harrison's data (ibid, Appendix II) show that in some years, harvests were apparently poor in all crops, but in others only one crop performed badly. Figure 2A.4 showstwo examples. In the first, the periods of poor crops and recovery are similar, while in the second the poor wheat harvests are accompanied by average barley and oats, and the poor year for barley and oats were average for wheat.

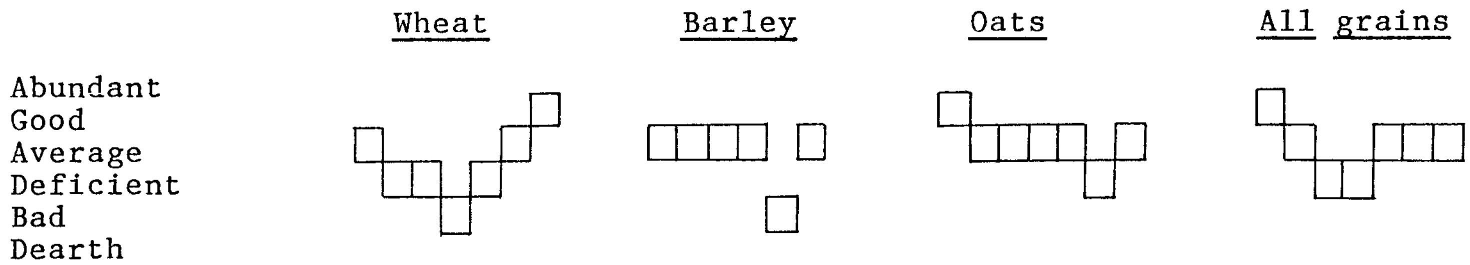
Figure 2A.4.
Harvest qualities 1465-1634: Comparison of two periods of below average harvests.

Source: Harrison 1971, Appendix II.

(i). 1480-1485.



(ii). 1499-1505.



However, very poor harvests seem to affect all crops. Where the harvest for one grain is classed as 'dearth', the other two are never better than deficient (but the non-independence of the prices must be remembered). Although a harvest classed as 'bad' is rarely accompanied by a 'good' harvest in another (5 occurrences in 26 years), it is often accompanied by an 'average' harvest in another (16 occurrences). This is shown in Table 2A.1. [Data for barley are not available for part of the period.]

The wheat harvest was below average for 37 out of 170 years (22%). In about half the cases where the wheat harvest was 'deficient', the other crops compensated sufficiently to result in an all grains classification of 'average' (Table 2A.2). This was the case in less than a fifth of 'bad' wheat harvests. Of the 11 'bad' wheat harvests, 7 were accompanied by 'average' or better harvests in oats (and where data was available, also in barley), resulting in an overall picture no worse than 'deficient'. In the other four, the oats harvests were 'deficient' or worse, resulting in all grains classifications of 'bad' or 'dearth'. taking the 'bad' and 'dearth' wheat harvests together, 9 were accompanied by poor harvests in oats (and barley where known), 7 by 'average' or 'good' harvests in the other grains. But of the latter, in only two years did the other cereals compensate for poor wheat harvests sufficiently to result in an 'average' all grains classification.

The leguminous crops may also have played an important role in spreading the risk of food shortage due to harvest failure, especially since they are affected differently to cereals by summer weather (see Tables 4.1 and 4.2). Unfortunately data on legume yields are scarce, and Harrison's analysis does not include them.

Table 2A.1
Occurrence of 'Dearth' and 'Bad' harvests, 1465-1634.

1. Harvests classed as 'Dearth'.

Year	Wheat	Barley	Oats	All grains
1481	d	*	x	x
1482	*	*	d	*
1527	*	-	x	x
1550	d	-	*	x
1555	x	-	d	*
1556	*	-	*	*
1596	*	-	*	*
1597	*	x	d	x
1630	x	*	x	x

2. Harvests classed as 'Bad'.

Year	Wheat	Barley	Oats	All grains
1465	g	x	a	a
1481	d	*	x	x
1483	d	x	g	d
1488	a	a	x	a
1492	g	a	x	a
1502	x	a	a	d
1504	a	x	d	a
1517	g	-	x	a
1520	x	-	d	x
1521	d	-	a	x
1527	*	-	x	x
1535	x	-	a	d
1550	d	-	*	x
1551	x	-	a	d
1554	a	-	x	d
1555	x	-	d	*
1562	x	-	a	a
1586	x	-	x	x
1590	a	-	x	d
1594	d	-	x	d
1595	x	-	a	d
1597	*	x	d	x
1600	a	x	x	x
1608	x	g	a	a
1615	a	a	x	d
1630	x	*	x	x

Key:
* dearth — a average — - no information
x bad — g good
d deficient

Source of data: Harrison 1971, Appendix II.

Table 2A.2.

Performance of other grain crops in years of poor wheat harvests, 1465-1634.

Class of wheat harvest.	Class of other harvests	No. of occurrences: Barley*	Oats	All grains
Deficient (total 22)	Abundant	0	0	0
	Good	4	7	1
	Average	5	11	11
	Deficient	1	1	7
	Bad	1	2	3
	Dearth	1	1	0
Bad (total 11)	Abundant	0	0	0
	Good	1	0	0
	Average	1	7	2
	Deficient	0	2	5
	Bad	0	2	3
	Dearth	1	0	0
Dearth (total 5)	Abundant	0	0	0
	Good	0	0	0
	Average	0	0	0
	Deficient	0	2	0
	Bad	1	1	2
	Dearth	1	2	3

* data for barley is incomplete.

Source of data: Harrison 1971, Appendix II.

Occurrence of below average harvest qualities, 1465-1634.

Crop	Wheat	Barley	Oats	All grains*
harvests recorded	170	87	170	170
all harvests below average	38 22%	14 16%	25 15%	33 19%
'deficient' harvests	22 13%	6 7%	10 6%	20 12%
'bad' or 'dearth' harvests	16 9%	8 9%	15 9%	13 8%

* does not include barley for all years.

Table 2A.3 shows a simplified list of price fluctuations in the period 1450-1499 AD for England and Wales, taken from Bowden (1967). The problems in using price tables as an indicator of harvest qualities were discussed above, and only limited inferences can be drawn because of the nature of the data and the problems in interpreting it. By using a crude price-based definition of harvests as average, above average or below average, it can be seen that the cereals and legumes fell into different categories roughly half of the time, with the divergence between wheat and beans being the most marked. Interestingly, the harvest qualities for peas and beans differed much more often than they agreed (20:12), perhaps reflecting their different soil preferences (Thirsk 1967,171). About half the poor wheat harvests (ie. the years of high wheat prices) were accompanied by average or lower pea or bean prices; for the small number (8) of these for which price data for both peas and beans is available, half (4) had average or lower prices for both, and only one had above average prices for both (Table 2A.4). The cautious suggestion is therefore that in roughly half the years with poor wheat harvests, the legume crops may have been unaffected by the conditions which reduced the wheat yields, and in at least some of the cases above average pea and bean yields may have helped compensate for the poor wheat crop. In contrast, above average wheat prices were never accompanied by below average "all grain" prices.

2A.2. The Winchester yields, 1283-1349.

Data from the Winchester manors (Titow 1972) were used to investigate the pattern of harvests experienced by individual communities. Because of substantial gaps in the earlier part of the series of figures, the years 1283 to 1349 only were considered; the period contained about 50 recorded harvests for each manor. The period included

Table 2A.3. Comparisons of cereal and legume yields.
Price fluctuations of crops 1450-1499 (England and Wales).

Year	Wheat	All grains	Peas	Beans
1450	+	+	-	+
1	+	a	-	a
2	a	a	-	a
3	-	a	a	a
4	-	-	-	/
5	a	a	-	/
6	-	-	-	a
7	+	a	-	a
8	a	a	-	/
9	a	a	a	a
1460	+	+	+	/
1	+	+	a	/
2	-	-	-	a
3	-	-	-	a
4	-	a	+	a
5	-	a	a	+
6	a	a	a	-
7	a	a	a	a
8	+	a	-	-
9	+	a	+	a
1470	+	+	+	/
1	+	a	+	/
2	-	-	-	/
3	-	-	a	a
4	-	-	a	/
5	-	-	-	a
6	-	-	+	-
7	+	a	/	/
8	+	a	a	a
9	a	-	+	a
1480	a	a	/	+
1	+	+	+	+
2	+	+	+	/
3	+	+	/	/
4	a	a	+	a
5	-	-	a	/
6	a	+	a	/
7	a	+	-	/
8	a	+	a	+
9	a	a	-	a
1490	+	+	+	/
1	a	a	a	-
2	-	+	/	/
3	-	-	-	-
4	-	-	-	-
5	-	-	+	a
6	a	a	-	-
7	a	a	-	-
8	a	a	+	+
9	-	-	a	+

Table 2A.3., continued.

Summary of comparisons.

CROPS	C	D	X	Total
Wheat and all grains	35	14	1	50
All grains and peas	20	21	5	46
All grains and beans	17	15	1	33
Wheat and peas	21	18	7	46
Wheat and beans	11	19	3	33
Peas and beans	12	18	2	32
As %:				
Wheat and all grains	70	28	2	
All grains and peas	43	47	11	
All grains and beans	52	45	3	
Wheat and peas	47	39	15	
Wheat and beans	33	58	9	
Peas and beans	38	56	6	

Notes:

1. The aim of this table is to allow comparisons between the harvest qualities of cereal and leguminous crops.

2. The crop prices were classed as follows:
   + above average: price 110% or more of average.
   a average: price 90 to 109% of the average price for the period 1450-1499.
   - below average: price below 90% of average.

3. The comparisons are classed as follows:
C crop price classifications coincide
D crop price classifications differ, but excluding
X an above average price in one crop is accompanied by a below average price in the other.

4. The data were incomplete, so the numbers of possible comparisons vary.

5. Source of data: Bowden 1967, Statistical Appendix Table 1, 815-7.

Table 2A.4.

Pea and bean harvests in years of poor wheat harvests.

Number of below average wheat harvests: 15.

13 of these have price data for legumes:

	peas	beans
years with data	13	7
prices above average	7	2
prices average	2	4
prices below average	4	1

7 have data for peas and beans:

prices of both above average		1
price of one average:	one above average	1
	the other average	1
	one below average	3
price of both below average		1

Years with either peas or beans prices average or lower: 7

Comparison with all grains prices:

all grains prices above average:	8
all grains prices average:	7
all grains prices below average:	0

Source: data from Bowden 1967; see Table 2A.3. above.

three years of national harvest failure and famine, 1315-6 and 1321 (Platt 1978,96).

Four manors were selected for examination. Only manors for which yield/acre as well as yield/seed figures were available were included. One manor was taken from each of the three main patterns of productivity changes between 1209 and 1349 identified by Titow, and the fourth was from a group of small manors with high productivity (Titow 1972,14-5,32-3). Where more than one manor satisfied the criteria, the first one in Hampshire on Titow's list was taken.

The analysis concentrated on the wheat yields. Grouped data was used throughout. Figure 2A.5 shows the number of years in each yield group for each manor, with the group in which the average yield falls indicated. The interesting feature of these figures is the sharp decline in the number of years as the yield levels decrease. There is a marked 'cut-off', with a relatively small number of harvests yielding less than it. This is one place where the use of grouped data is significant, as the exact position of the identified 'cut-off' depends on how the data were grouped. But the drop itself is clearly real. The yields defined as 'below cut-off' are indicated on the figure; they are the exceptionally bad yields and will be considered separately from other below average yields.

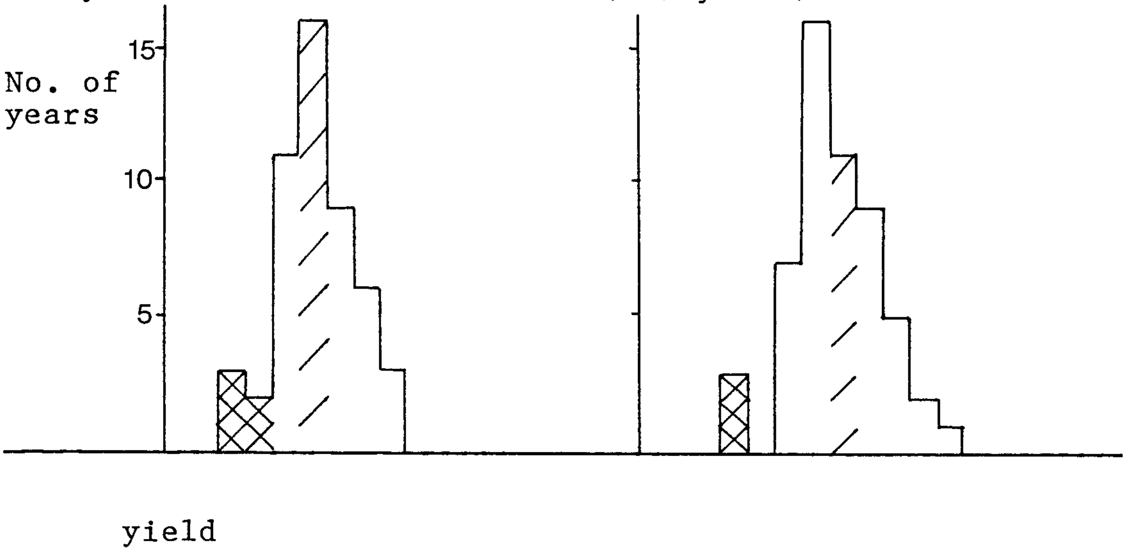
In general, it seemed clear where the marked drop occurred, but two less clear cases (Hambledon, yield/seed, and Beauworth, yield/acre) were considered more closely. The doubtful category of yields was subdivided into two; in each case, out of a total of seven years, five fell into the higher and two into the lower half of the range. The 'cut-off' was taken as the bottom of the yield category, although the midpoint would perhaps be more accurate, and this might imply that the number of 'below

Figure 2A.5.

Wheat Yields on four Winchester Manors, 1283-1349.
Number of years with each yield level.

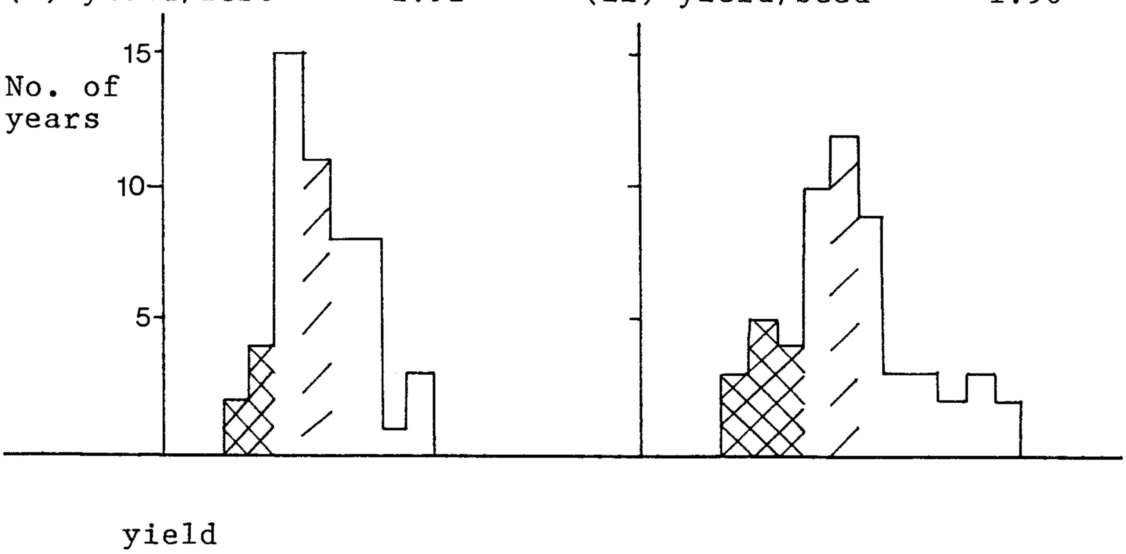
Hambledon.

(i) yield/acre T:50 (ii) yield/seed T:54



Alresford.

(i) yield/acre T:52 (ii) yield/seed T:56



Key: T: total recorded harvests in period

indicates the average yield for 1283-1349

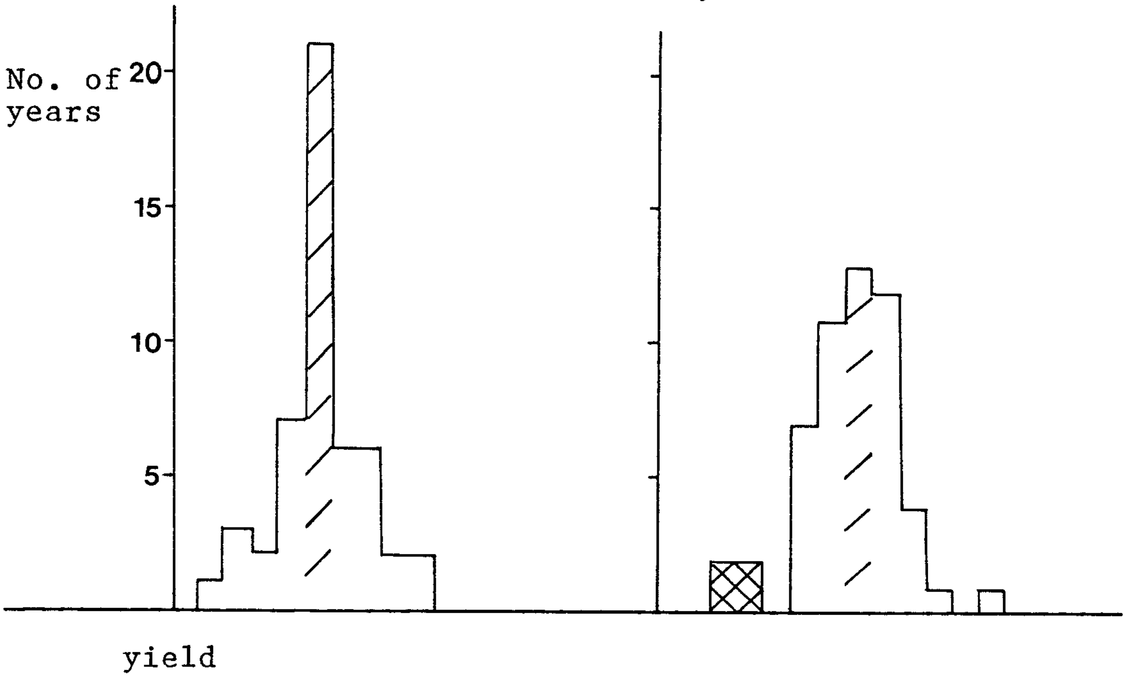
indicates yields classed as 'below cut-off'

Yield groupings (for all the Winchester yields figures)
Yield/seed data: intervals of 0.5
Yield/acre data: intervals of 0.2 quarters/acre

Figure 2A.5.(continued).

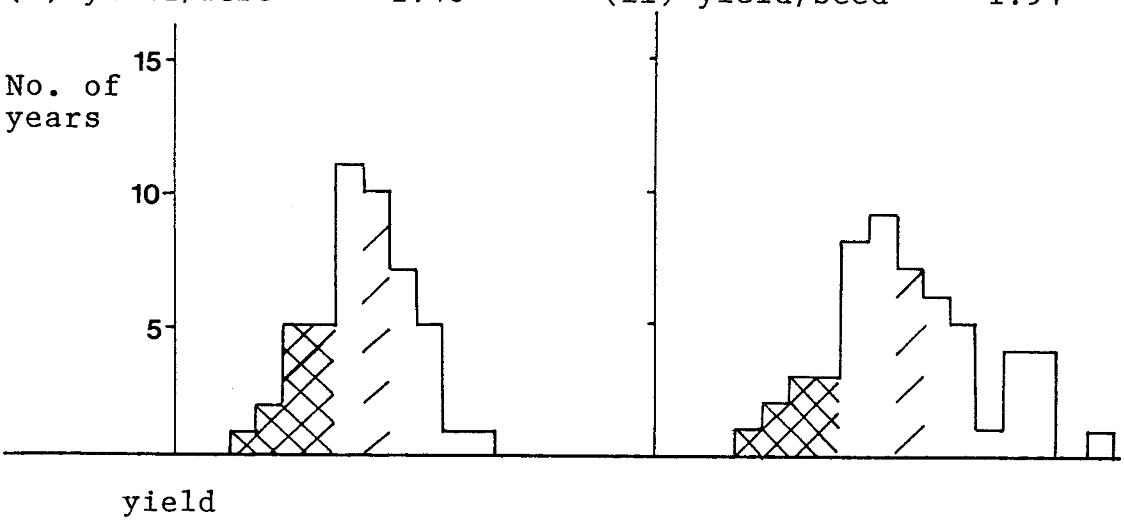
Beauworth.

(i) yield/acre T:50 (ii) yield/seed T:53



Bentley.

(i) yield/acre T:48 (ii) yield/seed T:54



Key: T: total recorded harvests in period

indicates the average yield for 1283-1349

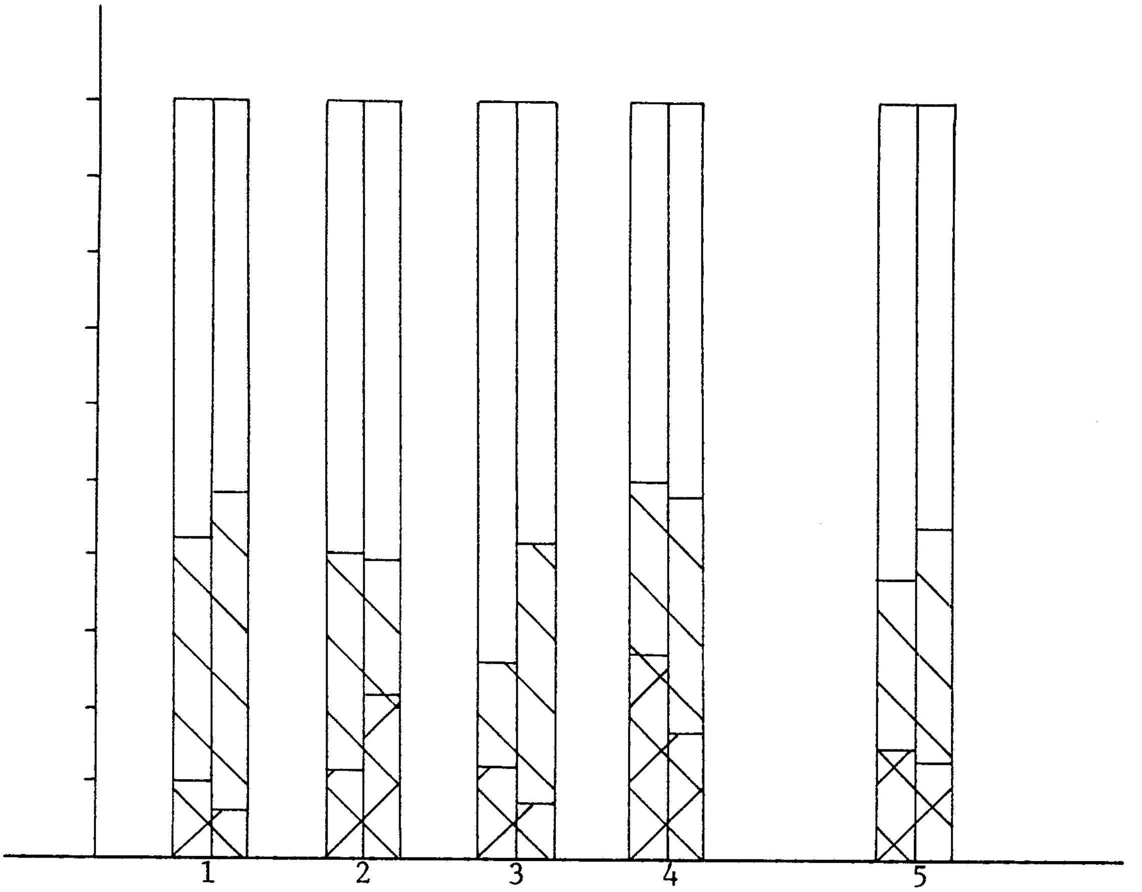
indicates yields classed as 'below cut-off' cut-off' harvests was underestimated by two in these cases. But the yield groups were not altered because of the need to maintain comparability with the other results.

Figure 2A.6 shows the proportions of below 'cut-off', below average and average or above harvests for the period. For the four manors together, 44% (based on yield/seed) or 37% (based on yield/acre) are below average, including 13% or 15% below 'cut-off'. [Because the data are grouped, below average means below the lower limit of the group into which the mean yield falls, not below the mean yield itself.] The figure also calculates the 'cut-off' value as a percentage of the average yield (here taken to be the mid point of the group into which it falls). The results are quite similar in size, and average around 75% (yield/acre) or 72% (yield/seed).

Estimates of prehistoric populations, such as the one by Mercer, discussed in Chapter 2 above, have tended to use mean grain yields to calculate the population supportable. But yields will fall below the mean in around half all harvests, implying some degree of food shortfall in every second year. It therefore seems better to take the subsistence element of the harvest (that is, the yield level necessary to meet the population's basic nutritional needs) at a level below the mean. For the cases discussed here, the point where the sharp drop in years/yield group occurs seems suitable. Below that level (ie. below the 'cut-off' defined above) there will be serious shortages. Above it, if in some years food is not plentiful, it will at least be adequate. This will make a considerable difference to the population estimated to be supportable. Which level is taken must depend on the sort of society the other archaeological evidence suggests. The ability to store and/or redistribute food to compensate for bad harvests is an obvious factor here.

Figure 2A.6.

Percentage of below average and bad wheat harvests on four Winchester manors, 1283-1349.



1. Hambledon 2.Alresford 3.Beauworth 4. Bentley
5. Average of the four.

First column is based on yield/acre and second on yield/seed figures.

'Cut-off' point as percentage of average yield.

	yield/acre	yield/seed
Hambledon	73	67
Alresford	73	80
Beauworth	80	74
Bentley	75	72

[Average yield here taken as mid-point of average yield group.]

It seems worth pointing out that this method of estimating population assumes that the food is grown primarily for consumption rather than for sale or exchange. Where this is not the case, whether on mediaeval estates or villas in Roman Italy, the method would simply be inappropriate. Its use by Mercer therefore constitutes another assumption about later prehistoric societies (see discussion in Chapter 2 above).

Whether the pattern identified above is applicable to later prehistoric agriculture remains an unanswered and important question. The most significant aspect is the sharp decline in the years/yield group figures, which can be seen in both the wheat and barley figures (Figures 2A.5, 2A.7) from the Winchester manors. The figure of 12 to 15% for bad harvests derived using the 'cut-off' level corresponds quite closely to the later mediaeval figures of "slightly more than one in six" (17%) identified by Hoskins (1964,29-30) from price data from the period 1480 - 1619, and also to the sixteenth century belief which he quotes that bad harvests occurred on year out of seven (14%). It is also uncertain whether the figure for the 'cut-off' level of yields as about 75% of the mean yield is specific to these examples or may be of wider applicability. Once there is a long run of yield data from Butser, these questions may be answerable. A 'normal' harvest minimum with a small number of bad harvests could be more conducive to population stability and effective organisation for failure years than a less patterned situation.

The data are now used to assess four specific questions relating to the ability of communities to compensate for or cope with inadequate harvests.

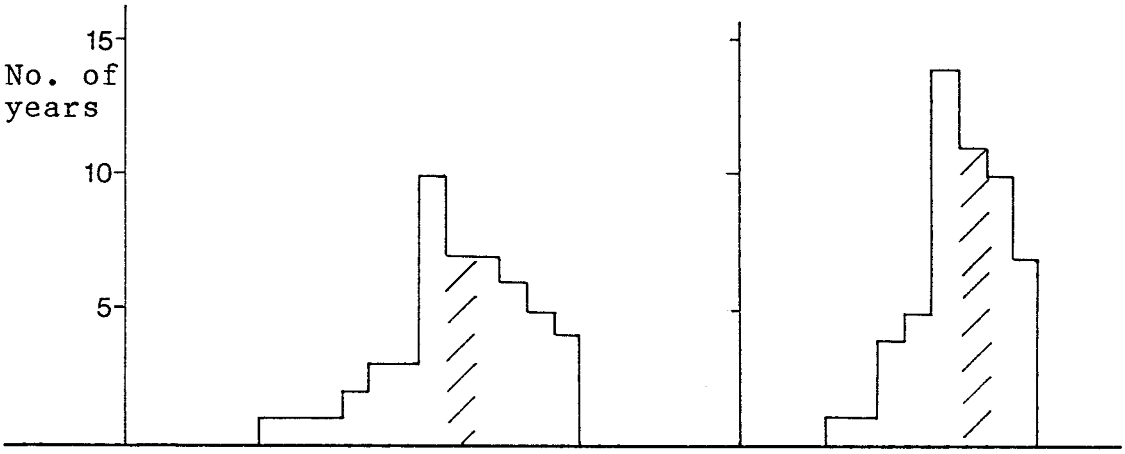
(a). The effect of bad harvests on subsequent years.

Table 2A.5 shows the frequency with which below

Figure 2A.7.

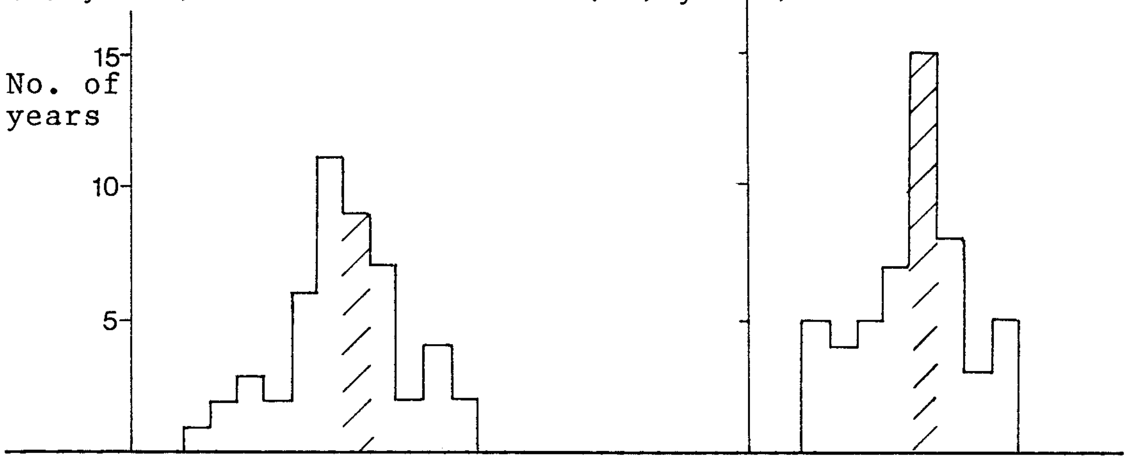
Barley Yields on four Winchester Manors, 1283-1349.
Number of years with each yield level.

Hambledon.
(i) yield/acre T:50 (ii) yield/seed T:53



yield

Alresford.
(i) yield/acre T:50 (ii) yield/seed T:52



yield

Key: T: total recorded harvests in period

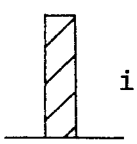
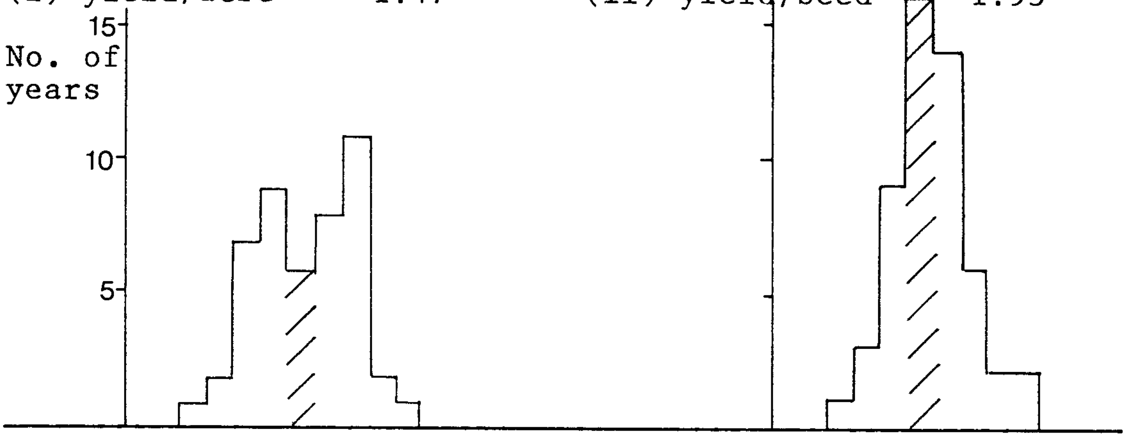
 indicates the average yield for 1283-1349

Figure 2A.7.(continued).

Beauworth.

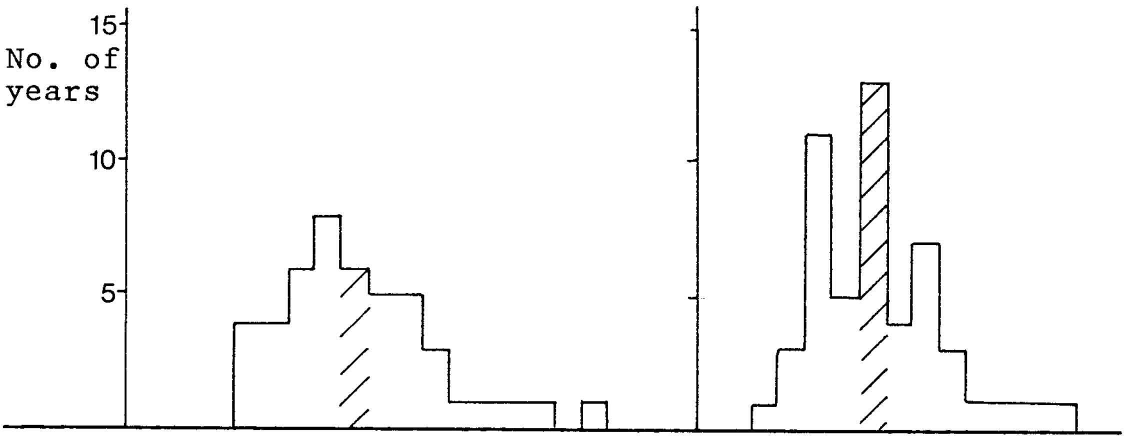
(i) yield/acre T:47 (ii) yield/seed T:53



yield

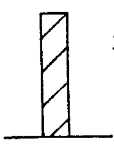
Bentley.

(i) yield/acre T:46 (ii) yield/seed T:51



yield

Key: T: total recorded harvests in period



indicates the average yield for 1283-1349

Table 2A.5.

Winchester wheat yields: runs of bad harvests.

The figures combine the data from the four manors.

	length of run in years	number of occurrences
Yield/acre figures		
(i) all below average years	1	31
Total years: 74	2	10
Total runs: 48	3	5
	4	2
% of runs lasting two or more years: 35%		
% of runs lasting three or more years: 15%		
(ii) below 'cut-off' years	1	18
Total years: 30	2	4
Total runs: 23	3	0
	4	1
% of runs lasting two or more years: 22%		
% of runs lasting three or more years: 4%		
Yield/seed figures		
(i) all below average years	1	34
Total years: 96	2	8
Total runs: 53	3	5
	4	4
	5	1
	...	...
	10	1
% of runs lasting two or more years: 36%		
% of runs lasting three or more years: 20%		
(ii) below 'cut-off' years	1	16
Total years: 26	2	1
Total runs: 19	3	1
	4	0
	5	1
% of runs lasting two or more years: 16%		
% of runs lasting three or more years: 11%		

Occurrence in runs of poor wheat harvests.

(i) below average harvests occurring in runs of:

	yield/acre	yield/seed
two or more years	58%	65%
three or more years	31%	48%

(as % of all below average harvests)

(ii) below 'cut-off' harvests occurring in runs of:

	yield/acre	yield/seed
two or more years	40%	38%
three or more years	13%	31%

(as % of all below 'cut-off' harvests)

average harvests occurred in runs. Harvests below the 'cut-off' occur more often singly than in runs, but it must be noted that nearly two thirds (19/30, y/a; 18/28, y/s) occur as part of a run of below average years.

Runs of bad harvests may have been due to weather variations (for example, the wet summers of the decade 1310-9 identified by Lamb), but as Hoskins noted "... a bad harvest, by reducing the yield ratio to a dangerously low level, almost automatically ensured another bad harvest from a sheer deficiency of seed" (1964,32). Lack of sufficient seed corn to sow the necessary acreage will produce an inadequate harvest, virtually irrespective of how good the yields achieved. Consideration of yields will not reveal a decline in production due to a decreased area under cultivation. This is one of the factors complicating use of experimental data.

The effects of bad harvests on yields are assessed in Figure 2A.8. It compares the yields recorded from years before and after one or more below 'cut-off' harvests. The effect is clear: yields in the following year are about five times more likely to be lower rather than higher than yields in the preceding year. It is interesting that there is a demonstrable effect on yields as well as on total production. This is likely to be due to poor quality or insufficient seed corn.

The effect of the other below average harvests on subsequent years was assessed in the same way. Runs which also included below 'cut-off' yields were excluded, and the overall change in yields calculated in the same way (Fig. 2A.8). Here the number of cases in which yields were depressed was almost the same as those in which they were raised. This is markedly different to the effects of the below 'cut-off' harvests, and reinforces the significance of the 'cut-off' point in assessing the adequacy of

Figure 2A.8.

Winchester manors: comparison of wheat yields in years preceding and following below average harvests.

(i). Yield/acre figures.

a. below cut-off harvests

```
  Change  (see below)
-5-4-3-2-1 0+1+2+3+4+5

         /
       / /
       / / /
     / / / /
     / / / / / /

      11   3  2
```

b. other below average harvests

```
  Change
-5-4-3-2-1 0+1+2+3+4+5

           /
           /
           /
           /
     /     /       /
     /     /       /
     /   / /   /   /
     / / / /   /   /

        7  8    6
```

(ii). Yields/seed figures.

a. below cut-off harvests

```
  Change  (see below)
-5-4-3-2-1 0+1+2+3+4+5

           /
   /       /
   / / / / /
   / / / / / /   /

      9    4   2
```

b. other below average harvests

```
  Change
-5-4-3-2-1 0+1+2+3+4+5+6

           /
           / /
         / / / /
 / / /   / / / / /     /

     5     4      7
```

'Change': this is the difference (expressed in the number of yield groups) between the yields before and after the below average harvest; it is negative if there is a fall, positive if a rise. If there are more than one below average harvest in a row, the change is the difference between the yields before the first and after the last of these.

yields. Yields lower than that evidently had adverse effects on the agrarian economy lasting more than one season.

(b). The coincidence of bad harvests on different manors.

The occurrence of poor harvest on the four manors are compared in Table 2A.6. This is an aspect which is important in assessing the potential of exchange within an area for alleviating the effects of crop failure.

It is clear from the figure that below 'cut-off' harvests on one manor are often (19/23) times accompanied by bad harvests on at least one of the others. The rarity of these harvests occurring in the same year as a harvest substantially above average on another manor can be seen. This occurred in 1286 and 1287, when Alresford was experiencing a prolonged bad spell, and in 1318 when Bentley took longer than the other manors to recover from the nationwide failure years of 1315-6. Otherwise only 1335 and 1336 show a mixture of bad and abundant harvests. Figure 2A.9 is a simplification of the patterns in Table 2A.6, intended to show the relationships more clearly. It uses only yield/acre data. Of the 16 years with a below 'cut-off' yield on one manor, only 3 also had any above average yields. Of the years with below average yields on at least one manor, 20/36 had also average yields on one or more other manors. Almost all the years including a below average yield but no below 'cut-off' yields had an above average yield one at least one of the other manors 17/20).

Assuming the existence of social mechanisms for the transfer of grain between individuals or communities, there appears to be a reasonable likelihood that a community which had a slightly below average harvest being able to make up its shortfall from others. However, the very bad harvests tended to affect more than one manor,

Table 2A.6.

The pattern of bad harvests: comparison of wheat harvests on four Winchester manors, 1283-1349.

(i). Below average harvests.

Key: X below 'cut-off' yields
x other below average yields
\- no data
First column based on yield/acre, second on yield/seed.

1. Hambledon 2. Alresford 3. Beauworth 4. Bentley

Year	Manor: 1	2	3	4
1283	xx	XX	X	XX
4	xx	x		x
5		x	x	-x
6		x		-X
7		X		
8		xX		
9		xX	xx	Xx
1290		XX	x	Xx
1	--	xX	x	xx
2	--	x	x	--
3	--	--	--	--
4	--	--	--	--
5	--	--	--	--
6	-	-	--	-x
7				xx
8				xx
9	XX	xX	-	
1300	x	x	--	xx
1		xX		
2			xx	
3	--	--	--	--
4	--	--	--	--
5	-x	-	-x	-
6	xx			
7		x		
8	xx			
9				
1310	xx	xx		x
1	x			
2		x		
3				
4	x			
5	XX	Xx	Xx	XX
6	Xx	xx	XX	XX
7	x		xx	XX
8				Xx
1319	--	--	--	--

Year	Manor: 1	2	3	4
1320	-x	-	-x	-x
1	--	--	--	--
2	--	--	--	--
3	--	--	--	--
4	-	-	-x	-x
5				x
6				
7			xx	x
8	Xx			xx
9	xx			
1330	x			Xx
1	xx	x	xx	XX
2	x			--
3	--	--	--	--
4	--	--	--	--
5	x	xX	xx	
6			Xx	XX
7				x
8				
9	XX	XX	XX	XX
1340				xx
1	xx	XX	XX	
2	xx	xx		
3	xx	xx	x	xx
4				
5				
6			xx	Xx
7	xx	xx		
8				
1349	x	XX	XX	Xx

Table 2A.6., continued.

(ii). Above and below average harvests.

Key:

X below 'cut-off' yields
x other below average yields
- no data

Yield groups above average:
. one
o two
0 three

First column based on yield/acre, second on yield/seed
1. Hambledon 2. Alresford 3. Beauworth 4. Bentley

Year	Manor: 1	2	3	4
1283	xx	XX	X	XX
4	xx	x	o.	x
5	..	x	x	-x
6	..	.x		-X
7		X	0o	.
8		xX	0o	.o
9		xX	xx	Xx
1290		XX	x	Xx
1	--	xX	x	xx
2	--	.x	x	--
3	--	--	--	--
4	--	--	--	--
5	--	--	--	--
6	-	-	--	-x
7	..	.	0o	xx
8	00	o	0	xx
9	XX	xX	-	
1300	x	x	--	xx
1	oo	xX	o.	
2	..	.	xx	
3	--	--	--	--
4	--	--	--	--
5	-x	-.	-x	-
6	xx	o	.	o0
7		x	..	.o
8	xx	oo	.	o0
9	oo	00	oo	o0
1310	xx	xx		x
1	x	.	o.	oo
2		x.	.	..
3	.	.	.	..
4	x	.	.	
5	XX	Xx	Xx	XX
6	Xx	xx	XX	XX
7	x	.	xx	XX
8	00	00	.	Xx
1319	--	--	--	--

Year	Manor: 1	2	3	4
1320	-x	-	-x	-x
1	--	--	--	--
2	--	--	--	--
3	--	--	--	--
4	-.	-0	-x	-x
5	oo	0	..	x
6	..	o0	00	00
7	..	..	xx	x
8	Xx			xx
9	xx	..		.
1330	x			Xx
1	xx	x	xx	XX
2	x			--
3	--	--	--	--
4	--	--	--	--
5	x	xX	xx	o0
6	00	00	Xx	XX
7	oo	00	..	x
8	..	o0	o0	.
9	XX	XX	XX	XX
1340		.o		xx
1	xx	XX	XX	.
2	xx	xx		.
3	xx	xx	x	xx
4	oo	.o		00
5	o	o0		.o
6		..	xx	Xx
7	xx	xx		.o
8	..		.	.o
1349	x	XX	XX	Xx

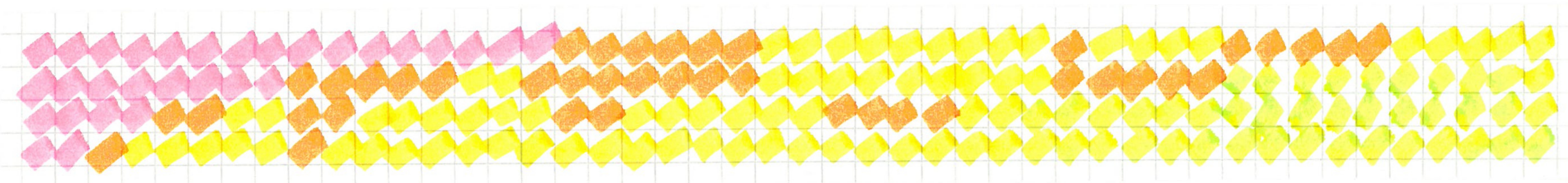
Figure 2A.9.
Relationships between good and bad wheat harvests on four Winchester manors, 1283-1349.

Notes:

1. Each vertical block of four represents the yield levels for the four manors in a single year, but neither years nor manor are in any order.
2. This figure is based on yield/acre data only.
3. Years with incomplete data are excluded.

Key:

- below 'cut-off'
- below average, but above 'cut-off'
- average
- above average



which suggests that acquisition would be less of an option. In a few cases it seems that local factors resulted in bad yields at one while others had abundant yields, and here again acquisition from other communities might be possible.

(c). The relationships between failures in harvests of different crops.

Cultivating more than one type of cereal crop may be intended in part as an insurance against the failure of the harvest. It is therefore interesting to consider as an example the performance of the barley crop in the years of below average wheat harvest.

For the wheat harvests defined as below 'cut-off', only about one in four is accompanied by a barley harvest which is average or better. Nearly half of the harvests with below average but above 'cut-off' yields are accompanied by average or better barley yields, around a third being accompanied by above average levels.

Table 2A.7.
Performance of the barley crop in years of below average wheat yields, 1283-1349.

	Barley, yield/acre				Barley, yield/seed			
	No. of harvests:				No. of harvests:			
	A	B	C	D	A	B	C	D
Wheat harvest:								
below cut-off	4	3	22	29	1	6	19	26
below average, above cut-off	15	4	23	42	18	15	34	67

A: above average C: below average
B: average D: total

An alternative way of considering the relationship between the wheat and barley crops is to establish whether a year which sees a rise (or fall) in wheat yield also sees a rise (or fall) in barley yield. The yield movements coincide in 77 of the 182 harvests for which comparisons are possible for the four manors, ie. in 42% of the cases. Assessing the meaning of this figure is complicated because rise, fall and no change in yields are not equally probable outcomes. Out of the 364 yield movements assessed, there are 149 rises, 139 falls, and 76 with no change, implying that the likelihoods of each outcome are, roughly, 2/5,2/5, and 1/5. If wheat and barley movements were independent, the chance of the yield movements coinciding in any year would be 9/25. Movement coincidences therefore occur only slightly more often than would be expected if the yields were independent (in 42% rather than 36% of years).

Table 2A.8.
Coincidences in rises and falls in wheat and barley yields

	No. of coincidences/No. of wheat harvests in category					
	Single manors				Total	Total,%
Wheat harvest:						
average and above	13/24	7/28	10/28	10/26	40/106	38%
below average, above cut-off	7/19	3/9	6/12	6/13	22/53	42%
below cut-off	3/3	6/9	3/4	3/7	15/23	65%
all					77/182	42%

However, if the coincidences are considered in relation to the quality of the wheat harvest, an interesting result emerges. For average and better harvests, movements seem to be essentially independent. But for the below 'cut-off' years, the movements coincide much more frequently.

From both approaches it therefore appears that the relationships between wheat and barley yields is strongest in the years when the wheat crop fails. This implies that although cultivating the two species seems to provide some compensation for poor performances in years of slightly below average yields, in years of outright failure of the wheat harvest the barley harvest is generally poor as well.

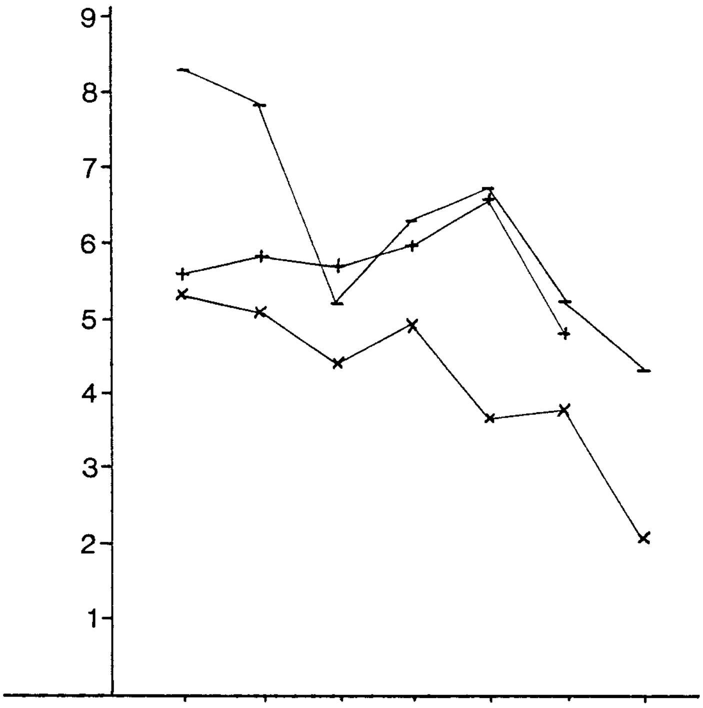
Unfortunately the Winchester figures do not include data on legume yields which would allow their value in this respect to be considered. Figure 2A.10 shows the decade average yields of peas and cereals from Cuxham, 1289-1359 AD (taken from Harvey, 1965). It can be seen that while the various cereal crops follow similar patterns of rises and falls in yields, the yields of peas move in almost exactly the opposite directions. There is therefore some indication that cultivating peas may provide a degree of insurance against cereal crop failures.

This is readily explicable in terms of agricultural practice. Wheat being autumn sown and barley spring sown in the mediaeval period (Thirsk 1967,168-173), each was vulnerable to adverse weather conditions at different times in the autumn to spring months. Cases are recorded where wheat planted in autumn and severely affected by a bad winter was ploughed in in the spring and the field successfully re-sown with spring crops such as barley (Brandon 1971). Both spring and autumn sown crops were

Figure 2A.10.
Comparison of cereal and legumes yields; average yields from Cuxham, 1289-1359.

Source: Harvey 1965, Table IV.

Cereal crops; decade average yields.



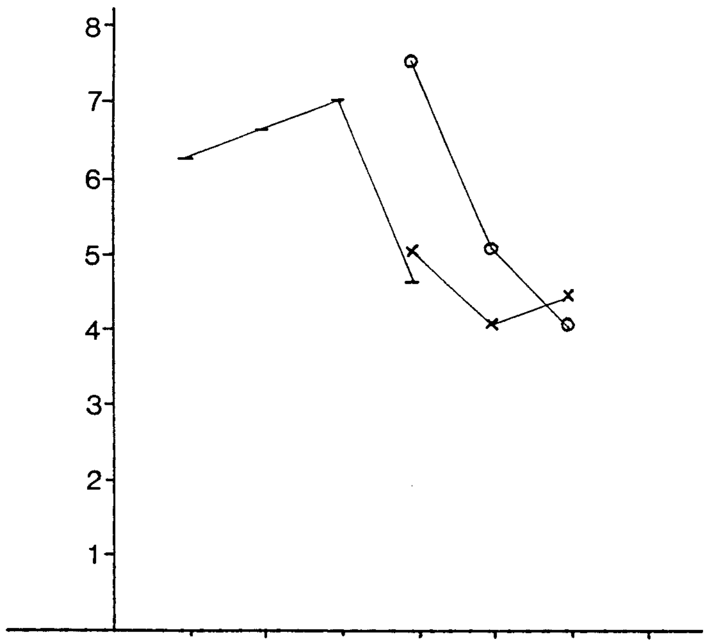
Average yields, 1289-1359

Wheat	6.4
Barley	5.8
Dredge	4.4

Key:

- wheat
+ barley
× dredge

Leguminous crops (peas): decade average yields.



Average yields, 1289-1359.

Peas	6.0
Grey peas	4.5
White peas	4.0

Key;

– peas
o grey peas
× white peas

however vulnerable to the wet summer weather which Bowden (1967,623) notes had the most serious effect on mediaeval harvests.

(d). The effect of bad years on yields.

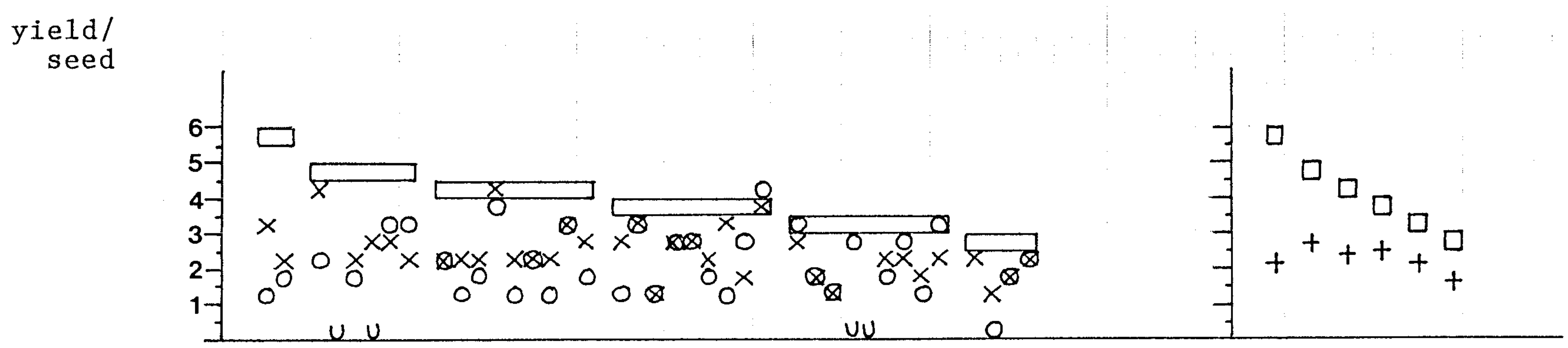
1315 and 1316 were years of crop failure and famine nationally. There is a danger of circularity in using documentary references to bad weather conditions (the basis of Lamb's weather indices; 1966,181-2) to explain mediaeval yield patterns (Titow 1971,24). However, Lamb's identification of the decade 1310-9 as characterised by wet summers (ibid,Fig.9) is accepted here.

The effect on yields of these bad summers is shown in Figure 2A.11, which compares the wheat yield/seed figures for each manor for 1315-6 with its average wheat yield/seed for 1300-1324. The yields are arranged according to the level of their average yields, and it can be seen that the greatest decline in yields occurred on the highest yielding manors. 1315-16 therefore had a levelling effect on yields. It may be significant that of the four manors used for closer analysis, the highest yielding manor (Bentley) appeared to take longer for its yields to recover from these bad years. The response to bad summer weather appears to be more marked on higher yielding manors than less productive ones.

2A.3. The pattern of bad harvests: some generalisations.

The purpose of this consideration of mediaeval yield patterns was to see if any generalisations about the pattern of bad harvests could be made, and to consider what their implications would be if they were taken to be relevant to earlier agricultural systems also. How applicable the conclusions are to prehistoric agriculture is of course open to question.

Figure 2A.11. Winchester wheat yields: harvests failures of 1315 and 1316.



(i) individual manors.

(ii) grouped according to average yields 1300-1324.

Key:

	Average yield 1300-1324
x	Yield 1315
o	Yield 1316
+	Average yield 1315-6
u	data unavailable for one or both years

(a). The frequency of bad harvests.

Because of the different bases for classification, comparisons of figures from different sources are difficult. Harrison's price-based analyses defined about 20% of wheat and 15% of oats and barley harvests as below 'average'. About 9% of harvests for each were defined as 'bad' or 'dearth', and in about 17% of years, harvests in at least one of the three were so designated. Hoskins' figures (again price-based) classed about 17% of wheat harvests as below average (1964,29-30). For the four Winchester manors, around 15% of the harvests were very poor (below the 'cut-off' yield).

Although an average frequency of poor harvests of around 15 to 20% of years can be suggested, it must be noted that considerable variation occurred. For the four Winchester manors individually, the proportion of bad wheat harvests varied from 10 to 27% (based on yields/acre) or 6 to 17% (yields/seed). Some settlements are known to have been much more susceptible to unfavourable weather than others. At Barnhorne in Sussex (where late mediaeval yields have been examined by Brandon) the frequency of bad harvests was higher than on other Sussex manors at the same time. 30% of wheat harvests (34% of barley) had yields more than 15% worse than average, with 16% (22% for barley) more than 30% worse. Brandon was able to relate the poor harvests to weather conditions, Barnhorne being liable to flooding and badly affected by wet weather (1971,85-93).

This demonstrates the importance of assessing local environmental factors where an estimate of the occurrence of harvest failures is required. However, as an approximation, around 10 to 20% of harvests were substantially below average. This implies one harvest failure in every five or ten years.

However, the tendency for poor harvests to occur in runs is also important. For the four Winchester manors, about 60% of below average harvests occurred in series of two or more years, and roughly 40% of below 'cut-off' years did so (figures depend on whether yield/acre or yield/seed is used). The tendency for the bad harvests to depress subsequent years' yields was also clear, although other below average harvests apparently did not have this effect. This is an interesting point which adds support to the idea of using the 'cut-off' level to separate 'adequate' and 'inadequate' yields, and as a basis for population estimation - where this is appropriate in the context of the society involved. [It would clearly not be appropriate for the Winchester manors themselves.]

The distinction between yield levels and total production (an important one which this discussion has largely ignored) is significant here. Even if yield rates did not fall in the year following a harvest failure, total production would still be depressed if a smaller area were sown because of lack of seed corn or the effects of food shortage on the population or livestock. And it is the total quantity of grain produced which is the important variable for its consumers. The true impact on subsequent years may thus be worse than the yield figures suggest. Attempts to maintain the area cultivated despite shortage of seed may have led to thinner seeding and thus contributed to the fall in yields.

(b). Strategies to avoid harvest failure.

Sowing both spring and winter cereals has the advantage of spreading the workload over a longer period of time and assisting weed control as well as spreading the risks of weather damage.

In using the price-based data, the non-independence of the prices for the different cereals must be remembered. However, in about half the years where the wheat harvest was 'deficient', the oats and barley harvests compensated sufficiently to keep overall grain prices (and therefore presumably supply) in the 'average' category. But in the two worst classes of wheat harvest, the other grains compensated in this way in only one of the eight years involved.

The Winchester figures show a similar pattern. Around a half of the below average/above 'cut-off' wheat harvests were accompanied by average or above average barley yields. But of the below 'cut-off' wheat harvests only a quarter were accompanied by average or better barley harvests (and very few of these were above average).

The conclusion is therefore that cultivating both spring and autumn sown cereals offers some protection against moderately poor years, as one can compensate for deficiency in about half the years concerned. In years of outright failure of one cereal, the others are generally also similarly affected.

The relationship between cereal and legume yields was difficult to discuss because of the limited data. Both yield rates from Cuxham and price data suggest some degree of compensation is likely. From the price data it can be suggested that in roughly half the years with poor wheat harvests, the legume crops may have been unaffected by the conditions which reduced the wheat yields, and in at least some of the cases above average pea and bean yields may have helped compensate for the poor wheat crop.

A possible way of coping with shortfalls is by establishing ways of obtaining grain from other communities within the area which had adequate yields. The conclusions are similar to those reached for the cereal crops. It appears that compensating for moderately poor harvests by exchange between communities should often have been possible, but in the very poor years all four of the Winchester manors were affected. For particular areas, assessment of local environmental variation might allow an estimate of the extent to which this form of insurance against bad harvests could have been effective.

Neither of these strategies appears to provide an effective defence against the very poor harvests, and this implies that strategies and evidence for such insurance must be sought in areas a society's organisation of storage and distribution rather than in the agricultural system and its characteristics.

(c). Estimating population statistics.

Mercer's estimate of prehistoric productivity and population recognises the "appalling hardship heralding widespread disease and death" which "a single year" of crop failure would cause (1981,236). The implications of this should be clear. The serious failures described by Mercer must be taken into account in assessing population numbers. The static population estimate based on average year yields is irrelevant if fluctuations in harvest qualities cause population falls of sufficient frequency and severity to prevent the levels being attained, or ,if occasionally attained, prevent their being maintained for any significant timespan.

The aim of this section is to attempt to establish the nature of the constraints imposed by the patterns of harvest failure which might be expected to have occurred in prehistoric agricultural societies. The problem of the applicability of the mediaeval patterns to this period is of course unresolved. But aspects such as the 'cut-off' in yields (whose relevance should eventually be supported or discounted by the Butser experiments), the effectiveness of various means for alleviating or preventing food shortage, and the frequencies of bad harvests singly and in series at least provide a basis for considering these problems in the earlier contexts.

Three types of situation involving below average harvests can be distinguished.

(i). The first involves harvests below average, but above about 75% of average levels, in one or more of the principal grain crops. This situation is common, and more often than not there are two or more consecutive years in this category. The poor yield in one grain will often be alleviated by adequate returns in another (ie. as a result of cropping decisions), and often other communities in an area will have adequate harvests. It was suggested that the 75% of average yields level should in general be regarded as the subsistence base for an agricultural community. Certainly where other archaeological evidence implies a stable community, it would seem unwise to assume a population model which implied that yields in this range constituted a problem. A society which had to rely on stored or imported food in this situation would be very vulnerable in the case of more serious failures.

(ii) The second is the single year in which yields fall below 75% of average in one or more of the principal cereal crops. This occurs perhaps one year in seven, and is unlikely to be alleviated by purely agricultural practices because of the tendency for all grain crops to be similarly affected. The next years harvest is likely to be adversely affected, reflecting the stress these years place on the economy. These years are often accompanied by one or more years in the previous category. These years will require additional means of preventing food shortages, such as access to stored foods, or the ability to obtain food from elsewhere (in this case, generally not in the immediate area). The extent to which these are achieved will determine the society's ability to avoid sudden and damaging change, and is therefore a crucial element in its social organisation.

(iii) The third type consists of two or more years of yields worse than 75% of average. This is a relatively uncommon event, recorded 7 times for the Winchester manors during the period considered. More than two such years together was recorded only twice. These are likely to result in serious famine, and the extent to which a community could overcome these once in thirty year events is obviously important. It seems unlikely that many prehistoric groups could cope with the disastrous longer series of bad harvests without substantial mortality and dislocation.

If population levels are to be estimated on the basis of agricultural productivity, it is necessary to first estimate the society's likely capacity for response to these different degrees of poor harvests, and to take the implications of this into account. The ability of most prehistoric societies to override harvest failures seems unlikely to have been sufficiently developed to make the use of simple static population estimates realistic. But these questions are of interest in more areas than population estimation. These abilities are key aspects of a community's socio-economic organisation, and should be seen as such.

Chapter 3
Tools and techniques.

3.1. Introduction.

This chapter has two aims. It examines the evidence for agricultural tools and the capabilities and efficiency, and the extent to which these may have acted as constraints on agricultural practices. The second intention is to identify areas and patterns of change, and assess their context. The discussion is confined to two areas, ploughing and the harvesting of food and fodder crops. The limited time periods and high labour demands of these processes imply that deficiencies in or improvements to the tools in use would be particularly significant in terms of overall productivity.

Some general problems in interpreting the evidence apply throughout. The variety of materials used in the manufacture of tools and the differential survival which results means that, for example, a map of the evidence for ploughing in prehistoric Britain would show markedly different distributions for the different classes of evidence. It also distorts the relative importance of tools, emphasising the commonly surviving objects (such as iron or stone shares) over those which survive rarely (wooden shares). This also complicates consideration of tools made of more than one material, such as the relationship between share and ard, or scythe and handle. Correlating different classes of evidence, such as an ard with the marks it might leave in the soil, presents similar problems.

The context of the tools presents further problems. A number of tools were multipurpose, rather than specifically agricultural. Of the iron tools which appear to be introductions in the Roman period, many occur initially in military contexts. Some surviving ploughmarks may relate to road construction rather than agricultural activity. The evidence for iron tools is greatly affected by the periods and contexts of hoard deposition. Some of the Danish ards appear to have been made or repaired specifically for ritual deposition, and not to have been entirely functional.

Tools represent a major form of investment in agriculture. This may be an investment of labour or of wealth, or of both. The distinction between make and type of tool has been pointed out by Boserup, who notes the distinction between a tool made by the cultivator, by a "village blacksmith", or as a specialist product (1965,27). As well as possible differences in efficiency, these imply differences in the nature of the investment made. An improved tool primarily saves labour or increases output; Simon (1978) has pointed out that a labour saving innovation is likely to be attractive, but suggested that a labour demanding and output increasing innovation is likely to be adopted only under pressure. Bronson (1972) comments that innovations in the latter class are more attractive where those taking the decisions are not those carrying out the work. But opportunities to gain from increased production may make such innovations more acceptable to producers. The relationship between technological change, labour exploitation and the nature of investment may be the key to understanding change.

3.2. Ards and ploughs.

In considering the evidence for cultivation tools and techniques, there are two important points to be made. Ards were probably both more varied and more capable than is often implied, at least outside the specialist literature. Fowler's (1981,220) description of "a limited and very conservative range of types" available during the Iron Age requires assessment and qualification if it is not to be assumed that a restricted range of ard types was a limiting factor in later prehistoric agriculture. For the Roman period, it is equally important that the evidence, and especially the dating, is carefully examined to avoid simplistic assertions about the effects of the conquest on agriculture. Throughout, the aim is to relate changes in the types of ard or plough and their characteristics to other aspects of the agrarian economy and to socio-economic change in broader context.

3.2.1. Types of ards and shares.

There are few securely dated wooden ard parts from Britain, and to put them and the stone and iron shares and share tips into context, it is necessary to consider the much wider range of material available from Scandinavia. It cannot, of course, be assumed that the ards in use in Britain and Scandinavia were identical, but the British ard parts (discussed by Rees,1979,42-8;1983) are closely paralleled in the Danish material. Glob (1951) describes four types of crook ard and two types of bow ards. Caution is needed in interpreting the bog finds, which Glob notes may not have been serviceable, and were probably constructed or patched together for ritual deposit (Glob 1951, 113,117-8).

3.2.1.i. Bow ards.

The two types of bow ard are well known. Their chief difference is that the Donnerupland ard has a short ard head, and therefore always a separate main share; in the Døstrup type the stilt widens into an ard head which could act as the main share, although some variants of the Døstrup type also had a separate main share. These are described and illustrated by Glob (1951,113-8,Figs.28-9,37).

There are also a variety of types of wooden shares. Glob (1951,121) lists 3 types of foreshare which may have been fitted onto bow ards. While the foreshares from the Døstrup and Donnerupland ards are spindle shaped, another group of implements (with short arrow shaped head and long tang) are identified as foreshares on the basis of their wear marks. A third type, with a rather longer blade, is also interpreted by Glob as a foreshare; this type seems closest to the British examples, from Abingdon and Walesland Rath (Fowler 1978; Wainwright 1971). Nielsen's analysis of ploughmarks "roughly indicates the use of two types of share .... one type [with] a breadth of about 3cm, roughly corresponding to the breadth of the barshare of the Døstrup ard, and as a second type a bigger breadth up to 6.5cm, which is approximately the breadth of several of the arrow shaped shares which were also used on bow ards" (1970,151). Everton and Fowler (1978,184) found a similar distinction in the pre-Roman ard marks at Lodge Farm, Alveston. Hansen's experiments confirm that bar and arrow shaped shares leave different marks in the subsoil (1969,82,Figs.18-19). Payne (1947,90) points out that traditional use in Britain (as recorded from the sixteenth century AD) employed two types of share, spear and wing. It is important to note that "the choice of share was dictated by the nature of the ground and did not depend on the plough type". A stony soil required the spear share.

The spear/arrow distinction reflects soil type and usage. Hansen (1969,20) noted the "considerable loosening effect on the soil" of arrow shaped shares compared with bar shares. Of the main types of Danish bow ards, the Donnerupland ard and some variants of the Døstrup ard combined an arrow shaped main share with a narrow foreshare (Glob 1951, Figs. 28-9,37). The Hendriksmose ard (a Døstrup type) however did not have a main share; Hansen's experiments with a reconstruction of this ard used foreshares of both types (1969,69). The two foreshare types may have represented different stages in the preparation of the ground; the typical wide spacing of the surviving ard marks (about 30 cm apart) has led Rees to suggest that they represent only one stage in this process (1979,82); it can be suggested that initial breaking with a narrow share was followed by further preparation with a wider, arrow-shaped share. It is clear from Reynolds' experiments that the foreshare of the Donnerupland type ards extended beyond the end of the mainshare when used to break the ground; this narrow foreshare would therefore cut more deeply than the mainshare (Reynolds 1982, 142-3,Figs 7.6-7.7). When found, the foreshare of the Donnerupland ard did not protrude in this way; perhaps the ards with two shares were adjusted in this way during the later soil loosening stages of tillage.

Traces suggesting both share types in use have been recorded from several sites (see above), and examination of the profiles of ard marks in relation to factors such as depth and soil type might prove informative. Unfortunately, since many marks survive only as shallow impressions in the subsoil, the number of sites with published trace sections or even descriptions of the profiles is few. For these examples, only a small number of profiles are recorded, and Hansen's caution, based on his experimental work, must be noted. He suggests that for adequate examination, the trace should be sectioned every 10 or 20cm over a 20m stretch; only one section out of "perhaps 20 or 50" is likely to characterise the profile of the ard (1969,85).

3.2.1.ii. Other ard types.

Rees concluded that while all the wooden ard pieces found in Britain appear to belong to bow ards, suggesting that this was the usual type in use, the crook ard may also have been used, possibly for a different purpose (1978,103,110). A wooden implement interpreted as part of a crook ard and dating to the mid first century AD has since been reported from Odell, Bedfordshire (Dix

1979,216; Fowler 1981,220). However, Rees (1979,33) found it "unconvincing". Reynolds (1981,100-1,104) suggests the crook ard was used to prepare a seed furrow, noting that the furrows left by a bow ard are too deep to receive seed directly. The crook ard leaves a narrow and shallow furrow, and it is "quite impossible" to use it as a "sod breaker" (Reynolds 1980,10). The iron shares from Britain probably all derive from bow ards (but see Reynolds' interpretation of the Slonk Hill share below) (Rees 1978,110). However Rees' (1981,73) examination of metal shares from modern crook ards in use in Bolivia revealed wear marks "much the same" although "rather shorter" than those seen on stone and iron shares from Britain attributed to bow ards. She notes that wear patterns on shares do not firmly distinguish the type of ard in use, or which aspect of ground preparation was involved.

Reynolds (1978) has argued that the ard tip from Slonk Hill (Hartridge 1978, Fig.11,No.4) represents a further type, its flared shape implying a different angle of penetration to the bow ard. He suggests this resembles a simple ard with a curved oak bough attached to a beam (el cambelo), currently in use in northern Spain. It is use in addition to the sole ard (the 'Roman' ard) and has the specific function of breaking up either new ground or old pasture. The Slonk Hill tip must have belonged to a smaller tool, but Reynolds suggests its use may have been similar, and that this would be compatible with the excavated ploughmarks (Hartridge 1978,89-90) which are mostly in one direction, deep, and in some case curved in a way he considers characteristic of pressure ploughing.

It is clearly satisfying to be able to relate ard marks to the tool parts recovered, and in some cases this has been informative (for example, the discussion by Lamb and Rees (1981) of stone shares and ard marks from Sumburgh, Shetland). However there is nothing particularly unusual about the ard marks from Slonk Hill; their depth into the subsoil, curving line and predominantly single axis can all be parallelled on other Iron Age sites in Britain or Denmark [for example, at Store Vildmose (Nielsen 1970, 157,161-3); Belling Law (Jobey 1977,10); Newhaven (Bell 1976,248-250); Bishopstone (Bell 1977,252)].

Indeed it is part of Reynolds' argument that most of the surviving ard marks were created by a "rip ard" rather than the bow ard (1981, 103-4). He concluded from his experiments with a bow ard of Donnerupland type that the ard would not cut sufficiently deeply into the subsoil to leave marks where the topsoil depth exceeded 25 cm (1981,103). This finds support in Hansen's experiments, where it was necessary to reduce the depth of the topsoil in order to produce subsoil traces (1969,79). Reynolds further suggests that if the ard marks as found represent normal ploughing, they should have been self-cancelling, with all the subsoil surface being removed. However individual ard marks survived clearly at Store Vildmose, despite considerable subsoil erosion; marks survived better at field edges where soil pushed off the plough built up banks or lynchets than in the centre of the fields where the subsoil was eroded (Nielsen 1969,152).

Certainly many of the surviving marks represent deeper ploughing than the normal practice. At Hyllerup (Jutland), Pedersen noted that the single criss-cross ploughing preserved in subsoil traces could not account for the "thorough destruction" of the Early Bronze Age house prior to the construction of the burial mound. This, he inferred, was caused by heavy ploughing of another kind, affecting only the topsoil (1986,172). At Store Vildmose, Nielsen noted that not all plough marks reached as deep as the subsoil; at times they could be detected only in the topsoil (1986,204). Nielsen does not suggest that they showed any difference in nature from the deeper marks. Some of the deeper marks cut through earlier furrows; this, as Nielsen, notes supports the idea that much routine cultivation was confined to working the upper layer of the soil. But deeper ploughing was clearly not restricted to a single clearance phase. Some of the marks were at an oblique angle to the rest; some of these (but not all) were particularly deep, and they presumably represent another type of less frequent more thorough working (ibid,207). Periodic deeper and more thorough working seems to have been a feature at Store Vildmose. The cultivation dates to the fifth to third centuries bc.

In addition, at Rosinish ard marks were preserved in both the subsoil and in sand blow accumulated on the old ground surface. The marks from these two contexts appear to be similar (Shepherd and Tuckwell 1977/8, 108,Fig.3), suggesting they derived from similar ploughing activity. The writers suggested a crook ard was responsible for these marks, apparently because of their early date (around 2000 bc) and the early date of the Hvorslev ard; there appears to be no direct evidence for this interpretation. It is generally assumed that the ard marks in Britain derive from bow ards because of the shallow furrow of the crook ard. On this basis the bow ard is presumed to have been in use from the time of the earliest ard marks [under a Neolithic barrow at South Street (Ashbee <u>et al</u> 1979,282-3)]; however it is interesting to note that the earliest radiocarbon dates for ards from Scandinavia relate to crook ards, with dates for bow ards restricted to the first millenium BC (see Table 3.1).

Rees also considers (1981,77) that the "irregular, far-spaced ard marks normally found" may reflect "some specialised use - levelling perhaps, or deep ploughing". [The use of an ard to level ground prior to the construction of Roman roads has been suggested in two

Table 3.1.

Radiocarbon dates for ards and ard parts.

Dates for implements from Britain and Denmark earlier than AD 1000.

Vebbestrup ard	crook ard	2860+/-100bp	1115 BC
Hvorslev ard	crook ard	3440+/-100bp	1820 BC
Døstrup ard	bow ard	2560+/-100bp	810 BC
Milton Loch ard head and stilt	bow ard	2350+/-100bp	450 BC
Hendriksmose ard	bow ard	2300+/-100bp	425 BC
Mors asymmetric ard head	from bow ard	2110+/-100bp	170 BC
Lochmaben ard beam	from bow ard	2030+/-100bp	55 BC
Mammen ard		1830+/-100bp	195 AD
Dabergotz ard	crook ard with foreshare	1215+/-80bp	735 AD

Source: Lerche and Steensberg 1980,81-6.

cases, at Stane Street and Stratton Park (Fasham and Hanworth 1978).] But Hansen demonstrated that even where two furrows were cut in similar fashion, one might leave a clear trace in the subsoil and the other none (1969,80,Fig.15). Steensberg comments that "the interrupted nature of fossil ard marks is often due to investigations made on too small a scale" (1983,62), and certainly none of the British examples include an excavated area comparable to that at Store Vildmose.

Apart from the Slonk Hill tip, a "rip ard" is only represented archaeologically by Reynolds' interpretation of some rock carvings, notably one from Aspeberg (Sweden) (Reynolds 1981, Fig.1; 1982,149-50,155). Taking, like Steensberg (1983,62), Reynolds' arguments "with reservations", the possibility remains that some form of rip ard was in use to break up established grass cover. The existence of such a tool would not be surprising. It is worth noting that its modern equivalents (Reynolds compares it with the chisel plough) has the additional function of breaking up ploughpan. This is a hard packed layer which may develop beneath the tillage zone after prolonged or heavy cultivation, especially in heavy clay soils (Briggs 1977,53). The possible existence of an ard type suited to dealing with ploughpan is of obvious interest when considering the fertility maintenance requirements of long term cultivation of heavy soils. Expansion of cultivation onto such soils during the Iron Age has often been inferred (eg. Marshall 1978).

But the existence of a rip-ard type is by no means firmly demonstrated; the evidence for the tool itself is poor, and the surviving marks do seem explicable without it. Nielsen demonstrated differences in the depth of cultivation without suggesting differences in the nature of the marks themselves. Consideration of the capabilities of bow ards (see below) and the use of spades for turf stripping suggest that agriculturally it was not essential. Turf removal prior to ploughing might also account for marks cut deeper than normal into the subsoil. One outcome of the views expressed about the atypical nature of the ard marks found is the tendency of some excavators to attribute marks to the earliest likely period of cultivation in the area (Bennett 1983,57-8). This is an unjustified extrapolation even if Reynolds' views are correct, as the Store Vildmose evidence shows.

3.2.1.iii. Iron shares and share tips.

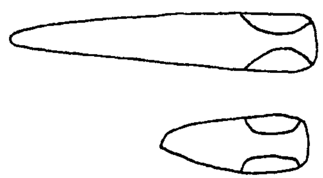
Excluding the few wooden parts and the stone ard tips from Orkney and Shetland, the iron share tips, shares and coulters form the main evidence for ploughs of the Iron Age and Roman periods in Britain. The interpretation of the iron share tips has been disputed; Reynolds (1981,102-3) seems to suggest that only the Slonk Hill tip may in fact have had this function. However, Rees (1979,52-3) concluded that the best interpretation of these items is as tips on the fore shares of bow ards, and this view is accepted here.

Rees differentiates seven different types of iron shares, three of which occurred during the Iron Age (1979,154, Fig.49). The types and their dates are summarised in Figure 3.1. The earliest can be dated to the fifth to third centuries BC, and represent iron tips attached to wooden barshares. There is a trend to increased length in these shares, continuing into the Roman period; this is discussed below. Apart from the Slonk Hill share tip, the only new type seen in the Iron Age are the spatulate tanged shares from Northamptonshire. Rees is doubtful about their attribution as shares (1979,57-8), although other writers accept them. They occur in an area of iron production, and may perhaps be interpreted as an experimental and ultimately unsuccessful share type. Some of Allen's "plough-share" currency bars

Figure 3.1. Types of iron share: classification by Rees 1979.

Socketed shares.

Type Ia

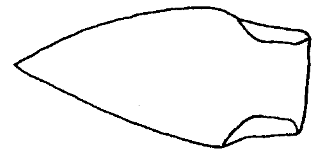


earliest date
to C5/C3 BC

Type Ib

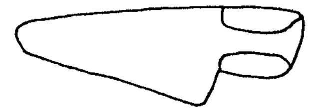
(i) small sized, one
example, C3/C1 BC.
(ii) larger examples
all R-B, from C1/C2 AD.

Type Ic



R-B contexts only
earliest are C1/C2 AD.

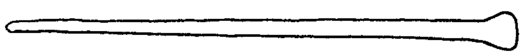
Type Id



late C3 and C4 AD.

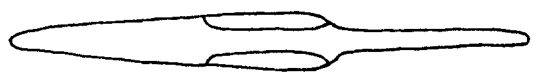
Tanged shares.

Type IIa



"almost exclusively"
C4 AD

Type IIb



only dated examples
are C3 AD

Type IIc

C4-C1 BC
(probably not shares)

Source: Rees 1979, Fig. 49 and pages 50-9, 279.

might also fall into this category. They do not appear to be currency bars; there are few of them and they do not occur in hoards (Allen 1967,312-4). Most are not accepted as shares by Rees. Interestingly Allen suggests some of these may be "votive or representational plough shares, not intended for actual use", reminiscent of the non-functional softwood head of the Døstrup ard (Glob 1951,117-8). A number have been recovered from the Thames.

The implications for changes in plough technology implied by the wider range of types seen in the Roman period must be assessed carefully. The winged iron shares (Rees' type 1c) which appear for the first time in the later first or second century AD "tend to be massive in width and in quantity of metal utilised" (Rees 1979,49). They may be an aspect of a trend to increase the quantity of iron used in shares (ibid,53-4), itself a feature of an increasing use of iron for tools in Britain in this period. It is possible that the new feature here is the extension of the use of iron to the wider share types, previously made entirely of wood, rather than a new share type. Rees' types 1b and 1c could both reflect this process. Fowler (1978) suggests that the Abingdon ard share (third century AD) was fitted with an iron tip; this share had a maximum width of about 8cm.

To examine this question more closely, the width distribution of the shares listed by Rees (1979) has been plotted. There are three figures (3.2-3.4), the first showing only Rees' type 1a, the commonest in Iron Age and early Roman Britain; the second shows all types recorded before the end of the second century AD, and the third shows all types. The main points are the wider size range of 1a shares from the Iron Age; the Romano-British 1a shares fall into a narrower size range, but are accompanied by a group of wider shares of different types. Taken with the ploughmark evidence discussed above, and the share from Walesland Rath (dated to the first century BC), it seems reasonable to accept a spear/arrow distinction in share forms in both periods, with the wider arrow or paddle shaped share only being iron clad in the Roman period, and a more defined distinction between the wider and narrow shares appearing at this time.

There are considerable problems in discussing the wider iron share types which appear in the Romano-British period (Rees 1979, 55-7 describes these). One problem is the discrepancy between the classification used by Rees in her discussion and catalogue; it is not always possible to be sure what is meant on the basis of the information given.

The most noticeable feature of these shares is the unusual range of contexts in which they have been found. Apart from Romanised contexts like villas, towns and military sites, they are mostly from Scotland. The shares will here be taken in four groups.

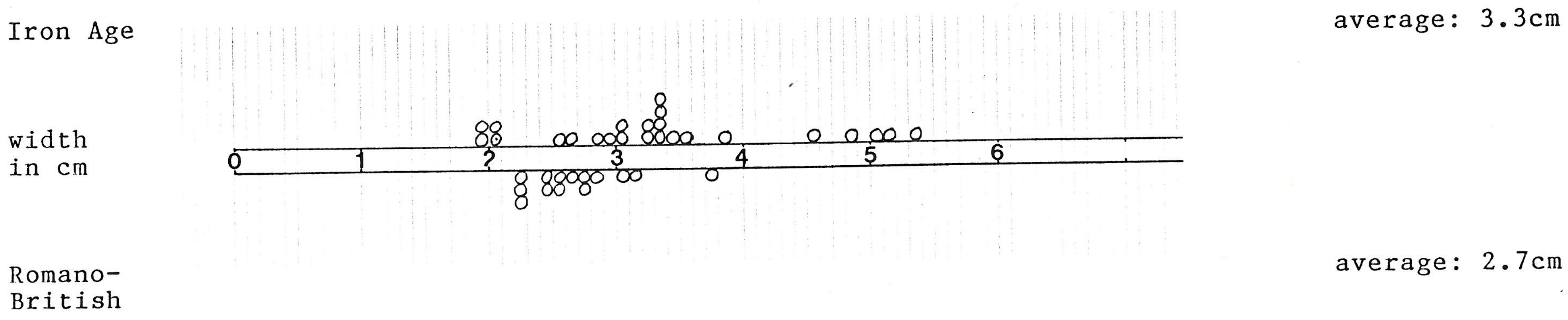
(1). Shares of Rees' type 1b consist of the small Iron Age share tip from Slonk Hill, a larger but similar share from the villa at Chedworth, and two "massive" examples from Scotland, one from a hoard at Blackburn Mill, probably first or second century AD, the other undated.

(2). Wide socketed shares, one being from the Frindsbury villa (described by Rees as her type Ic, but not winged like the other Ic shares) and the other, not listed by Rees, from a hoard in the military tilery at Brampton and probably dated to c. 125 AD (Manning 1966,8-9).

(3). Symmetrical winged shares, Rees' type Ic; two come from London, of which one dates to the first or second century and the other is undated. There are three Scottish examples, but two are damaged and their function is uncertain.

(4). Asymmetrical winged shares are unlike the others in that they appear to date from no earlier than the late

Figure 3.2. Maximum blade widths of Romano-British and Iron Age iron shares: 1. Type Ia shares.

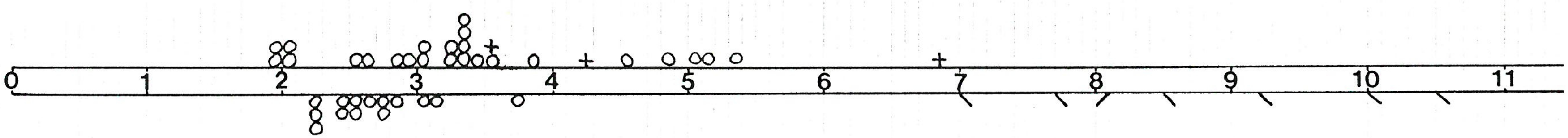


Source; data from Rees 1979.

Figure 3.3. Maximum blade widths of Romano-British and Iron Age iron shares: 2. Shares of types known before 200 AD.

Iron Age

width
in cm

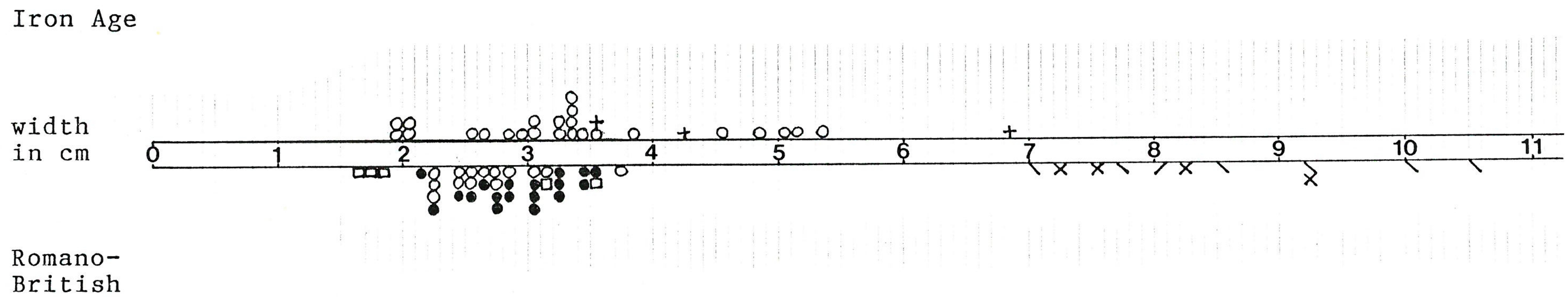


Romano-
British

Key: Type Ia ○
Ib /
Ic \
IIc +

Source; data from Rees 1979.

Figure 3.4. Maximum blade widths of Romano-British and Iron Age iron shares: 3. All Iron Age and Romano-British iron shares.



Key: Type Ia ○   IIa ●
Ib ⁄   IIb □
Ic ∖   IIc +
Id ×

Source; data from Rees 1979.

third or early fourth century AD. There are two from villas, one from a hoard in a town and one from fourth century occupation in a hillfort.

These shares are difficult to interpret. The Scottish examples must at present be regarded with caution, especially as there are no examples of Rees' type Ia shares (the commonest type in the Iron Age and on Romano-British habitation sites) from Scotland. The implication is that they are scrap or hoard material, probably deriving from military sites in the frontier region. It is therefore possible the earlier wide types (1 to 3 above) were introduced by the army; it is this aspect of their occurrence which suggests that the wide shares do not simply represent the extension of iron cladding to wider share types, although this process may also be represented. There are only three examples of these wide shares securely attributed to contexts in villas (2) or towns (1), although they may be under-represented because of their size and scrap value. The restricted width range of Ia shares in the Roman period may be the clearest sign that this wider class of share was not insignificant in the agricultural economy.

What are clearly new types appearing during the Roman period are the asymmetric wing shares of Rees' type ld, the bar shares (type 2a) and the flanged bar share from Box. The implications of these introductions are considered below. It is important to note that these are not known from contexts before the late third century AD. Rees' type llb (mostly third century AD) are possibly interpretable as a development of type la in the context of increased use of iron (see Table 3.6 below). Their absence in the fourth century may represent their supplanting by the new type 2a barshares.

3.2.2. The efficiency of ards in Iron Age and Roman Britain.

Discussions of Iron Age agriculture often stress the inadequacies of ards in contrast to the capabilities of later ploughs. Cunliffe comments that "ploughing was undertaken using the simple iron-shod crook or bow ard (without a mould-board to turn the sod), the effect of which would simply have been to scratch a furrow in the soil" (1974,171). The furrows were however more than a "scratch": Aberg and Bowen (1960,145) managed furrows 25 to 30cm wide and 15cm deep; Reynolds (1982,149) records an average penetration of 15cm, resulting in a depth of furrow from crest to trough of 30cm, "too deep for the direct sowing of cereal seeds". The crook ard may, as noted above, have been used essentially as a seed drill; Reynolds reports its suitability on the basis of experiments (1981,100-1); it produces a narrow furrow which may more reasonably be described as a scratch, its depth presumably being near the 5cm which Reynolds (1982,149) reports is the ideal depth for a seed drill. The difference in the capabilities of crook and bow ards is clearly considerable.

There are three main areas in which bow ards have been described as inadequate; these are ploughing heavy soils such as clays, breaking established grass cover, and inverting the soil. Both the accuracy of these descriptions and the significance of the limitations of the bow ard will be assessed.

3.2.2.i. Ploughing on clay.

It is now generally accepted that bow ards were perfectly capable of dealing with heavy soils. In Denmark, ard marks on clay have been found under an Early Bronze Age barrow at Slots Bjergby (Glob 1951,124), and under Neolithic barrows at Sevel (ibid,123) and Aptrup (Seeberg and Kristensen 1964). Rowley-Conwy (1987) argues convincingly that at least some of the Danish Neolithic and Bronze Age ard marks from under barrows represent ritual practice preceding the construction of the mounds. In some cases however ard marks in association with these barrows are clearly the result of cultivation (Asingh 1987,143-5). In any case, the interpretation does not affect the conclusion that the ards in use were capable of ploughing on the heavy clay soils involved. These were presumably a form of bow ard, as crook ards do not cut sufficiently deeply to leave subsoil traces (Rees 1981,78). In view of this evidence it seems surprising that the idea ards could not cope with clay persisted for so long - yet as recently as 1978 Bowen described the discovery of ard marks on a clay soil as "challenging" (1978,2).

In Britain, a number of Roman military sites (mostly Hadrianic) from northern England on clay soils have produced ard marks ante-dating their earliest occupation (Gillam _et al_ 1973,84-5). Because of the evidence discussed above for the use of ards to level ground for road construction, it is useful to note that at Wallhouses (Bennett and Turner 1983,66) and Throckley (Bennett 1983,51-8) soil analyses confirmed that the buried soil had been cultivated. The rigs in the buried topsoil at Rudchester (discussed below) also imply an agricultural context for the marks.

Similar marks in the area are also known from other pre-Roman contexts. At Belling Law, the ard marks cut into boulder clay appear to relate to enclosures dated to 160+/- 80 bc, and are sealed by a bank of the second century AD (Jobey 1970,10,Fig.4). At Fenton Hill, the marks predate the rampart constructed c.210 bc (Burgess 1984,156, Fig.8.9).

At Lodge Farm, Alveston, Avon, an area of ploughmarks on clay subsoil predate Romano-British occupation of the first century AD (Everton and Fowler, 1978). The tendency to date agricultural features as early as possible is again illustrated by Rees' (1979,81) suggestion, presumably on the basis of a small scatter of Neolithic or Beaker flints nearby but not in association (Everton and Fowler 1978,179), that they "could be late Neolithic".

Early Bronze Age cultivation of clay soils is demonstrated by lynchets at Barnett Copse, dated by a Wessex culture cremation inserted into one of them. These are situated on a heavy clay-with-flints soil (Perry 1967,37-9).

Experimental work by Reynolds (1982,149) demonstrated that given good ploughing conditions (see section on drainage in Chapter 6 below), a reconstructed Donnerupland ard was "perfectly capable of dealing with the heaviest of soils" (in this case, Midlands clays and marls).

3.2.2.ii. Ploughing grassland.

The inability of both bow and crook ards to break up a fallow field is often stressed (eg Rees 1978,112). This section will qualify these statements, and consider how significant the limitations of the ard in this respect may have been.

The experimental results are in fact not as poor as Rees suggests. Hansen's attempts to plough grassland 5-10 years old showed that his reconstructed Hendriksmose ard (with wooden share) was "clearly not fit for breaking up old fallow ground", but it did have "a good capacity for breaking the soil of an 18 month grassland" (1969,76,79). Similarly Reynolds (1967,61-2) found a reconstructed Donnerupland ard capable of ploughing two year fallow on light soil. The distinction between inability to break short term fallow and more established grassland is clearly important in practical terms and should not be overlooked.

A variety of means exist to prepare established grassland for cultivation. There is no evidence from prehistoric or Roman Britain for the use of a coulter-only tool (a ristle) to prepare the land for ploughing, as described by both Payne (1947,87-8) and Hansen (1969,78-9). Pohanka (1986, Fig.1) illustrates a tool of this type used in Roman Austria. Burning is another possibility, but the most efficient means is turf paring. The turf can be inverted to rot, burnt, or built into ridges (Gailey 1971,229). Turf removal can affect fertility; in traditional Danish agriculture, turf was removed with as little soil as possible, except where it was used to build heavy walls (Lerche 1970). Removed turves used in buildings or as animal beddings can be returned to the fields as manure, enriched with soot or animal wastes (Fenton 1981).

Turf cutting is demonstrated by the use of turves in construction. It is not uncommon in barrows of Neolithic and Bronze Age date, but this source of evidence is largely unavailable for the Iron Age; turf is rarely used in the construction of hillforts (Hogg 1975,58). It becomes common as a building material again in the Roman period. Turves used in the construction of Hadrian's Wall were about 15cm thick (Breeze and Dobson 1978,32), as were the turves used in a Bronze Age barrow at Ascot (Bradley and Keith-Lucas 1975). This is about twice as thick as the maximum noted by Lerche, and presumably would have reduced the agricultural potential of the stripped area seriously. Use of turf for building has been suggested for a few Iron Age sites. At Farmoor, turf and topsoil had been stripped from one enclosure of the Middle Iron Age, and possibly used in the construction of a round house (Lambrick and

Robinson 1979,70-1). Turf walling may have been used at Great Oakley (Drury 1982,10-13), an interpretation based largely on the evidence from Farmoor. In none of these examples can the turf cutting be related directly to arable land use.

The limitations of the bow ard in this respect may not have been a serious limitation on agriculture. It should have been capable of ploughing lands after one or two years of grass fallow, and for more established grass cover, methods of turf paring were clearly known from the Neolithic onwards (Evans 1970,3; Bradley 1978,16-7). If turf was valued as a building material, the need for stripping would not have been a disadvantage.

3.2.2.iii. Inverting the soil.

The third area of argument about the capabilities of ards is the question of their ability to invert the soil. The case that ards were regularly tilted in use depends on examination of wear marks on shares and the profile of ard marks.

Wear marks on both crook and bow ards from Scandinavia are typically asymmetric. Glob suggests that "the arrow-shaped main share of [the bow ard] acts as a mould board, turning the soil mainly to the one side when held obliquely during ploughing"; the wear marks confirm this (1951,113). Wear on the (undated) wooden ard heads from Virdifield (Shetland) shows they had been used asymmetrically, and Rees suggests their winged shape may have been intended to aid in turning the soil (Rees 1981,70). The Milton Loch ard head (dated to about 400 bc) also shows asymmetric wear. Rees (1978,106-8) notes that the stone ard shares from Orkney and Shetland not only show asymmetric wear but also were deliberately shaped asymmetrically. Ard marks indicated the ard was tilted during ploughing. At Sumburgh, Shetland, the angles of tilt ranged from 6 to 18° from the vertical (Lamb and Rees 1981,117). The ard cultivation spanned the whole second millenium BC. At the Danish Iron Age site of Store Vildmose, the angle of tilt had a similar range, but fell into two distinct groups of 3 to 5° and 15 to 20°. Nielsen attributes this to tilting, which "could be fortuitous or intentional for example in connection with turning or in pushing the earth over to one side" (1970,157-9). A number of other British sites have produced asymmetric ploughmarks (eg. Lodge Farm, Alveston: Everton and Fowler 1978,Fig.28.1.c; Stane Street: Fasham and Hanworth 1978,176).

However, Reynolds (1982,143-4) makes a strong case, based on experiment, against the view that these features are the result of tilting bow ards to turn the soil. To summarize his arguments, tilting causes the angle of the foreshare to diverge from the angle of traction, and thus the ard to veer; tilting interferes with the traction animals and makes it necessary to harness them in a way he considers less efficient; tilting stresses the stilt in a way which makes it liable to break; although inverting the soil is desirable, in labour intensive agriculture where the seed bed is not prepared solely by ploughing, it is not essential. He concluded that if the ards had been intended to invert the soil, they could easily have been designed to do so, without the need for tilting (see discussion of Mors ard head below).

Other experiments support his view. Hansen (1969,90), using a Hendriksmose type of bow ard, reported that "an ard with a curved beam and a stilt through the base is not very suitable for ploughing in a tilted position". In loose soil, tilting caused the ard to slip out of the furrow. Aberg and Bowen (1960,146), using like Reynolds a Donnerupland type ard, found that tilting the ard allowed them to turn a furrow slice up to 7 inches wide. But this could not be achieved consistently, and with the ard tilted at an angle of 30° from the vertical the shares broke. This is a steeper angle than suggested by the ploughmarks at Sumburgh and Store Vildmose. Reynolds (1982,144) noted that "a 45° angle [is] sufficient to invert the sod a little although a steeper angle is preferable".

Hence the experimental evidence argues against tilting to invert the soil - it is difficult to achieve, inappropriate given the ards' design, and the angles of tilt inferred from the ploughmarks would have been insufficient to achieve the effect. As an alternative explanation, Reynolds suggests that round and round ploughing (where the same side of the ard is always offered to the land side) could account for asymmetric share wear and the appearance of tilting. A slighter tilt, not steep enough to turn the sod, might have thrown the soil to one side; this could allow the creation of ridges. Steensberg (1976) has suggested that the Døstrup, Donnerupland and Hendriksmose ards all show signs of the use of a crossbar to support mouldstrokers, which he suggests were attached to the ard when needed to push the soil into ridges, perhaps to cover the seed.

Evidence for ridges attributed to ploughing in Iron Age and Roman Britain is limited to the ridges from Rudchester (Gillam _et al_ 1973). Their interpretation is difficult; as the ridging did not affect the subsoil (unlike mediaeval ridge and furrow), recovery is likely only in a restricted range of circumstances, and their unique nature should not lead to their being ignored. It may be significant these were on clay soils; they are discussed further in the section on drainage in Chapter 6. Cultivation ridges have been found at a number of Scottish sites; they appear to be spade built, in one case (not securely dated) showing traces of ard cultivation of the ridges. The earliest ridges (North Mains) predate a late Neolithic barrow (Halliday et al 1981,55-6). Similar ridges have been found at some Irish Neolithic and Bronze Age sites (Caulfield 1978,140; Fowler 1981,20-1). Most of these survive because of peat growth. Halliday notes over 30 examples of rigged cultivation identified from air photographs in northeast England and southeast Scotland, some of which may be associated with prehistoric settlements, and suggests they may represent a "specialised form of cultivation for a particular crop" (1982,82,86). Fowler, remaining sceptical about the Rudchester ridges, suggests they may "just possibly" represent the introduction of a new and specialised tool (1983,154-5,177).

Another possible reason for tilting is provided by Steensberg's (1958) interpretation of Columella's (II,II,25) description of ploughing alternate upright and slanting furrows to ensure that there is no ground left unbroken between them. This is the first ploughing of the compacted earth. This technique would account for asymmetric wear, and possibly because the ard was tilted away from the land side (the ploughman must walk on the broken ground) and hence would veer towards it (Reynolds 1982,144), steering the tilted ard would be less difficult. Fowler (1971,175) reports that the efficiency of repeated ploughing in the same groove (followed by shallower ploughing between furrows and then cross-ploughing) has been demonstrated experimentally. He does not mention tilting the ard. However the type of plough used in Roman Italy may have been the sole ard rather than the bow ard (see below), and this suggests that this explanation cannot be regarded as proven. But it remains a possible explanation for the asymmetric wear.

The Danish evidence does however include an ard head which appears to have been designed to function as part of an asymmetric ard. The Mors ard head belongs to an ard of Døstrup type, and resembles the main share of the Donnerupland ard except that it has only one hole in its upper face. The purpose of the two holes in the Donnerupland main share is considered to have been to hold wooden pins to keep the foreshare in position. The single hole in the left side of the Mors ard head implies the ard head was intended to be used tilted to the right. The ard head has been dated to 160+/-100 bc (Laegsmand 1968). There are also two asymmetric ard shares from Rappendam, each having a shoulder on one side only (Glob 1951,119). These date from the first century BC (Steensberg 1986,142).

Ards or ploughs capable of turning the sod existed in the coastal marshland areas of Germany and the Netherlands in the late pre-Roman Iron Age (Steensberg 1986, 144-5). At Feddersen Wierde the mound preserved beneath it plough furrows which in section clearly show that the soil was turned (Haarnagel 1961, Table 17(2); Steensberg 1986, Fig.56). Steensberg infers the use of a heavy plough, equipped with coulter and wheel carriage, drawn by more than one yoke of oxen, and needed to cut through the "tough and matted greensward" of the marshlands. That is, he regards the plough furrows as indicating a different type of tool to the asymmetric ard parts from Denmark. However he does not state whether a turf line survives in any of the examples cited, and without some supporting evidence for his interpretation, the possibility that the tool used was also an asymmetric form of the ard remains.

His discussion of these implements raises some important general points. He suggests that while the types must have been more widely known in northwest Europe, it would have been adopted only where soil conditions made it advantageous. He stresses that there is no reason to suppose that "such a revolutionary invention would have spread rapidly"; instead "manipulating man ... modified his means of tillage according to local conditions and needs" (ibid,145). This evidence does not demonstrate that a sod-turning ard or plough was known in pre-Roman Britain; but where soil conditions demanded (e.g. on heavy clays requiring ridging for drainage) there seems no reason to assume that such a tool was not used. The Rudchester ridges are much less anomalous set against this background of evidence from northwest Europe, and suggest that tools of this type were known here.

These ard parts and furrows again illustrate the problems which arises from an essentially static view of prehistoric agriculture. Bow ards of the Døstrup type have dates from the ninth century BC onwards (Lerche and Steensberg 1980,81-6). The Donnerupland ard used as the basis for Reynolds' reconstruction is probably early Iron Age or late Bronze Age (Glob 1951,114). Modifications and improvements in design during their period of use to meet a variety of needs (both before and after the time of the few fairly completely preserved examples) are surely to be expected. Recent work on both ards and ploughs shows that there is "no clear distinction .... between a symmetrical ard and an asymmetrical plough" - ards used asymmetrically or equipped with coulters (the latter from the Ukraine) are now known, and ards with mould strokers or wheels have been inferred (Lerche and Steensberg 1980,55-7).

The evidence, mostly from Scandinavia but supported by the limited British material, suggests that bow ards, falling into two main types depending on the size of the ard head, with or without main shares, and with three types of foreshare suited to different soil conditions, were versatile and efficient tools. The evidence may be too thin to identify patterns of development in detail, but the Mors ard head strongly suggests that by the second century BC the principle of pushing the soil to one side was established, whether used to invert the soil or to build ridges. The Rudchester ridges suggest this was understood in Britain too, and its role in drainage may have been of considerable economic importance in cultivating clay soils. But perhaps the important aspect of this apparent middle Iron Age innovation is that it demonstrates that experimentation and development were continuing.

3.2.3. Changes in ploughing technology during the Romano-British period.

Inferences about the influence of the Roman occupation on ploughing technology are hindered by uncertainty about the types of plough in use in Roman Italy and elsewhere in the Empire.

The type of plough in use in Roman Italy remains a matter of dispute (Rees, 198 ,489). The most quoted evidence (a passage from Vergil's Georgics I,169-175) is interpreted by White (1967,123-135,213-6) to imply a sole ard and by Aitken (1956) to imply a bow ard. Steensberg (and Manning 1964,55-7) follow Aitken. Again problems arise from the essentially static viewpoint which discussions of agricultural practice so often take. This is illustrated by White's comments on the wheeled plough, described by Pliny (Natural History 18,172) as recently invented in Raetia. White dismisses this as having "no place in Roman agriculture" - and yet it was, obviously, known to Pliny, and little Roman writing on agriculture survives from after the first century AD (White 1970,xiv). It could have been adopted in Roman Italy; it certainly could have been adopted elsewhere in the provinces. Manning's (1964,60) attempt to relate shares from Roman Britain to the categories described by Pliny illustrates the same problem.

Pohanka (1986) concluded that the plough in use in Roman Austria was a sole ard type, and (the area he considers includes Raetia) probably with wheels. The iron share type which is most usual (a two-winged symmetric share) resembles Rees' type Ic, which first appears in Britain in the first century AD. If Pohanka's interpretation of these shares as fitting directly to the sole of a sole plough/ard is correct, it is possible that a new plough type is represented. But Rees (1979) does not suggest there is any problem in relating these shares to a bow ard.

In this connection, it is interesting to compare the winged shares from Britain and Austria with the socketed share from Saalburg and the tanged share of the Cologne plough model illustrated by Manning (1964,Fig.6,Plate 8). These types do not occur in Britain (Rees 1979,64).The much narrower necks of these German examples in contrast to the broad necks of the winged shares suggests they are different in the way they related to the structure of the plough. A plough model from Sussex appears structurally different from the Cologne models (I am not convinced by Manning's view these are "in the same tradition"); its wide neck between ground wrests and share make these wide necked winged shares more explicable. The cast model is difficult to interpret in terms of "which part is supposed to be mortised into what" (Rees 1979,63); while Rees is "fairly sure" of Manning's interpretation of the tool as a bow ard and offers a structural interpretation (ibid, Fig 71b,c), there seems a strong case for it being very different from bow ards of the Donnerupland or Døstrup types. The other British plough model, from Piercebridge is, interestingly, of a sole ard; the ploughman, using a team composed of a bull and a cow, is apparently performing a ritual (Mann 1975,23), and caution is necessary in relating it to ploughing practice in Britain. It could be speculated that the Sussex plough reflects cross-fertilisation of ideas between an introduced sole ard type with ground wrests and the indigenous bow ards.

The evidence does suggest that during the Romano-British period, new types of share and plough/ard became known and were introduced. The share from Box (illustrated by Manning 1964, Plate 8) seems to be an illustration of this. It is of a type otherwise not known in Britain, though Manning notes that 6, accompanied by 6 coulters, were found in a hoard from Gettenau. Rees (1979,59) regards this as a development of her type IIb shares, but it is much more massive and on the basis of her illustrated examples, it is difficult to accept the relationship. It should be noted that its dating is not secure, although Rees and Manning both accept it as Romano-British (Rees 1979,59). However, it may demonstrate the ability of villa owners in Britain to experiment with agricultural tools from a wide range of sources.

Returning to the question of the capacity of the tools in use to invert the soil, both asymmetric shares and the presence of ground wrests on plough models can be cited to indicate this was possible by the later Roman period. The provision of ground wrests on ploughs or ards would seem to be a logical extension from the use of wide arrow shaped main shares. They act to push the soil aside and into ridges. The Sussex model has clear ground wrests, which are also claimed for plough models from Cologne by Manning (1964,57), but Wightman (1985,123) doubts this interpretation. These models appear to be the only evidence for the use of ground wrests; the date of their introduction is unclear, but one of the German plough models is dated to the fourth century AD (Manning 1964, note 18). Ground wrests can be used to invert the soil if the ard is tilted in use; Manning suggests that a 'keel', as on the Sussex model, would aid this (1964,64).

The asymmetric iron winged shares of the late third and fourth century AD are the first strong evidence for a plough designed to invert the soil in Roman Britain. Although these are often take along with the coulters found in the period to represent a new heavy plough type, it must be noted that the coulters are associated with the bar shares and not with shares of this winged form. Pliny (Natural History 18,173) seems to imply that shares of this form were themselves capable of cutting through roots etc; use with a coulter cannot be assumed. A winged share (symmetric) and coulter pair found in York (Tweddle 1986,195-7) were "effectively unstratified"; they may be Romano-British in date, but the typology of the coulter suggests they are later, and as this find would represent a combination not otherwise documented, it is safer at present to assume that they are later in date. The asymmetric share may be a British innovation; it is not present in Gaul (Wightman 1985,123), or in the material from Austria catalogued by Pohanka (1986), despite the fact that the symmetrical winged share is the normal type there.

The implication is therefore that two new types are seen in the material from later Roman Britain, the bar share and coulter plough/ard and the plough/ard with asymmetric winged share, and, presumably, a mould board to help turn the sod (Manning 1964,65). However Rees (1987,498) notes that the use of a mouldboard is not proved. This view is clearly liable to modification with the recovery of new data, but it is important to note that a single late Roman type heavy plough combining the features of asymmetric share, coulter, mouldboard and wheels is not supported by the evidence as it stands.

There is of course a question as the whether these types represent introductions in the later Roman period, or whether, as Rees (1979,60-1) notes, their dating is biased by the pattern of occurrence of hoards. Heavy tools with scrap value might well be under represented in the evidence from the earlier part of the period, when few hoards were deposited. But Salway's summary of economic change in the later Roman period emphasises both the redistribution of wealth in favour of larger land owners (also Wacher 1978,117-8) and an accompanying shortage of manpower, especially agricultural labour (1981,545-9). This context could clearly encourage experimentation with new tool types or wider adoption of existing types which required a greater investment of raw materials (and probably also of productive skill) but reduced the labour inputs required in the basic processes of agricultural production (see also discussion of scythes below).

In the context of the dating, it is worth noting that elongated fields, often regarded as a Romano-British introduction reflecting changes in plough technology (Bowen 1961,24), are known from as early as the first or second centuries AD at Totterdown (Fowler 1964,185-6; Bowen and Fowler 1962, Pl.1b). Whether this represents a change in technique or in technology is an interesting question.

While the idea of widescale Roman introductions of agricultural improvements is now almost universally discounted (eg Reece 1987,3), this should not obscure the evidence that the Romano-British period was one of substantial experiment and innovation. It is interesting to contrast writers on Roman Britain, such as Wacher (1978,106-9), and their emphasis on improvements resulting from Roman influence with White's discussion of Roman agriculture in a wider context. He considers that "technical advances within the closed economy of the Roman Empire were few" and of these, "six out of the ten improvements came from outside Italy and the majority of the latter were from the northern provinces of Gaul, Germany and Britain" (1970,xx). It can be argued that in both Iron Age and Roman Britain there is a tradition of agricultural innovation and experiment. In the Romano-British period wider and different contacts may have brought a range of new types to try and modify to Britain. The new types of plough shares have been found predominantly in towns or villas; on other rural settlements the types found are overwhelmingly Ia and its lengthened form IIb. There are clear indications that by the late Roman period some specifically British types had developed from the variety of sources.

3.2.4. The context of iron shares and share tips.

Evidence from ploughmarks and experiments combine to allow the conclusion that the bow ard with wooden share was an effective tool, though with a few limitations. Neither its probable inability to invert the soil nor its inability to break established grass cover may have been a major drawback. But the frequency with which the wooden foreshares will have needed sharpening or replacement requires comment.

Some figures are provided by Reynolds (1982,142-3) and Hansen (1969,87). Reynolds found the share worn by 2.5cm in ploughing half a hectare; it needed adjusting twice in a day's work and sharpening occasionally. The shares used by Hansen wore more rapidly (wear rate depends on soil type), and wore 1.5cm in ploughing 480 m. He sharpened the share every 12 furrows and used up 6 shares in ploughing a half hectare. These rates clearly show why stone was used to tip the shares of wooden ards on treeless Orkney and Shetland (Rees 1978,104).

The limited period available for ploughing implies that the labour consuming process of sharpening and changing share might have constituted a significant limitation on cultivation. Sharp shares are of particular importance on heavy clay soils, to prevent smearing and pan formation (Briggs 1977,52-3). At present there is no evidence suggesting that fitting an iron tip to the foreshare of a bow ard would increase its performance, and it is probably its increased durability and the time saved which were the major incentives.

There is an important distinction between a wooden share and one tipped with iron, recalling Boserup's differentiation of 'make' and 'type' of tool (1965,26-7). While a wooden bar share was presumably simple to make, an iron tip requires specialist skills and equipment. A parallel is perhaps provided by Gailey's description of the traditional manufacture of turf spades in Ireland; the user made the wooden tool and took it to the blacksmith to have the iron blade added. A further distinction can be made between the iron bar shares (Rees' type IIa) and the other share forms, which consisted of a iron part attached to a wooden part. As the bar share did not need to be fitted to a wooden part, they could be made independently and marketed as finished commodities, usually it seems in a share and coulter set. This may account for their frequent occurrence in towns (see Table 3.2).

Two trends in iron shares are described by Rees. One is an extension of the area in which they are found; this is primarily southeast in the Iron Age and more widespread in Roman Britain (1978,112). The second is for increasing size and quantity of metal used. Manning (1964,59-60) recognises this trend in the later Iron Age, although as Rees notes, it is "neither consistent nor uniform". She comments that "the final development of this lengthening process was clearly to make the whole share of iron" (1979,52-3). While some exceptions are noted, the intention seems to be to impose an evolutionary model onto the material. It is suggested here that to do so is misleading.

Table 3.2.

The context of Romano-British shares and coulters.

Shares.

Type	In hoard : Not in hoard	Habitation site	Villa	Town	Other
Ia	0:17	11 (7)	1	3 (2)	3 (2)
Ib	1:2		1		2 (S)
Ic	0:5	1?	1	1	3 (S)
Id	1:3		2		2
IIa	18:1	1		12 (4)	6
IIb	0:9	3*	5 (1)	2	
[Box type	0:1		1		]

Coulters.

	15:13	4	3	14	7

Notes

1. Information taken directly from Rees' catalogue (1979,269-286); discrepancies between her catalogue and text classifications have been corrected as far as possible.
2. Figure in brackets is number of different sites.
3. (S) indicates finds from Scotland.
4. * 2 of these are doubtful either in interpretation or date.

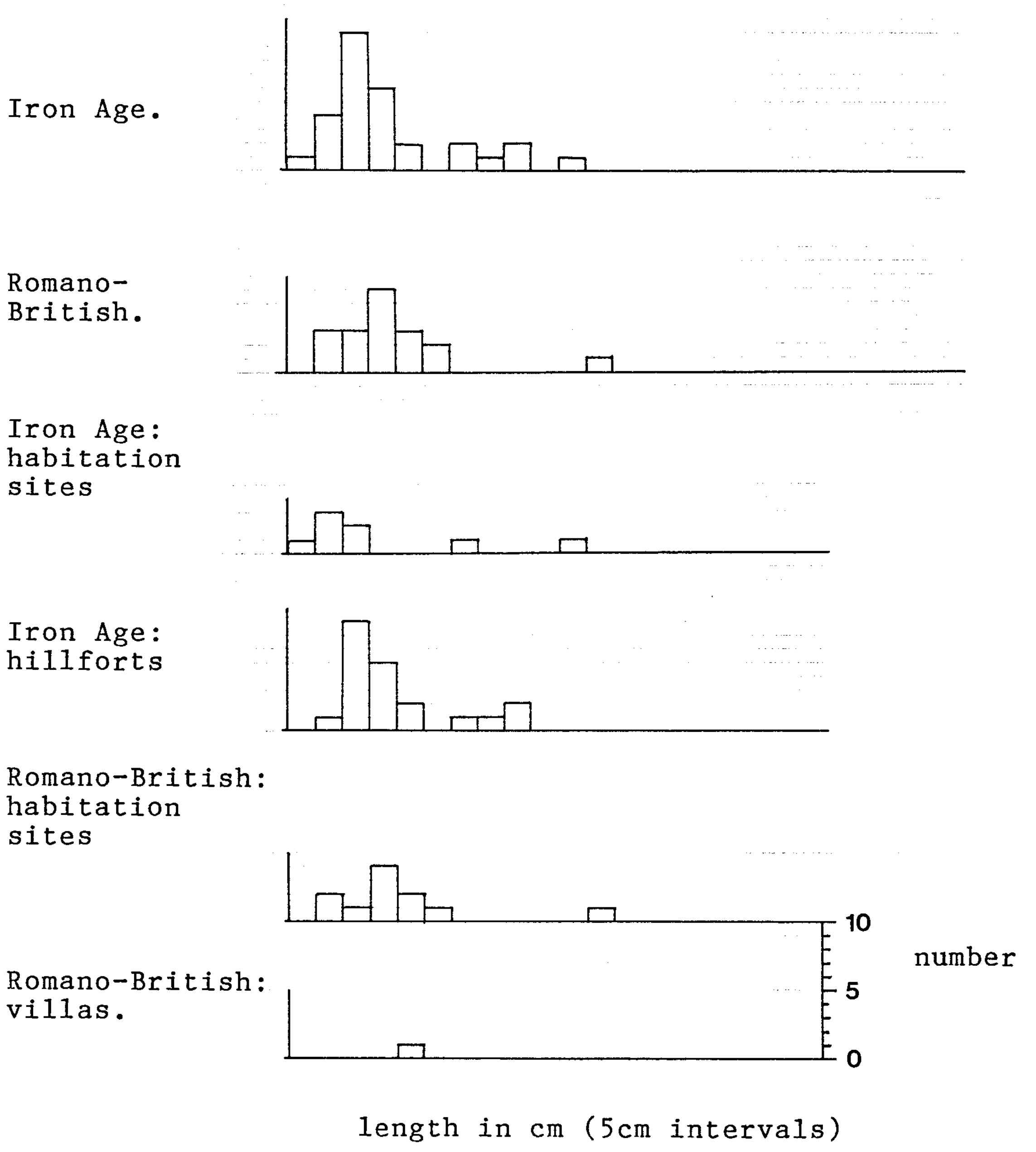
Two reasons can be given. The lengthening of share tips of type Ia can be accepted, but the mean difference in length between Iron Age and Romano-British shares is small (1.6cm). [The lengths are plotted in Fig.3.5; only shares from Rees' catalogue are included]. Some long shares date to fairly early in the Iron Age (for example, at Danebury the longest plough share bar (at 69 cm, the longest Iron Age share known and comparable in length with the smaller of the type IIa bar shares from Silchester and Great Chesterford) dates to the fourth century BC, predating the two shorter share tips from the site (Cunliffe 1984,354-7). But as well as the chronological change, when the lengths of these shares are plotted in terms of their contexts, it is clear that there are also economic factors acting. The average length from hillforts exceeds that from other Iron Age sites. There is only one type Ia share from a villa, which may in itself be significant. Type IIb, which it was suggested above is a development of type Ia, is correspondingly commoner on villas (Table 3.2).

Secondly, the introduction of type IIa bar shares, and their firm association with coulters, seems to imply a change more radical than a simple elongation of the iron component of the share. Their contexts, and especially their representation in hoards, distinguish them from the bar share tips of types Ia and IIb. The asymmetric winged shares may similarly represent a more fundamental change in plough technology.

Descriptively the view may be broadly accurate; but it does not offer an explanation of the processes involved. Both innovation and variation in size within types must be explored in terms of responses to socio-economic conditions and change. Figure 3.6. is a reclassification of the iron shares and share tips, which tries to take into account the points discussed here.

Figure 3.5.

Length of iron share tips of Rees' type Ia.



Average lengths:

Iron Age:		Romano-British:	
all	18.9cm	all	20.5cm
hillforts	19.8	villas	22.0
habitation sites	16.7	habitation sites	20.9

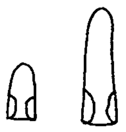
Figure 3.6.

Reassessment of iron shares and share tips.

Shares fitted to wooden foreshare.

A. Narrow shares.

A1. Lengths vary considerably, but all have blade widths of less than 5.5 cm. Romano-British examples have a noticeably smaller width range (less than 4 cm). Includes all Rees' types Ia and IIb.



Rees Ia; dates from C5-C3 BC onwards.

3 examples only; may be interim stage between Ia/IIb. Dates in C2-C3 AD.

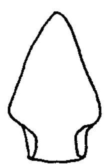
Rees' type IIb: dated examples are C3 AD.

These shares show a process of development from a simple tip to a wooden share to an iron extension of the share.

A2. A single example of a narrow socketed share with enfolding tip, from Rees' type Ib. C3/C1 BC.

B. Wider shares.
These are all socketed and all have maximum blade widths greater than 7cm. Rees identifies three types.

Rees Ib:
enfolding tip.
from C1/C2 AD



Rees Ic:
shouldered.
from C1/C2 AD

Rees Id:
asymmetric winged.
late C3/C4 AD

Shares entirely of iron.

C. Iron bar shares.
All less than 4 cm wide, and associated with coulters. One possible example is a worn and broken stray find; the others are from fourth century hoards.
Possibly represent a new plough type.

Source:
Information from Rees 1979, Fig. 49 and pages 50-59, 279.

The developments seen in the evidence for ploughing relate closely to socio-economic factors. Changes in tools reflect changes in investment levels and types, and changes in the relationships between labour and production. Increasing use of iron tools and their development represent increasing investment of wealth in agricultural production, and increasing attempts to increase the productivity of labour.

In this context, the differential lengths of shares from hillfort and non-hillfort Iron Age sites is interesting (the unusually long non-hillfort share is from Glastonbury, hardly a minor site). It suggests that agriculture formed an important part of the Iron Age status system, and that this may form a key to understanding changes here.

The occurrence of the different share types in the Romano British period also reflects the status of the sites they were found on. The developments of the third and fourth centuries, with increases in the quantity of iron in shares (seen in the introduction of Rees' IIb type) culminating in the later third and fourth centuries in new plough types apparently developed within Britain, also suggests economic developments in that period. Two issues may be important here. The first is the availability of labour; Salway (1981,545-9) has suggested that the supposed late Roman population decline was primarily a shortage of agricultural labour. The second is changing economic relationships in the countryside, in the form of a changed system of taxation and the development of a market economy, which some writers suggest did not occur until after 200 AD.

The point which is stressed here is not simply that it is essential to incorporate socio-economic factors in any attempt at explaining changes in agricultural technology. These changes themselves, rather than representing a marginal area of specialised interest, have considerable potential as a key source of information on social and economic change.

3.3. Scythes and sickles.

In addition to the evidence for harvesting cereal crops, this section concentrates on tools for cutting fodder crops, because of their relationship with fertility maintenance practices dependent on the management of livestock. The development of scythes and sickles is more readily understood if the two processes of grain reaping and straw cutting are considered separately. These tools show evidence both for the introduction of a new tool type following the Roman invasion, and for the development of new types during the Romano-British period. These changes are related to aspects of both agricultural practice and the economic context of agriculture which are discussed in later chapters.

The paucity of the evidence for even the better known types and the biases which appear to result in other types being substantially underrepresented are discussed. It is suggested that because some Romano-British tool types are well known, it is often assumed that the range of tools in use is also firmly established; this is not the case. Because of the importance of the ironwork hoards in this respect, their contexts of deposition are examined. Which tools are (and are not) found in hoards is also important in considering socio-economic aspects of tool use. Two other factors are considered: the relationship between tool type and labour organisation, and the possibility of changes in the production of tools .

3.3.1. Patterns of change in tool types.

As before, much of the data on tool types derives from the discussion and catalogue by Rees (1979). Rees does not list the dating and context of the harvesting tools in her catalogue, and this imposes some constraints on the discussion. It was not possible within the limits of this thesis to assemble this information (not least because so many of the tools are unpublished) but evidence for the date and context of the non-military balanced scythes has been listed, if published.

3.3.1.i. The use of sickles.

Before discussing the sickles, it is necessary to review the evidence for their use. Reynolds (1981,113) has concluded from experiments that the sickles of the Iron Age were "grossly inefficient and far too slow" for reaping, suggesting that the heads of corn were picked by hand. As the sickles were "similar in size and weight to the traditional spar hook" they were used for splitting hazel, stripping bark and cutting branches. Given the importance of wattles in building, the interpretation is plausible. He does not comment on their suitability for cutting straw or fodder plants, but in the absence of an obvious alternative and the need for thatch etc, this must be considered to have been a likely function of at least some of the "reaping hooks" (see below).

The balanced sickles can probably be assumed to have been used for reaping grain and/or for cutting hay and straw. Roman practice is summarised by White (1967,98-101). A balanced sickle was used for reaping, while the scythe was usually used for hay. However where the ground was uneven or the crop poor, hay was sickle cut. Cato's inventories include a _falx stramentaria_, interpreted by White as a special type to cut straw after the grain had been harvested. A number of methods of harvesting are recorded, both by Roman writers (eg Columella 2.20.3) and in more recent use (Fowler 1983,179; Steensberg 1943,124-5). In the open field areas of France, grain was sickle reaped up to the eighteenth century AD; scything was not permitted as there were common rights to cut the long stubble as straw (Bloch 1966,47). The persistence of alternative methods to sickle cutting even after the balanced types of sickle became universal lends support to Reynolds' scepticism about the use of unbalanced forms. Reaping grain and cutting straw are therefore best treated as two separate processes, which may at times be carried out in one operation.

3.3.1.ii. Developments in sickle types.

The balanced sickle occurs in Britain for the first time in the late Iron Age (Rees 1979,458). Rees suggests it was "by no means a commonplace tool", accounting for 9 of the 50 Iron Age sickles she listed. The proportion in the Roman period is twice as high (30/83), but as the balanced type is not found in the earlier Iron Age, the difference may not be real and Rees' interpretation should be treated with caution. The question of whether this tool was used primarily for reaping or straw cutting is difficult to resolve. Steensberg related the early modern transition from sickle to scythe reaping to increased production of grain; a greater acreage must be harvested, and to save labour a faster if more wasteful technique is adopted (1943,246). Similar factors could have resulted in the adoption of the balanced sickle; attempts to increase production of grain, perhaps for export as documented by Strabo (4.5.2), may have encouraged use of sickles and experimentation with new types. This view of later Iron Age agriculture is, it must be noted, significantly divergent from those (eg. Cunliffe 1984b) which infer population pressure, declining soils and agricultural stress at this time. In that case, there would be no cause to save on labour and a wasteful means of harvesting would hardly be acceptable - although the practice of allowing the poor to glean waste grain on the lands of the rich is very old (eg Lerche 1968,37). But this would imply a markedly stratified agrarian society, and the cause of poverty in such a system would as much social and economic as environmental.

The unbalanced reaping hooks fall into two main categories, angular and curved (see Figure 3.7). The socketed angular form (Rees' Ia)is "strikingly similar" to the bronze laterally socketed sickles, and occurs from the start of the Iron Age. Rees (1979,448) concluded that it had "a quite separate identity and , presumably, function"; it continued "virtually unchanged" until at least the early Roman period, when it appears to have been superseded by a tanged tool (Rees' IIc) otherwise similar to it. Rees considers its function was cutting weeds or fodder (ibid 451). It is less common than the curved types, and in the Roman period is found on a restricted range of sites (none from villas). If Reynolds is right about the use of the curved types, this is probably the straw cutting tool.

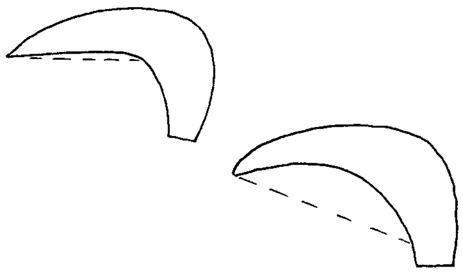
The earliest of the tanged curved sickles date to the period from the fifth to the third century BC; the narrow spike tang however only appears later in the Iron Age. The socketed type appear "relatively late in the Iron Age". Both forms continue into the Roman period, but are noticeably uncommon from villas (see below). The shorter balanced sickle of the Iron Age seems to have developed from the tanged sickles of type IIb tools and a number of "borderline" examples exist (Rees 1979,454-7). This suggests that despite Reynolds' doubts these were harvesting tools, though plausibly used to cut straw rather than for reaping.

Changes seen in the period relate chiefly to the forms of tang or socket rather than blade; the two

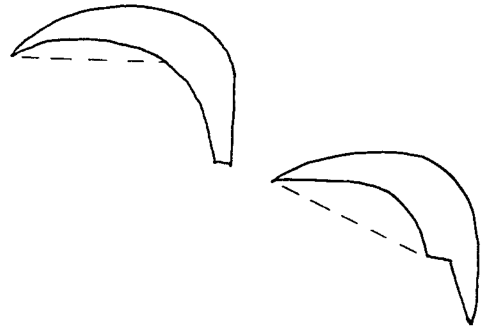
Figure 3.7. Classification of reaping hooks.

Angular blades

socketed (Ia)
E.I.A. - E.R-B.
7, 4:1:2

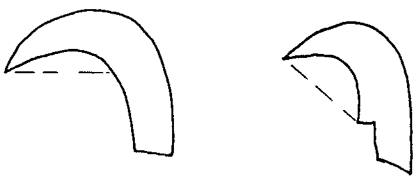


tanged (IIc)
R-B, none very early.
10, 0:6:4 *



Curved blades

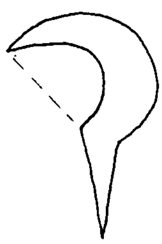
socketed (Ib)
"relatively late" in I.A. to C4 AD.
46, 21:19:6



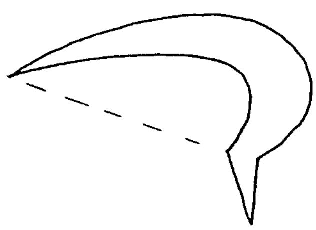
tanged (IIa)
from C5-C3 BC, but spike tang late I.A.
48, 16:22:0

Balanced types

shorter blade (IIb)
from C1 BC
35, 9:20:6



longer blade (IId)
only dated ex. are C4 AD
12, 0:6:6 *



- - - - indicates chord of cutting edge.
Numbers given as Total, I.A.:R-B.:unknown, following Rees' Table XI, except * alterations based on her catalogue.

Source: Rees 1979, 450-461, Fig 158, and Table XI.

distinct types, angular and curved, continue throughout the Iron Age and the Romano-British period. During the latter their use apparently largely excluded the villas; the socio-economic aspect to their distribution may be important in understanding both their use and developments in other tool types, such as scythes.

Balanced sickles are all tanged types, although a few Romano-British socketed examples "appear to verge on a balancing of the tool" (Rees 1979,452,455). While Rees regards the distinction between tanging and socketing as of little importance functionally, it seems that for the balanced types it was significant. Because of problems which arise in trying to understand the use of some tool types (especially the short-handled scythes) the differences between tangs and sockets was examined more closely for the sickles.

Rees (1979, Table XI) shows that the proportion of tanged to socketed forms changes from roughly 1:1 in the Iron Age to 3:1 in Roman Britain. For the unbalanced curved types (Ib and IIa) the change is slight (from 43% to 54% tanged); the change is most marked in the angular and balanced types. Table 3.3 relates the type of hafting to the length of the tool and of the chord of the cutting edge. The results are interesting. For the curved types (Ib,IIa) there is no relationship with the length, but the proportion which is tanged increases with the chord length (from 42% of those less than 5cm to 73% of those greater than 10cm). For the angular types (Ia,IIc) both longer tool and tools with longer chords are more likely to be tanged.

Since Rees does not give the dating of individual tools in her catalogue, size and chronology cannot easily be compared. Larger and smaller examples of Ib and IIa appear to occur in both the Iron Age and Romano-British

Table 3.3.

Comparison of dimensions of tanged and socketed tools of similar blade form.

Curved types, Ib and IIa.

(i) Length.

Length(cm)	No.socketed	No.tanged	Ratio S:T	% socketed
0-4	2	0		
5-9	5	9	7:9	44%
10-14	18	20	9:10	47%
15-19	7	8		
20+	1	2	4:5	44%

(ii) Chord of cutting edge.

Length(cm)	No.socketed	No.tanged	Ratio S:T	% socketed
0-4	4	3	4:3	58%
5-9	26	28	13:14	48%
10-14	3	7		
15-19	0	1	3:8	27%

Angular types, Ia,Ic, and IIc.

(i) Length.

Length(cm)	No.socketed	No.tanged	Ratio S:T	% socketed
5-9	3	1	3:1	75%
10-14	3	3	3:3	50%
15-19	1	2	1:2	33%
20-24	0	3	0:3	0%

(ii) Chord of cutting edge.

Length(cm)	No.socketed	No.tanged	Ratio S:T	% socketed
5-9	2	0	2:0	100%
10-14	5	4	5:4	56%
15-19	0	2	0:2	0%
20-24	0	1	0:1	0

Source: data from Rees 1979.

periods (Rees 1979,454,456-7). For both angular and curved types it is possible that the changing proportions relate to increasing length with time. However both the total transfer to tanging in the angular types (in contrast to the smaller change in the curved) and the absence of balanced socketed tools suggest a real functional relationship exists.

These factors may be important in considering the varied group of implements described by Rees as either short-handled scythes or slashing tools. The methods of hafting of these is often problematic; if practical problems attach to socketing tools which are balanced or have long cutting edges at right angles to the socket, this may lessen some of the difficulties. Billhooks, whose cutting edges are essentially in line with the handle, are mostly socketed; tanged examples are mostly in the beaked type, in which up to a quarter of the cutting edge is at right angles to the handle.

3.3.1.iii. Developments in scythes.

The long handled balanced scythe is one of the tools which can be regarded as Roman introductions, appearing in military contexts of the first century AD. Rees distinguishes two types. The shorter and wider type, Ia, occurs in early military contexts and the complete examples lack the inward turning point found on complete Ib scythes; experiments with reconstructions of the Great Chesterford scythes found this point gathered the corn and was essential for their effective use in harvesting grain (Anstee 1967). All dated Ib scythes are from the fourth century AD, mostly from hoards (Tables 3.4-3.5). It is unfortunate that the scythes found in agricultural contexts are not more firmly dated. Of those discussed by Rees (1979,476) the Farmoor example is "quite compatible with a fourth century date" but not certainly so dated (Lambrick and Robinson 1979,74-5), and, despite Rees'

Table 3.4. Contexts of Type I scythes.

site:	type & number	context	
Abington Pigotts	frag.,1b	hoard	X
Ameys Pit	frag.	well group	
Baldock	frags	(small town)	X
Bar Hill	2 frags	fort	
Barnsley Park	2, 1b	villa	1
Brampton	2 frags, prob. 1a	military tilery, c125 AD.	
Caerhun	2 frags	fort	
Caernarvon	frag	fort	
Carlingwark Loch	frags	hoard in cauldron in loch; late C1/early C2 AD.	
Castle Hill	frags	workshop deposit, road side settlement; c.150-180 AD.	
Corbridge	frags	fort	
Duston	frag, narrow 1a	(town, with high status housing).	2
Epping Forest	frag	stray find	X
Farmoor	1b	droveway and fields	3
Folkestone	frag	villa -not mentioned in excavation report.	
Gadebridge	frags	villa - dated pre-300 AD	
Great Chesterford	12, 1b	hoard, C4 AD.	
Haltwhistle Burn	1a	military, C1/C2 AD.	
Hardwick	1b	no information	X
Irchester	narrow 1a	probably C4 AD; not military	
Kingsholm	frag	not certainly R-B.	X
Loudon Hill	frag, 1a	fort, early R-B.	X
Newstead	4, 1a	fort; hoard; late C1 AD.	
Shenstone	frags	probably villa	
Sibson	narrow 1a	hoard; post 350 AD	X
Silchester	2 frags	(walled town)	X
Wilderspool	frag, ?1a	early Roman, probably military	X

Source:
Rees 1979, 719-729, catalogue of iron scythes
Information on context from Rees 1979 (473-480) and references cited there, unless otherwise stated.
X indicates Rees cites no reference.
1: Webster 1981,59-62.
2: Windell 1981,17 (site only; does not refer to scythe).
3: Lambrick and Robinson 1979.

Table 3.5. Summary of contexts of type 1 scythes.

military	civil				no information
	towns		rural		
	walled	other	villa	other	
/	/	/	* [2]	?H /	H /
/	Ø	Ø	/	H Ø	/
/	H * [12]		/	H *	/
/			/	*	/
/					*
H O [4]					
?H O					
?H O					
O					

Key:

/	Scythe fragment
O	Type 1a
Ø	Narrow form of Type 1a
*	Type 1b
H	Found in hoard
?H	Probably from a hoard
[4]	Number of scythes (where greater than 1)

Source: see Table 3.4.

comments, the Barnsley Park scythes are dated to the fourth century by their form not their archaeological context ("they were found in 1962....and it is unfortunate that at that early stage, the basic chronology and relevant stratification were not fully understood" Webster 1981,59). Webster seems to favour an earlier date (see below).

Rees considers that the "large majority" of Romano-British scythes are of the long-handled balanced type, but she also discusses a number of less readily classified tools. Three (from Rushall Down and Woodyates) are classed as short-handled scythes, while others (Ham Hill, Castle Dykes) she regards as "slashing tools", and the angular sickle from Chew Stoke has some scythe-like features. In the pre-Roman period there are five tools from Bigbury, which can "scarcely be defined as scythes" but are "suggestive of a type intermediate between sickle and scythe" (Rees 1979,466-7). These varied 'slashing tools' "seem to be in some way related"; she suggests they could represent "an earlier, separate attempt at the development of a tool type for which a need had been felt" (ibid,714). But she concludes that neither type of scythe occurred in pre-Roman Britain, and that the short-handled scythe was uncommon during the Roman period, when the long-handled scythe was "by far the most commonly used type" (ibid,479).

A number of problems clearly remain outstanding. The 'gap' in the evidence for the long-handled scythes, filled only by a few fragments, is both a problem and potentially a key to understanding the problems of archaeological visibility of agricultural tools. It is instructive to consider just what the evidence for this wellknown type would be without the hoard finds. The hoards may also distort the relative importance of the balanced scythes compared to the short-handled scythes or 'slashing tools'.

3.3.2. Scythes in the agrarian economy.

In an investigation of the agrarian economy, scythes are of interest for a number of reasons. As tools for cutting hay and straw, they are a source of information about livestock management, influencing the ability to house or pen animals for the winter months and so to accumulate manure for the arable. If scythes were used for harvesting grain, analogy with recent practice suggests this has important implications for the organisation of labour. The restrictions of certain types of sickle or scythe to particular classes of site should also be informative. Their use relates not only to wealth (that is, the ability to acquire the tools) but also to the context of their use - the tool must be appropriate not only for the physical task but also to the socio-economic organisation of the farming unit and the composition of its labour force. But the problems outlined above must be resolved before these factors can be discussed with any confidence; and these problems of interpretation are of wider interest in themselves.

3.3.2.i. The long-handled balanced scythes.

These tools are dominated by hoard finds, which fall into two distinct chronological and geographic groups - from military sites in northern Britain in the late first to mid second century, and from south and east Britain in the fourth century AD. As Manning has pointed out, casual finds of single iron objects are less likely to be recognised as of archaeological interest than groups (1972). A group of iron objects is also open to 'internal' dating when its context is unknown.

The two balanced scythe types identified by Rees correlate with these two hoard categories. What is interesting is that she infers there was "very probably" a third type, which she describes as a "narrow Ia" (Rees 1979,475). These are similar in width to the Ib scythes, but where their tangs survive, they are comparable in length with the Ia scythes, too short to be adequate for the Ib types. Rees' catalogue shows that the only scythe fragments from civil sites with surviving tangs fit into this category (Duston, Irchester, Sibson; see Table 3.4 above). It is possible that all or most of the fragments of scythe from civil sites are from this type, yet because it is poorly represented in the large iron hoards (Sibson only), its importance is underrated. Nor does this absence seem to be a chronological effect, as two of the recognised "narrow Ia" pieces are probably of fourth century date.

It is the scythes found during excavations which should provide the clearest information on the scythes in use. It is unfortunate that the scythes found are usually fragmentary (and there are few well-dated fragments) and that these are then usually evaluated in a framework based on the hoard finds, both as regards typology and dating. The uncertainties regarding the dates of the Ib scythes from Farmoor and Barnsley Park were noted above. Webster considers any date in the period 140 to 315 AD possible for the latter, but the area was also disturbed in the period 360-375 AD, and no reliable conclusion seems possible. The only two well dated fragments from excavations are also the only clearcut evidence for the use of scythes on civil sites before the fourth century. The fragment at Gadebridge Park villa dates to before the end of the second century (Neal 1974,17,170-1); the piece from Castle Hill (Margidunum) comes from a "workshop deposit" from the civil occupation of the site, dated on the basis of its pottery to about 150 to 180AD (Todd 1969,61-2,65,91-2). Both blades are narrow. [This excludes the Carlingwark Loch fragment, a hoard in a cauldron in a loch dated to the late first or early second century; it is comparable with the wide plough shares from Scottish contexts, although interestingly its width is in the range of the narrower 'civil' types. But the fragment from Brampton may also have been a narrower military scythe (Rees 1979,475).]

Conclusions about the use of balanced scythes are limited. There is evidence for their use in civil agriculture from the mid or late second century, but the type is unclear. There is a suspicion that the "narrow Ia", though poorly represented in the overall record, may account for many of the fragments and may even have been the usual type. It seems that neither of the known narrow types can be shown to have been in use before the fourth century, although a narrow scythe type clearly was. The contexts of the finds is discussed below. The paucity of the data about what is a wellknown tool type is surprising.

3.3.2.ii. Short-handled or unbalanced scythes.

Given the quality of the data for the balanced type, discussing the less common and less well understood short-handled scythe does not look promising. But understanding gained from the earlier discussion does help in assessing the evidence here.

The variety of tools classed by Rees as Type II unbalanced scythes or slashing tools all present problems in understanding how they were hafted and used. The five tools from Bigbury, dated to the mid first century AD could be "hafted as billhooks and used as slashing tools" (Rees 1979,466-7) or "hafted on handles turning through a right angle for use as true scythes" (Applebaum 1972,76). Four are socketed, one has a wide tang. Rees regards them as "slashing tools". The five Romano-British tools she accepts as Type II scythes have haftings ranging from spike tangs (Castle Dykes and Ham Hill) or flat tangs which curve round towards the back of the blade.(477-8, Figs 240,243a-c). It was suggested above that for tools whose cutting edge is at right angles to the handle, socketing may have been an less unsatisfactory means of hafting for tools with longer cutting edges. Problems such as this with hafting might explain some of the unusual arrangements seen in these types of tool, and the need for L-shaped handles.

Without experiment, the problems in understanding the hafting and use of these tools will not be resolved. But while they are largely regarded as an unimportant odd type, such work is unlikely. L-shaped handles are quite possible; they occur on other tools and the reconstructed Great Chesterford scythes required L or S-shaped handles (Rees 1981b,Plates 15-16). Recent balanced scythes have substantial cast steel sockets, and the S-shaped handle seems to have been first used in Britain in the twelfth century AD (Brigden 1983,21). Rees' comments on the practicality of these tools (1979,466,477) are not dissimilar in character to those made about the Great Chesterford scythes by their excavator:

"Their great length would render these scythes inconvenient, even if they were made to be fixed on the sneed in the modern fashion; but the recurved portion at the end of the blade, makes it difficult to understand how the handles could be attached so as to render them available for mowing in the ordinary manner.....the prevailing impression was that they.... belonged to the celebrated war chariots of old....so incredible did it appear that they could have been employed in simple harvest work." (Neville 1856,11).

But Anstee's experiments (1967) demonstrated both the practicality and efficiency of these scythes, and also the importance of the curved butt as a counterweight and in collecting together the cut crop.

Short-handled scythes are known from the Danish Roman Iron Age, and Steensberg experimented with a reconstruction of the Uggerby scythe. This dates from early in the period, and is more curved than later types. It is socketed, but the socket "was forged on after the bent up point had been driven into the handle" (Steensberg 1943,103-7). The tool was not well balanced, being "point heavy" and it required the use of both hands (as did a reconstruction of a longer-bladed unbalanced Viking Age tool). It was efficient in terms of speed of cutting, and did not uproot the plant. But the straw became mixed up in cutting and it loosened much more grain from the ears than did sickles used for comparison; Steensberg concluded that it "would scarcely have been employed for cutting corn" (ibid,20,44). But it clearly would have been an efficient tool for cutting straw or fodder crops, and when found the Uggerby scythe had a number of seeds of <u>Polygonum lapthifolium</u> embedded in rust on its blade; this species seems to have been a cultivated species in Denmark and the Netherlands in the Iron Age (van Zeist 1968(1970),166). The experiments show that a tool can be unbalanced and point heavy but still quicker and more efficient in cutting straw than a sickle, and this must be weighed against Rees' assessment of the Romano-British type II scythes and similar tools as "unwieldy" and "extremely awkward".

There are some indications that tools of this general type may have existed in Gaul in the first century AD. Tools illustrated on the Porte de Mars (Reims) are interpreted by White as a form of scythe rather than a long handled sickle. This could be the tool referred to by Pliny (<u>Natural History</u> 18,261); White notes that the balanced scythe is incapable of "cutting the stalks of grass in the middle" as Pliny described (1967,100-1). According to Pliny, the tool was used to save labour. But he appears to be describing it as a larger type of scythe, and the interpretation remains uncertain.

Whether scythes or slashing tools, these types can probably be related to ground clearance. They do not resemble recent hedgers' slashers (eg Brigden 1983,8) nor seem sturdy enough for the job, and a well-developed class of billhooks existed for hedging. Rees notes that if they were used for ground clearance, it implies a "necessity for larger scale clearing tools" developing at the end of the Iron Age (Rees 1979,467). Taken together, the tools could be "an earlier,separate attempt at a development of a tool type for which a need had been felt" (ibid,741). There seems no reason why a tool which could clear weeds could not also cut fodder crops - indeed it is probably unwise to assume that these were necessarily two distinct categories. Pliny (Natural History 18,261) describes the small scythe used in Italy as "shorter and easy to use even among brambles", and it seems reasonable to relate this to cutting weeds rather than use in a meadow.

If these tools represent the development of a distinct type of unbalanced scythe, as is known from elsewhere in Europe (eg Rees 1979,Fig.248; Steensberg 1943), two questions remain. One is how important and widespread it was, and the second is why it was not superseded by the introduced balanced types.

The first question is difficult to answer. The comments made about the "narrow Ia" scythe are relevant here. It was noted that many of the undated scythe fragments might derive from that type rather than the better known Ib; on the basis of the widths catalogued by Rees, they could equally belong to unbalanced forms. Scythe fragments can be identified as such as they are characterised by thicker rolled-round back edge; these occur on both balanced and unbalanced forms. The paucity of the evidence for scythes in civil contexts before the fourth century was noted - the only two securely dated examples are fragments. The important points are the influence the hoards have on our view of 'Romano-British agricultural tools' - and how restricted it would be without them (Manning 1972,224). The lack of iron work hoards during much of the Iron Age (ibid 239) introduces a similar bias, with a quantity of late Iron Age tools of a variety of little understood forms. Comparing the occurrence of tool which do occur in hoards with those which for chronological, geographic or socio-economic reasons do not is clearly open to bias. Recognising how incomplete the picture is is an important step.

The second question can be expanded as follows: if the Bigbury tools demonstrate an early attempt to make a scythe, why should possibly related forms (Woodyates and Rushall Down) be found in the Roman period, after balanced scythes were known in Britain? They may have been cheaper - the Ham Hill and Rushall Down examples are about half the length of the shorter balanced scythes, although the Woodyates scythe is only 10cm less than the smallest of these. The type may have persisted and continued to develop in a limited sector of the agricultural economy, whose needs it met. Their date within the Romano-British period is not known. Their unusual form might perhaps be accounted for by noting Frere's comments on the sculptured reliefs from Rushall Down; though "curiously blundered", they "express an awareness of the fundamentals of Romano-British civilisation" (1974,359). Similarly, these tools might reflect an imperfect attempt to reproduce a large scythe type known but not accessible to the user.

3.3.3. The economic context of the harvesting tools.

The indications from the context of the large iron tools (the scythes, and the barshare and coulter sets) are that their production and distribution centred on the walled towns (Tables 3.4-3.6). The difficulty is that the contexts of these types do reflect chiefly their production and possibly recycling as scrap rather than

Table 3.6. Summary of contexts of barshares and coulters.

Source: Rees 1979,269-289

	towns		rural		unknown
	walled	other	villa	other	
coulters:					
	5 H	1 s*	1	1 H	1 H
	6 H		1	1 H	1 s
	1 H		1 ?	1	1 s
	2		1 ?*	1 s	
				1 s	
barshares:					
	5 H			1 H	1 H
	2 H				5 H
	4 H				1 s
	1 H				

Key:

H hoard

s stray find

? context not certain

Contexts after Rees 1979, except where marked * (see text) their agricultural use. The more complete scythes and bar shares derive almost entirely from hoards. It is argued below that these can be regarded as preserving some aspects of economic organisation, whatever the reason for their deposition, rather than being interpreted as ritual deposits. The inclusion of smiths' tools, scrap or unfinished items in some of the hoards suggests a relationship with production.

For indications of the agricultural context, the evidence is a much reduced number of tools, often fragmentary. This is unsurprising, as in the normal course of events tools can be expected to have been used, repaired, reused and finally used as scrap. This process is represented by the finds, several of which are from contexts suggesting iron working; these include the scythe fragments from Castle Hill and the two scythes from Barnsley Park. The coulter from Fishtoft (Wilson 1971,7) may also be from an area of industrial activity of some sort. The more complete long scythes often show signs of repair (Rees 1979b,62); hence the portable mowers' anvils, whose findspots closely mirror those of the type 1 scythes (Rees 1979,480-1). The scythes also need frequent sharpening during use (Pliny _Natural History_ 18,261; Brigden 1983,22).

Applebaum concludes a discussion of agricultural tools with the assertion that the "increase in iron tools in Britain takes its commencement from the last century BC, but there is no doubt that the Roman conquest saw a further increase which brought well-made reliable tools within the reach of the common man" (1972,82).

Applebaum (1972,86) asserts that the "distribution of the large Romano-British coulter shows that its use, if not its introduction, was not exclusively related to highly romanized farms". The sites quoted to support this are "the former hillfort of Sandy..., the small settlement of Abington Pigotts.... and near the village site of Twyford Down". The following paragraphs will examine the contexts of the barshares, coulters and scythes and assess the strength of his argument.

The only fairly complete scythes are from Barnsley Park and Farmoor. The Barnsley Park scythes appear to pre-date the stone built 'villa' phase, but the earlier timber framed building may also have been the centre of a prosperous farm, as the addition of a bathhouse and subsequent stone house may imply. The Farmoor site consists of a droveway, with fields and a later yard. The environment was predominantly grassland, but the yard produced evidence for cereal processing. Lambrick and Robinson (1979,136) suggest that the "excavated occupation site was ... probably a subsidiary farmyard added to a more complicated agricultural settlement,...perhaps an estate attached to a villa". The other scythe fragments from rural sites are predominantly from villas; they derive from 2 hoards and a well group. At Appleford the scythe fragments apparently came from a well, which also produced a pewter hoard (Brown 1973). The barshare, coulter and scythe from Abington Pigotts came from an apparently unpublished hoard. This "small settlement" also produced a hoard of four pewter dishes, also unpublished (Peal 1967,30); it is not clear if one hoard or two is involved. But the presence of a pewter hoard should imply a "highly romanized" site nearby. The hoard from Sibson (scythe and coulter) was located "during a magnetometer survey for Roman pottery kilns near Water Newton" (Manning 1972,236). These are the only scythes listed by Rees from rural settlements not known to be villas; none of the sites can be shown to be a small farm rather than a villa or industrial settlement.

White's view (1972,81-2) that the Ib scythes relate to the fodder needs of the increased proportion of cavalry in the later Roman army can be discounted. Manning (1975) emphasises that the Roman army depended on local supply whenever possible, and if these scythes related to the hay needs of the army, their distribution should reflect that of third and fourth century military sites, which it clearly does not (Rees 1979, Map 16 can be compared with, for example, Wacher 1978, Fig.52)

The situation is the same for the coulters. Hockwold-cum-Wilton is a large cropmark complex, with a villa or bathhouse indicated by the presence of tiles (unusual in the Fenland). Salway suggests the site may be a villa with vicus (1967,141) or an unwalled small town (1981,593-4). Sandy was an unenclosed settlement at a road junction; its large cemetery and "regular discoveries of unusual finds" led Johnston (1974,51-2) to suggest it was a "centre for consumption and redistribution" for a population "dispersed in the countryside". The Sandy coulter (a stray find) may well have derived from a "highly romanized" source; the hillfort is an irrelevance in this context. The broken coulter from Twyford Down is also a stray find, from a Romano-British enclosure recognised from the air (Stuart and Birkbeck 1937,188,190). The site is close to Winchester, there is a villa at Twyford. Again, this is scarcely convincing evidence for the use of these tools in poorer or less "highly romanized" contexts. It is not reasonable to assume that because a tool is not demonstrably from a villa, it must derive from a "native settlement".

The evidence of the larger iron tools, the barshares, coulters and scythes contradicts the view that the Roman conquest "brought well-made reliable tools within the reach of the common man" (Applebaum 1972,82). For ploughing, the smaller or poorer farmers continued to use either wooden shares or the iron tipped shares of Rees' type la. Unbalanced curved sickles (Rees' Ib and IIa) are rare on villas (2/19 and 0/22 of the Romano-British examples; Rees 1979,454,455,457) and Rees notes that "many" of type IIa are from "native sites". They do occur in hoards (Sibson and Worlington). The smaller balanced sickle (Rees' IIb) occurs on a wide range of sites from the first century BC onwards (Rees 1979,458). [The longer bladed form might be expected to show a similar distribution to the larger iron tools discussed above; however, of the 12 examples listed by Rees only half can be securely dated as Romano-British, and only two are published.]

The fodder cutting role of the scythes may have continued to rest with the angular sickles. The continuity of this tool from the Middle Bronze Age (Rees 443,449) onwards and throughout the Roman period (despite the change in metal and from socket to tang) was noted earlier. Rees (ibid,479) suggests some of the longer examples of the Romano-British angular sickles may have been used as short handled scythes; two of this type, from Chew Stoke and Saltersford (ibid 664-5) have the rolled back characteristic of scythes. None of this type were found on villas; the angular reaping hook appears to have been a low status tool in the Roman period - perhaps better described as a tool more appropriate to the needs of a different agricultural economy to the villas with their large scythes.

The introduction of scythes, balanced or unbalanced, is an important event because it implies the adoption of a 'package' of agricultural practices, and carries implications for the division of labour which are also significant. The efficiency of scythes depends on the cultivation of a good quality crop in a prepared field or meadow. White (1967,99) notes that poor crops of hay or fodder are still reaped with sickles in traditional agriculture. Columella (2,17,4) describes the preparation of a new meadow; it was a three year process, involving both levelling the ground and sowing with a mix of grass and vetch. The Polygonum seeds on the Uggerby scythe, together with the evidence for heaps of small stones cleared from the fields (Steensberg 1943,249), represent the elements of the 'package' in the Roman Iron Age of Denmark.

The 'package' can perhaps be recognised in the later Iron Age in Britain. The increasing evidence for the cultivation of vetches in the later Iron Age is discussed in Chapter 4.4.4. A form of scythe is arguably the best explanation for the Bigbury tools, and it may fit into a picture of experimentation with agricultural technology at the end of the Iron Age (with, for example the Hunsbury shares of Rees' type IIc). Field clearance is less easy to document; the two problems are the difficulties in dating of field banks and lynchets, discussed in Chapter 7, and the lack of the necessary information in the case of published examples. Only the consistent clearance of smaller stones (Steensberg says "hand-sized"), too small to interfere with ploughing can be interpreted in this way. This interpretation can clearly not be put forward with any great confidence in the present state of the evidence. Understanding the implications and interrelationships of the different areas of agricultural practice will be crucial in reaching a firmer conclusion. These questions will also be related to the discussion of livestock management and fertility maintenance in later chapters.

Accounts of the adoption of the balanced scythe for reaping corn have stressed the change in labour patterns involved. Brigden (1983,19) notes that use of the sickle continued on small holdings "where the family constituted the primary labour force" because they can be used by women as well as men. The short handled scythe reconstruction was heavy in use; the closest comparable tool in recent use may be the bagging hook, as Steensberg's description of the use of the scythes and Brigden's (1983,20-1) of the hooks are similar. The bagging hook was also regarded as too heavy for women.

The motivation for the transition relate to labour problems. While Collins (1969) attributed this to overall shortage, Perkins (1977) suggests that fluctuations in labour demand in the early nineteenth century due to variations in crop quality and weather were the key factor. The problem was acute when haymaking had to continue into the harvest period. Perkins identified a range of factors influencing adoption, including soil types, the pre-existence of mowing skills, the adoption of certain other agricultural innovations (ie, it was part of a 'package' including machine threshing, field rollers, seed drills and new crop varieties), and the size of holding (larger farms stood to gain more) and social and educational status of the farmer. Collins (1969,459) noted that scythes were not widely adopted for corn until their design was modified. Initial (and not always successful) experimentation prompted development of the tool, which then resulted in its wider adoption. Scything is a difficult skill to learn, and an initial drop in productivity follows its introduction (Perkins 1977,54-7). While this adoption of the scythe for reaping is clearly different from its initial adoption for mowing, some analogies can be drawn, particularly in the case of the need for experiment and development, its role as part of a 'package', and the relationship with the farmer's knowledge and size of holding.

It is possible that the long type Ib scythes were used for cutting corn. Anstee (1967,368) suggests that while the earlier Ia scythes were for mowing, the Ib scythes were for reaping, being "probably developed for cutting the relatively widely spaced stalks of a corn crop" and resembling a long slender bladed nineteenth century corn scythe type. White's rejection of this view (1972,81-2) is based on the literary evidence, which, as noted before, is mostly no later than first century AD, and in any case cannot be assumed to apply in Britain. The reaping machines of Gaul, however effective or widely used they actually were, at least imply a desire to cut the labour needs of reaping.

The Ib scythes are found only in Britain (Rees 1987,499), and it is unfortunate their introduction cannot be closely dated. Later third or fourth century seems the best estimate, attributing the earlier non-military fragments to the 'narrow Ia' category. If they do represent the introduction of scythe reaping at this time, it might prove possible to relate this to others aspects of the economy of agriculture at this time. The introduction of wage labour in the mid fourth century at Barnsley Park has been suggested on the basis of a dramatic increase in coin losses (Webster and Smith 1982,104-6). This is of course later than the date Webster prefers for the two scythes, but the use of wage labour would provide an obvious incentive for investment in labour-saving tools, and the ability to increase the labour force only at periods of high labour demand would have allowed a marked increase in labour productivity.

The development of harvesting tools can be briefly summarised. The angular sickle, interpretable as a tool for cutting weeds or fodder, exists from the Middle Bronze Age onwards. Curved iron sickles appear in the fifth to third centuries BC; although their use in reaping has been disputed, they may have been used to cut the straw. The balanced form which appears to develop from them during the first century BC presumably was used for reaping or cutting hay or straw. Another later Iron Age development was a beaked billhook, possibly used to cut leaves for fodder. As there is only one Romano-British example of this type, it may have soon become redundant, perhaps as the result of a shift from gathered to cultivated fodder, but possibly simply replaced by another type. The Bigbury "slashing tools" may represent a form of unbalanced scythe, which on the basis of Steensberg's experiments can be presumed to have been for mowing not reaping, and can be related to the evidence for the cultivation of vetches as fodder.

In the Roman period, balanced scythes are an early military introduction. Some form of scythe was in civil use before the end of the second century AD. The scythes can only be shown to have been used on the more affluent of the agricultural sites, that is, the villas. [The same is true of the coulters and, by implication only, barshares.] The longer variety of the balanced scythes appears to have been introduced in the later third or fourth century. The longer form of the balanced sickle, a specifically British type, cannot be dated to before the fourth century on present evidence. The recognition that many of the introductions of new types during the Roman period cannot be dated to earlier than the late third or fourth centuries is important, but the bias resulting from the fourth century hoards must be recognised. In the case of the scythes, because fragments can be identified by their characteristic back rib, use can be dated earlier, even though in only two cases. It can be argued that scythes were adopted into civil use because they were a tool for which a need already existed. More attention must be given to the identification of iron work fragments if the chronologies of the large Romano-British tools is to be clarified; outside the hoards, complete examples must be expected to be remain rare.

The balanced scythes are found in a restricted range of contexts; outside the villas, the fodder cutting role remained with the angular sickles. Some of these became elongated and reinforced during the Romano-British period, and may have been used as small unbalanced scythes. The larger unbalanced scythes remain poorly understood; there is a possibility that some of the scythe fragments are from these types.

These tools are significant on two levels in understanding the agrarian economy. Because of the relationship between fodder cutting and livestock management, these tools, together with the evidence for animal housing and penning and the cultivation of fodder crops assessed in later chapters, may help in evaluating the development and importance of fertility maintenance practices based on the collection of farmyard manures. In addition, consideration of their chronology and context, provides an insight into the changing socio-economic conditions of agriculture, and hence into the economic framework of Iron Age and Romano-British society.

Chapter 4.
Crops and their implications.

4.1. Introduction.

This chapter is not intended as a comprehensive review of the evidence for cultivated crops in later prehistoric and Roman Britain. The aim is to consider the implications of cropping decisions in terms of the organisation of agricultural systems and their social and economic framework. In this context it is arguably of little interest, for example, to know the relative proportions through time of the various wheat species under cultivation, unless there are some identified differences between these species which may impose different agricultural practices or reflect different environmental conditions, or which, because of factors such as ease in processing, storage or transportation, may relate to differences in the economic role of the wheat crop.

The discussion is in three main sections: some differences between crop species and their possible significance; the cereal crops; and the leguminous species, as food and fodder crops.

4.2. Some differences between crop species and their possible significance.

4.2.1. Ecological characteristics and requirements.

Tables 4.1 and 4.2 summarize some information on the cereal and leguminous crops and their needs. Some difficulties can be noted. Inference based on modern data, whether relating to environmental preferences, sowing times or yields, assumes a close resemblance between modern crop varieties and the prehistoric and Romano-British forms. It is known that morphological differences existed, for example between modern and Romano-British or Iron Age spelt (Jones 1978,103; van Zeist 1968,103-4);

Table 4.1. Characteristics of cereal crops.

Species	Soils	Sowing time	Other characteristics
Barley	Heavy or light, but not poorly drained , or with pH less than 6. Soils heavier than medium loam unsuitable because of difficulty in obtaining fine tilth in time for spring sowing (W,109).	winter or spring	Naked varieties need short hot summers, tend to have weak straw and brittle ears (W,100-5). Six-row varieties have a higher protein content (H,320) and tend to be late maturing (W,107). Wide variety of types suited to different conditions (H,320). Mixed varieties can change rapidly in changing conditions (B,44-5,52-4) Inferior to wheat for bread making because of low gluten content (H,320)
Wheats			
Emmer	Light, dry soils	Frost susceptible, spring sown	High protein content. *Spring sowing disputed by HN,146-8
Spelt	Heavy or light "can be grown on the poorest soils" (H,299)	Hardy, suited to winter sowing	Hardy to pests and disease
Breadwheat	Strong heavy land, especially clay loams	Winter hardy	Needs high soil fertility - has high yield potential if well manured. Poor competitor (needs weeding) and vulnerable to birds and fungi. Easily threshed.

(continues)

Table 4.1 (continued). Characteristics of cereal crops.

Species	Soils	Sowing time	Other characteristics
Oats	Can tolerate acidity and low fertility; needs high water content (especially clay loams). Prefers heavy soils; will grow in poor, exhausted soils (H,324).	Usually spring; less frost hardy than wheat or barley.	"the most nutritious of all the cereals for human use", but not good for bread (H,324).
Rye	Anything except very heavy clays. Tolerates low fertility, acidity, dryness.	winter or spring	"the most adaptable of the cereals" - satisfactory even in severe winter temperatures, high altitudes, poor soils (H,321).

Sources: Principal source: Jones 1981, 105-9.

Additional information from:

	Beaven 1947	(B)
	Hill 1952	(H)
	Hillman 1981	(HN)
	Wilson 1859, Vol.1	(W)

Table 4.2. Characteristics of leguminous crops.

Species	Soils	Sowing time	Other characteristics
Beans	Well drained clays; not wet or shallow soils. Must be calcareous, or limed/marled/chalked.	February or March - must not be sown into cold wet land. Winter sown only if mild winters/mild dry springs (J,109)	Benefits from thorough soil preparation (harrowing), especially on heavy soils. Prone to insect pests (weevils, aphids, wireworms). Growth restricted by hot dry summers (H,341).
Peas	Light dry soils - suits sandy or gravelly soils, but clay "will do" (McC,122). Growth too luxuriant in rich soils. In C19th, peas said to be profitable only if soil too poor for beans. Soil must be calcareous, or limed/chalked/marled.	Sown as early in spring as possible. Winter varieties exist.	Needs cool summer temperatures and abundant moisture (H,336-7). Suffers greatly from insect attack (weevils, aphids, pea-maggots). Some insect infestation can be reduced by hoeing and harrowing. Shallower root system than beans (McC,122).
Vetches	All soils (McC,124), but musted be calcareous or limed/chalked/marled.	Catch-crop, sown spring; autumn sown for spring forage.	Difficult to dry properly when cut as hay.

(continues)

Table 4.2, continued. Characteristics of leguminous crops.

Species	Soils	Sowing time	Other characteristics
Lentils	Heavy or light (P) Runs to leaf if soils too rich.	March and April; soil must be warm	Stores best in husk. Cultivated in some parts of Britain in C18/C19 as cattle fodder (C.F.,P). Not listed as cultivated by McConnell
Vetchlings	Any	*L. sativus* spring sown. *L. cicera* more hardy.	Cultivated like vetches. Poisonous seeds cause paralysis in people and livestock if consumed in quantity. "esteemed" as fodder in C19th Spain and France (L,284).

Sources: Principal source used: Morton 1855, Volume 1, 204-5,213
Volume 2, 576,578-9,581,769,863-4.

Other sources:

(McC)	McConnell 1883
(H)	Hill 1952
(J)	Jones 1981
(L)	Low 1838
(P)	Potts 1809, sv. Lentil, vetch, vetchling.
(C.F.)	Complete Farmer 1807, sv. vetch, tares

other characteristics may also have varied. Prehistoric barleys were genetically diverse, and need not have shared the all characteristics of modern highly selected strains. The question of spring or autumn sowing is important in assessing the labour patterns in agriculture, particularly in relation to the introduction of spelt, but there is disagreement on the question of whether emmer was generally spring (Jones 1981,106) or autumn (Hillman 1981,146-8) sown.

Soil preferences are also not independent of other aspects of agricultural practice. A species may give good yields on heavy soils, but only where there is adequate drainage. The unsuitability of heavy soils for barley is due to the difficulty in ploughing these soils to a proper tilth early enough in the spring, as barley yields decline if sowing is delayed (Wilson 1859, Vol.1,109,121). Provided the soils were not actually waterlogged in the winter months, autumn sown barley could be grown; it is the practice of spring sowing which renders the soils unsuitable. The soils regarded as suitable for barley in recent times have been limited by the specific requirements of malting barley; soils which are too fertile produce grain too protein-rich for malting (Beaven 1947,32-3,185).

Jones (1984,122) has suggested that the first half of the first millenium BC saw "the general adoption ... of a range of crops ... in response to particular conditions". These crops share "the common feature of ... their ability to cope with unfavourable conditions in one form or another", allowing "sustenance of cultivation on deteriorating land" and "expansion on to hitherto marginal lands" despite worsening weather conditions (1981,109-110). Jones related these developments not simply to environmental change, but to social factors, notably the development of central places and the extent of "non-agrarian investment of surplus" (1981,119-120), which he suggests resulted in alternate periods of stagnation and innovation in the arable economy.

Two aspects of Jones' discussion have specific importance for the arable economy of the second half of the first millenium BC. The first is the question of how the increase in weed species in this period is to be interpreted. Jones interprets it as evidence for soil exhaustion. It may however reflect the development of a specific arable field ecosystem, contrasting with earlier fields where the ecosystem remained essentially that of grassland. Alternatively it may be related to the absence of heavy manuring, as suggested in Chapter 6. The different nature of the carbonised seed remains from pre-Iron Age contexts may be a significant bias in the evidence for weed seeds (see below). The dating of innovations is another problem. For example, although well-developed field drainage is seen in the first century BC, there is some evidence for ditched fields from the third century BC onwards, and a period of innovation and experimentation in field drainage seems to have predated the first century BC. Both these points are discussed more fully later, in this chapter and Chapter 6.

Whatever the chronology of their introductions, it is clear that during the second half of the first millenium BC there was a diverse "crop repertoire" (Jones 1981,109) available to farming communities in Britain. The extent to which crop choices were determined by the ecological characteristics of the crop species can probably be assessed only in detailed regional studies. Soil types may have been crucial in decisions in some areas, but much less limiting in others.

One such study is of the Hampshire chalklands by Murphy (1977). He concluded that soils were "not the overriding factor as far as the staple food crops were concerned", although they were possibly the reason for the scarcity of beans, as chalkland soils are not deep enough for good yields of beans, and of rye, which prefers an acid soil, although neither Jones (1981,108) nor Hill (1952,321) suggests that acidity is essential. Although barley is the crop most suited to the chalkland soils, Murphy did not think that this influenced the choices between wheat and barley substantially (1977,216-220). Neither did he consider that climatic change in the period post 800 BC was sufficiently severe in this area to explain the increased cultivation of spelt or the increased representation of oats, especially given the lack of evidence that the oats were of the cultivated variety (ibid, 222-5). This assessment was based on Lamb's view that the mean annual temperature in the late first millenium BC was only 0.5 to 1.0°C cooler than at present (ibid,224).

However the nature of the climate in the second half of the first millenium BC is by no means certain. Table 4.3 summarises three accounts of later prehistoric climate; while all agree on a sharp worsening in the first half of the millenium, they differ markedly for the latter part. If the early decline was as severe as Lamb suggests (a 2°C drop in mean temperature), this "presumably shortened the growing season by more than five weeks" (Lamb 1981,55). This must surely have had a significant impact on cereal cultivation, favouring barley over wheat because of its shorter growing season (Hill, 1952,320) and perhaps spelt over emmer, as modern spelt varieties ripen earlier than most emmer types (Green 1981b,154, citing Hillman 1977,110). This century, the harvest season varies from the end of July or early August in warm districts of southern England to late August/early September in most of Scotland, and as late as October in the colder most northerly areas (Percival 1943,38-9). Assuming a similar

Table 4.3. Climate in later prehistoric Britain.

This table summarises the main conclusions from three papers on later prehistoric climate. These differ markedly, especially for the last centuries BC.

DATE	1. Barber, (1982,110).	2. Turner, (1981,260-1).	3. Lamb, (1981,52-7).
BC 2000	minor deterioration		warmer than now, marked changes from century to century in temperature and rainfall
1500	more pronounced decline	deteriorating slightly	
1000			warm and dry for 200 years
	catastrophic decline to cooler and/or wetter	deteriorating more rapidly	colder, stormier
		wettest conditions	wetness increasing
500		warmer and drier	
	some evidence for further decline		milder; still stormy episodes
1			like present day
			warmer and drier
500 AD			sudden change to colder summers and wetter winters

diversity in earlier periods, a contraction of five weeks in the growing season would have varied accordingly in the seriousness of its impact on cereal cultivation. Even if climate were not critical in cropping decisions on the Hampshire chalklands, it may well have been so elsewhere in Britain.

4.2.2. The yields levels of crops.

4.2.2.i. Consistent differences in returns.

There are consistent differences in per hectare returns for different crop species. Barley produces higher yields than wheat, as seen from both nineteenth century and mediaeval data.

Table 4.4. Comparison of wheat and barley yields.

	Wheat yield as % of barley yield.
Average yields, C19 Britain (McConnell 1883,95)	87%
Winchester manors, 1325-49 AD	
1. All manors	54%
2. Hampshire manors only (Titow 1972, Appendix P)	69%

Experimental data from the Butser project (discussed in Chapter 2 above) is limited to the wheat species. Average yields of spelt and emmer are broadly similar, the emmer yields being slightly higher (Reynolds 1981, Table 1).

In the later nineteenth century, the average yields for beans and oats were intermediate between those for wheat and barley (McConnell 1883,95). Mediaeval figures for peas and beans are generally given in yield/seed terms, without specified sowing rates, making comparison difficult (eg. Harvey 1965,Table IV; Slicher van Bath 1968, Table II).

4.2.2.ii. Differences in the variability of yields.

Some crops are more prone than others to seasonal fluctuations in yields, due to factors such as weather conditions, disease, or infestation. The less variable crops may be regarded as 'safer'; they have a lower risk of poor yields, but often are correspondingly less likely to produce very high yields in good years. Russell notes that early varieties of cereals were more resistant to unfavourable weather, as they have larger root systems and store more nutrients in their stems. Spelt -"one of the hardiest of the cereals"- can survive cold and drought, and is resistant to several crop diseases and bird attack (1981,164). Jones (1981,107) notes that breadwheat is more prone to attack by birds, fungal diseases and harm from weed competition than either spelt or emmer. From the data so far available from the Butser experiments, there is a clear suggestion that emmer is more variable than spelt. Although the mean yields per hectare are similar, the range of yields recorded for emmer is nearly twice that for spelt (Reynolds 1981, Table 1).

4.2.2.iii. Differences in performances of crops in the same year.

The important question is whether a poor year for one crop species is likely to be accompanied by poor harvests in other crops, or whether their yields can be high enough to provide some compensation for its scarcity.

The relationships between wheat and barley yields were considered in the discussion of the pattern of the mediaeval yields from the Winchester manors, and price data (in Chapter 2 and its Appendix). Although to some extent winter and spring crops differ in their responses to weather conditions, it is the summer weather which is critical in determining yields, and this affects both. The conclusion reached in the discussion of the mediaeval yields was that while other cereal crops compensated to some extent for low yields in roughly half the moderately poor wheat harvests, where the wheat harvest was very poor, the other cereal crops were usually similarly affected.

Since peas and beans are affected differently to cereals by summer weather (see Tables 4.1 and 4.2), they might offer a more reliable form of insurance against low cereal harvests. This question was also discussed in Chapter 2, Appendix. It was suggested that in roughly half the years with poor wheat harvests, the legume crops may have been unaffected by the conditions which reduced the wheat yields, and in at least some of the cases above average pea and bean yields may have helped compensate for the poor wheat crop.

One important point in this context is that winter failure of an autumn-sown crop may be compensated for by planting of a different crop in the spring, providing that seed is available. This may well be a significant feature in the data quoted above. The two factors - differences in the crops' characteristics and performance and the agricultural practices involved - are probably not separable in these contexts. It is unfortunate that the Butser experiments are essentially restricted to wheat, with the beans cultivated only as part of a soil fertility experiment and their yields not being recorded (Reynolds 1987,17-8). The question may be an important one in understanding agricultural decisions and the stability of agricultural systems.

4.2.3. Crops and labour inputs.

4.2.3.i. Differences in the intensity of cultivation required.

More intensive cultivation (soil preparation, manuring, weeding) will lead to increased yield levels for most crop species. Some crops varieties, however, will fail to produce adequate yields without considerable inputs of this type. This is particularly so for species such as bread wheat, which demands high soil fertility (hence usually manuring) and protection from weed competition and birds (Jones 1981,107). However, the point was made earlier that it is an assumption that prehistoric varieties closely resembled their modern equivalents; earlier varieties of bread wheat may have been more resilient than recent types.

Manuring is very labour intensive. It should be noted that cereals which can produce yields even on poor soils (eg rye and oats) will do better on good, fertile soils (Hill 1952,321,324). For barley, manuring was traditionally regarded as necessary only after another white straw crop, but this is in the context of ensuring good malting grain. More fertile soil produces higher yields, better seed corn, and a higher protein content in the grain (Beaven 1947,32,119,125,184). On heavy soils, leguminous crops such as beans did not need manuring, unless grown in continuous rotations with no fallow years (Morton 1855 Vol.1,205,208).

According to the Roman agronomists, wheat required a greater labour input than beans, needing 9 days work (excluding harvesting) compared with the 7 days *per iugerum* required by beans. The labour inputs for beans could be reduced further by sowing beans directly into newly cropped land, omitting harrowing and allowing grass and weeds to grow unchecked between the bean plants. Omitting harrowing can benefit plants in colder climates as clods shelter the young plant, and while beans are generally spring sown in Britain, they can be autumn sown (Wilson 1859 Vol.1,213) provided winters are mild (Jones 1981,109). Omitting hoeing was apparently a common practice in Roman Italy; it was criticised by Columella because it reduced yields, but the hay undercrop was of considerable value in a region of acute summer fodder shortage. In harvesting, beans needed 1 man-day _per iugerum_ (uprooting the entire plant), while wheat needed 1½ man-days for reaping plus 1 for cutting the straw. Neither figure includes carting, stacking, threshing, etc. Pliny noted that vetch cultivation "entails no labour for the farmer" as it can be sown with only one ploughing and without hoeing or manuring (_Natural History_ XVIII, 137); and Columella (II.X.29) similarly notes vetch could be sown in "untilled land".

It is important to note that lower labour inputs may reflect the usage and economic importance of the crop rather than the characteristics of the crop species itself. Crops grown as, for example, animal fodders, will tend to receive less attention and be grown on poorer soils than the principal food species. The same point applies to the decision to sow crops in autumn or spring.

4.2.3.ii. Sowing season.

Combining autumn and spring sown crop varieties can increase the area cultivatable as it spreads the period of high demand for labour and draught power. It can also mean that the loss of a few days' work due to adverse weather or soil conditions is less critical. If the seed is available, an autumn sown crop which fails due to winter conditions (Field II at Butser suffered total crop loss during the winter of 1987/8; Reynolds 1988,56) can be ploughed in and the field re-sown with a spring-sown crop.

Wheats are generally autumn sown in temperate regions; the exceptions are where soils are waterlogged or frozen for long periods without snow cover. Hillman (1981,146-8) doubts that wheats, including emmer which is often taken to have been spring-sown, were ever spring-sown, except under such severe conditions, where there had not been time to finish the sowing in the autumn, or where they were unimportant crops whose "yields were no longer central to survival". The time of sowing, like the intensity of cultivation and the quality of the soil used, reflects the economic priorities of the farmer as well as, and possibly to a more important extent than, the biological characteristics of the crop species. Distinguishing between an ecological constraint and a choice in the use of resources is a key question.

With spring sowing, bad weather can delay sowing; ploughing while the land is still too cold and wet causes poor growth (Morton 1855, Vol.1,205). Yields of spring sown crops decrease sharply as the delay increases. Table 4.5 shows that February is the prime sowing time for both beans and barley; it must be remembered these results come from a time when effective field drainage was standard. On many soils conditions would still have been too wet and cold without good drainage. For beans, which prefer deep heavy soils, Morton (1855, Vol.1,205) notes that soils were sometimes dug when they remained too wet to plough. Optimal planting times depend on area, being later further north. The order of the spring sowing can occasionally be recovered from mediaeval records, as at Cuxham (Table 4.6). It seems likely that the late sowing would have reduced the yields of barley to well below its potential.

Table 4.5.

Yield and sowing time for spring sown barley and beans.

(experiments quoted by Wilson 1859, Vol.1,121,213)

month	beans	barley
January	4.42	-
February	4.49	12.5
March	4.0	11.5
April	2.1	8.5
May	1.42	6.5
June	-	3.15

Table 4.6

Spring sowing order; Cuxham, fourteenth century AD.

time (year)	already sown	not yet sown
mid-March (1303)	all the beans, some oats.	peas, dredge, barley.
mid-April (1349)	all peas and vetch, most dredge and oats.	all the barley, small amounts of oats and dredge.

Archaeologically, autumn sowing can be recognised by analysing the germination times of the weed species present in crops and processing residues. It was inferred in this way for the Iron Age site at Ashville (Jones 1978,106) and Jones notes that "the autumn sowing practice can be backdated at least to the Bronze Age" (1981,109). It is possibly simply the scarcity of earlier carbonised seed deposits and the different nature of the deposits from pre-Iron Age contexts (see section 4.2.4.i. below) which have prevented the practice from being identified from the entire time span of agriculture in Britain. Hillman (1981,147) notes that earlier and more primitive wheats are even more likely to have required autumn sowing than later varieties. Identifying spring sowing is more difficult. Hillman suggests that suitable criteria would be the consistent absence of the autumn germinating weed species, in samples from which seeds of other species which are similar in growing habit, height and seed size were recovered (1981,146).

4.2.3.iii. Harvesting.

As harvest is the peak labour period, labour spreading is particularly valuable at that time. For the cereal crops, harvest time depends on the area of the country and the variety sown. Cultivating more than one species or variety can therefore spread the harvest period and increase the area a given workforce can harvest. For both wheat and barley, different varieties of the same species require different growing periods and hence ripen at different times (Percival 1943,38-9; Beaven 1947,50). Speculating on the ripening times of prehistoric varieties whose characteristics are uncertain is probably unwise, but spelt now ripens before most modern emmer varieties (Green 1981b,154), and this might have been an incentive for cultivating both species.

Legumes generally ripen after grain, beans being harvested at the end of September in an average season. Peas ripen earlier, and in warm dry years can be harvested as early as cereals. This could be a factor favouring the cultivation of beans in preference to peas.

Without additional labour from outside the farm, the harvest labour needs would have been a major limitation on the cultivated area. In the eighteenth and nineteenth centuries AD, harvesting (with sickles) depended on the availability of hired labour, either from nearby towns or from groups of migrant reapers who followed the harvest season through Britain (Collins 1969,463; Perkins 1977,128-9). Mediaeval manors such as Cuxham also found the use of outside labour at harvest was "inevitable" (Harvey 1965,81). Webster and Smith (1982,104-6) suggest that coin loss patterns at some (but not all) Romano-British villas reflect the use of daily hired labour. If the large scythes from Barnsley Park are taken to indicate an investment to save labour, the combination of this with the coin loss pattern could suggest hired labour for the harvest. However the dating of these scythes is not entirely clear, and they may pre-date the coins.

4.2.4. Crops' implications with regard to agricultural and related techniques.

A change in agricultural practice may only be realised successfully if certain other conditions are met. A well documented example of this is the nineteenth century replacement of the sickle by the scythe for harvesting wheat. This did not become general until improvements in threshing technology allowed easier threshing of wheat harvested unripe, which is very laborious with flails; cutting fully ripened wheat with scythes results in wasteful loss of grain, and until new crop varieties which were more easily scythe cut were introduced (Collins 1969,459; Perkins 1977,112-3,127,130-1).

This section considers three examples of agricultural technology and their relationships with the archaeological evidence for crop cultivation.

4.2.4.i. Drying or parching grain.

The techniques involved in drying or parching grain are important both because of their role in later prehistoric and Roman Britain agricultural economies and because of their relationship to the evidence for the crops cultivated. Most of the carbonised grain from British sites results from accidents in parching or roasting grain, or from the use of processing wastes as a fuel (Hillman 1981,139-140), which is itself particularly suitable for use in grain drying (Hillman 1982,138).

Helbaek noted that the carbonised grain deposits in Britain "appear with a certain suddenness at the transition between the Late Bronze Age and the Early Iron Age", when "together with the introduction of spelt came the practice of grain drying" (1952,232-3). There are two reasons for regarding this association as incorrect. Spelt is now known from several Bronze Age sites, and may have been cultivated in Britain continuously from the neolithic (see section 4.3.2. below). Emmer also needs parching to release the grain in the same way as spelt, and it is therefore difficult to see why only spelt users should have evolved the techniques of drying the grain. The scarcity of pre-Iron Age domestic sites had resulted in a gap in Helbaek's data, which more recent excavations have gone some way towards filling.

There are a variety of reasons for drying grain (listed by Hillman 1982,137-8), and it is important to note that some of these apply to free-threshing cereals as well as the glume wheats. These include drying prior to storage (prevents spoilage and destroys pests) and to facilitate milling. Experiments by Curwen (1941,29-31) showed that grinding wheat with a rotary quern took four times as long when the wheat had not been roasted. The ground meal also differs in character depending on whether the grain was roasted, and Curwen states this can be recognised from carbonised material (1938,151-2; 1946,104). The need to parch free-threshing varieties for these purposes and the suggestion that "fuels potentially provide the bulk of the charred crop remains on most British sites" (Hillman 1981,140), do suggest that assumptions about the underrepresentation of free-threshing varieties demand caution. However, Hillman noted that when chaff is used as a fuel, more diagnostic fragments survive from glume wheats that from free-threshing cereals (1978,170). The free-threshing varieties would also be parched after threshing, with the chaff removed.

An initial question is how grain was dried in later prehistoric and Roman Britain. Hillman (1981,54) notes that some parts of Anatolia are dry enough for parching to be unnecessary, and Reynolds (1981b,37) has successfully dried grain in the open air in hot dry weather at Butser. However, in Britain after the onset of climatic deterioration sometime in the second millenium BC (Table 4.3), this method must have become at best unreliable even if it had been feasible earlier.

Corn drying ovens are known from Roman Britain, but most date from later in the period (Morris 1979, 146-8). Although Morris associated them with processing large quantities of grain for marketing in "a healthy economy" (ibid,21), Reynolds (1981b,36-43) has stated on the basis of experiment that the type of drier he examined was inefficient at grain drying, and that its likely function was malting, at which it was experimentally successful. Hillman (1982) concluded that spelt from a kiln at Catsgore had been malted, and most of the carbonised grain from corndrier III at Mucking was also sprouted spelt (M.U. Jones 1985,16). Jones has suggested that brewing can be seen as a response to the seasonal nature of agriculture in a developing cash economy (M. Jones 1981,115,118). Demonstrating that corndriers were at times used for malting cannot of course be taken to imply this was their sole or main function, but even if they were generally used for grain drying, their limited occurrence suggests they were by no means the only method of drying grain.

Of Morris' catalogue of over a hundred corn driers and drying rooms from Roman Britain, most of the datable examples are from the later third century AD onwards (1979,9,20). However more recent work was changing the pattern, with increasing numbers of driers known from earlier periods and from non-villa rural settlements. Roughly half of the dated examples are from villas (ibid,83-107,Table 1). The proportion from other rural settlements is 40% higher in the period post 250 AD than the earlier Romano-British period, but the numbers involved are small. Without a complete review of the occurrence of corndriers taking into account the work published in the ten years since Morris' survey, it is difficult to be sure this is a real trend, rather than a reflection of the nature of the evidence for rural settlement in Roman Britain. However, on some rural settlements, such as Catsgore (Leech 1982), corn driers were constructed only in the later phases of occupation (later third century onwards). Their increased presence may be related to economic changes in the third century, such as the introduction of taxation in kind and the suggestion that a market economy may only have developed in Britain and rural areas of the Roman Empire around 200 AD (see Chapter 10 below).

Large scale drying of grain may well have been inefficient in the Romano-British period. Fungal attack on damp grain and the resultant heating of the grain may have been a factor in allowing the spread of grain weevils (Osbourne 1978,34).

For the Iron Age, "temporary ovens built of cob" are "generally assumed" to have been used to dry grain (Cunliffe 1974,167-8). At Little Woodbury, Bersu distinguished between smaller baked clay ovens, suited to baking bread, and larger ones, made of cob or daub incorporating various plant materials, which could be as much as a metre in height and in diameter. The remains of these larger ovens occurred "with particular frequency in those pits which contain the layers of ashes and burnt flints", and Bersu interpreted them as "roasting places for corn" (1940,53,62-3). Scott (1951,205) disputed this interpretation, considering that "domed ovens of three feet in diameter are too small for the quantity drying of grain and are designed to give a temperature which for that purpose would be an embarrassment". However Bersu had noted that the larger oven fragments were much less burnt than those from the smaller baked clay ovens (1940,53), and the association with large quantities of burnt flints could imply the use of stones in the fire-space to aid the maintenance of a steady and not excessive temperature.

Scott (1951,197,n.7,204) quotes an eighteenth century description (by Boswell,1963,138; entry for 10 September 1773) of "a little house-kiln for drying corn ... a little at a time". The kiln was made of wattles plastered with clay, and stood inside a house on Raasay; it was "about the size of a hogshead". A hogshead is a quarter tun barrel, containing 63 gallons. Its internal capacity is therefore about 0.3 cubic metres, and if this volume was contained in the hemisphere on cylinder shape suggested by the Little Woodbury descriptions, it would be 0.76 m in diameter and height internally. The size is therefore not greatly dissimilar to that implied by the Little Woodbury fragments, for which Bersu suggests a 1 metre maximum external diameter and height. There is no information given on how the kiln operated, but its existence may dispose of his objection in terms of size and usefulness to the identification of the larger Little Woodbury ovens in this way.

Unfortunately no reconstructions of the Little Woodbury ovens have been published, and Brailsford's descriptions (1948,159) do not include illustrations. The main additional information from his account is that smoke apparently did not enter the drying chambers of the ovens/kilns, and in addition to having at least one larger opening (presumably for putting the grain in and out), the domes were ventilated by a number of small (1 to 2 inch diameter) circular vents.

Fasham (1985,23-5) interpreted one of the middle Iron Age pits at Winnall Down as a possible corn drier. Its fill incorporated burnt flints and charred material, chiefly chaff and small twigs, which would have been suitable drier fuel. Helbaek (1952,231) had in fact suggested that Iron Age pits were "perhaps most often" a "primitive grain drying contrivance", but the possible corn drier at Winnall Down is markedly atypical of pits on that and other Iron Age sites. The combination of experimental work (Reynolds 1974) and botanical analyses (especially Jones 1984,491-3) makes the identification of the original function of the large Iron Age pits as grain stores appear virtually certain.

Quantities of burnt flint on Iron Age sites have generally been regarded as the product of grain drying (eg. Field et al 1964,373). A group of late Bronze Age sites from Sussex (Itford Hill, Plumpton Plain A, and New Barn Down) have also produced quantities of burnt flints, but differed from the Iron Age sites like Little Woodbury and Winnall Down in that the flints were accompanied by little or no charcoal or ash (Burstow and Holleyman 1957,172-3; Holleyman and Curwen 1935,26-7). The flints were found in quantity on the three sites, largely within specific locations interpreted by Burstow and Holleyman as "cooking compounds" with grain drying as one of their possible functions (1957,173).

Probably because they are so commonplace, burnt flints rarely receive much attention in excavation reports. At the late Bronze Age site at Black Patch, the relatively small quantities of burnt flint were interpreted as the product of domestic hearths, subsequently collected as a filler in pottery making (Drewett 1982,333). Ovens at the late Bronze Age site of Knights Farm, Burghfield, apparently produced quantities of burnt flint and charcoal, recovered from nearby pits. But these ovens are unlikely to have been used for grain drying; sampling and analysis of their fills did not recover any carbonised cereal remains. The ovens consisted of pits cut into clay pockets in the subsoil, with flints set in the sides and base of the best preserved example (Bradley et al 1980,258,260). They therefore differ from the Little Woodbury ovens which were represented by their clay superstructures only. None of the Little Woodbury pits produced the evidence for in-situ burning found in the Knights Farm pit-ovens.

Hot stones can be used in a variety of ways to dry grain. Cunliffe (1974,167-8) suggests grain was spread on skins lying over hot stones, and Fenton (1978,375) describes a traditional method in which hot stones were rolled among the grain in a straw container. Such methods would leave little recognisable trace apart from fire-cracked stones.

Another method of drying grain on a small scale is described by Fenton (1978,375,395). The grain is turned in a round bottomed iron pot over a fire; a similar result could presumably be achieved in a pottery vessel. The grain tends to burst during roasting, which might happen less if use of pottery resulted in more gentle heating. This method would leave no distinctive trace archaeologically, except that the grains which were overheated and carbonised would be likely to have burst. Green (1981b,111) suggested that the poor preservation of the phase III (early Iron Age) wheat from Old Down Farm could be a result of the processing method used, and this could perhaps relate to this sort of drying technique.

It is possible to suggest a difference between the late Bronze Age sites in Sussex, using one of the hot stones methods, and the use in the Iron Age of ovens, which produced characteristic deposits of mixed burnt flint and charcoal.

There does seem to be enough evidence to suggest there was a change in the scale and techniques of grain drying, perhaps in the early Iron Age, in some parts of southern Britain. There is a contrast between the Iron Age where large quantities of burnt flint, ash and charcoal are frequently found in association, and the middle/late Bronze Age where this does not appear to be the case. The use of heated stones, inferred for sites such as Itford Hill, may indicate a development in agricultural technology in the middle Bronze Age, perhaps accompanied by a variety of other small scale methods of drying grain. Its context may have been deteriorations in climate during the second millenium BC, or it may have been part of a package of agricultural developments during the middle Bronze Age, along with the small permanent field systems (see Chapter 7), and corresponding to Fowler's "first real husbandry" (1983,95).

The use of clay or daub ovens, still using flints in their fires perhaps as an aid to ensuring even and controllable temperatures, may then be seen as developing during the Iron Age. This might relate to the major climatic deterioration of the first half of the first millenium BC, but again explanations may need to incorporate wider considerations in terms of the organisation of agriculture and agricultural societies. One question is whether the development of drying ovens, the use of 'four poster' granaries, and the evidence (see below) suggesting a change in the location of the initial processing of the harvest, together represent a change in the social context of agriculture, perhaps to a situation where the regulation of production and the treatment of the produce was by then increasingly a matter for the community as well as the individual.

4.2.4.ii. The location of crop processing activities.

Another change in the processing of the cereal crop can be inferred and also related to the same time period. The differences in preservation noted by Green (1981b,111,118) between the cereals remains from phase III (seventh century BC) and phases IV and later (sixth to fourth centuries BC onwards) were noted above. In addition, phase III samples lacked chaff and other non-seed parts of the plant. Green suggested three "equally likely" explanations for this: that crops were not being processed on the site, not being processed near the features sampled, or that the processing residues were not being discarded and burnt. In contrast, from phase IV, there is clear evidence that crops were processed and wastes burnt on the site.

The lack of crop processing wastes from the late Bronze Age site of Aldermaston Wharf was commented on by Smith (1985,209), who notes that this implies that the plant evidence alone suggests that the site functioned as "a consumer rather than a producer of grain". Smith in fact rejects this interpretation because of the site's location in relation to a ditched field system, which he assigns to the middle Bronze Age; this is discussed in Chapter 6, where the Iron Age date suggested by its excavators is preferred. However, Smith's comment raises questions about the interpretation of cereal remains to distinguish 'producer' and 'consumer' sites.

Table 4.7 summarizes the carbonised cereal remains from some published Bronze Age and early Iron Age sites. The lack of crop processing residues can be seen to be a general feature of the Bronze Age sites, and on three sites (Old Down Farm, Ashville and Winnall Down) a contrast between Bronze Age/earliest Iron Age and succeeding phases is seen. Hillman (1981,140) suggests that the use of crop wastes as fuel may be the source of most of the carbonised crop material from Britain. This does not, on present evidence, appear to be the case at the Bronze Age sites listed in Table 4.7, and this constitutes an important distinction between the carbonised material from the Bronze Age and the Iron Age (except for the earliest Iron Age phases, as at Old Down Farm).

There are a number of substantial deposits (probably mostly resulting from the accidental burning of part of the main crop product at some stage during its processing, storage or use) from the Bronze Age, but most of the samples produced only scattered grains. Where both types of deposit were found on the same site and appear to be contemporary, comparisons can be particularly informative. Several examples can be quoted. At Black Patch, spelt was identified only in the "major" deposits (and only in samples which produced 1.5kg or more of grain), and beans were found only in one large (19.5kg) "stored grain" deposit. [The occurrence of beans is discussed further in section 4.4.3 below.]. Most of the cereals from Grimes Graves were recovered from midden deposits, without which "evidence for the cultivation of cereals at the site would have been almost wholly lacking". Legge (1981,93) suggests the Grimes Graves material resembles Dennell's samples from middens and floors, which seems to imply Dennell's Type II (Dennell 1974,278-280). The midden probably included material from a variety of sources, including the "rubbish from accidents at cooking places" which Hinton

Table 4.7. Cereal crops and processing in the middle and late Bronze Age and earliest Iron Age.

Site	Date	Cereals present						Crop processing	
		1	2	3	4	5	6	Processing wastes present	Comments [Reference]
West Row, Mildenhall	E/MBA	*	x			*		No	No evidence for early stages of processing - processing of part-cleaned spikelets only indicated. [Murphy 1983]
Ashville	MBA			*	*	*		No.	Bronze Age cereals represented by grains only, in contrast to Iron Age. [Jones 1978,93,103]
Grimes Graves	MBA	*				*			Samples are described as most like Dennell's samples from floors and middens. This seems to imply Dennell's Type II, secondary cleaning residues, without spikelet parts. The presence of non-seed parts is not noted in the report. [Legge 1981,90-3]
Itford Hill	MBA	*				*			Described as unthreshed grain. [Burstow and Holleyman 1957,206-9]

(continues)

Table 4.7, continued.

Site	Date	Cereals present						Crop processing	
		1	2	3	4	5	6	Processing wastes present	Comments [Reference]
Fengate	MBA	x	x		*	*	*	No	Virtually no chaff present [Wilson 1984]
Aldermaston Wharf	LBA	*				*		No	Complete absence of processing residues noted. [Bradley _et al_ 1980, 246-8]
Albury	LBA	x			*	*		No	Absence of spikelet fragments noted. [Harding 1964,14]
Black Patch	LBA	*	*			*	*	No	No mention of processing residues. Material classed as stored pure grain, burnt grain from accidents at hearths, or scattered solitary grains. [Hinton 1982]
Winnall Down:									
Phase 2	LBA					*		No	A single grain of barley only.
Phase 3	EIA				*	*		Yes	Material interpreted as charred crop processing wastes. [Monk and Fasham 1981,331-2]

(continues)

Table 4.7, continued.

Site	Date	Cereals present						Crop processing	
		1	2	3	4	5	6	Processing wastes present	Comments [Reference]
Old Down Farm									
Phase 3	C7 BC		*		*			No	Lack of chaff and other non-seed fragments noted.
Phase 4	C6 - C4 BC	*	*			*	*	Yes	Burnt crop wastes. [Green 1981b]

Notes: Cereal crops are: 1.Emmer 2.Spelt 3.Breadwheat 4.Unidentified wheat species 5.Barley 6.Oats (including wild oats).

* present
x probably present

(1982,388) suggested comprised the smaller of the "major" deposits at Black Patch.

Because the lack of processing wastes is apparently usual in this period, conclusions such as

"None of the wheat recovered at Aldermaston seems to have been processed on the site. This evidence implies at least one further settlement nucleus in the vicinity." (Bradley et al 1980,291)

must be treated with caution, at least until 'producer sites' have also been identified in this way. Initial processing may have taken place in the fields or in temporary activity areas leaving little or no archaeological trace. The scarcity of processing residues in the Bronze Age should be seen as a result of the organisation of crop preparation in the period, due to either the way in which the crop was processed or the subsequent use or disposals of wastes and by-products.

The points stress the importance in attempting to achieve an understanding of the range of agricultural activities and their socio-economic context. Questions about the interpretation of cereal remains relate not only to the technology of processing but also its spatial and social organisation. Assumptions of uniformity in these areas in the entire period from the middle Bronze Age to the early Iron Age may, as with other aspects of agricultural organisation and practice, both be incorrect and lead to misinterpretation of the data resulting in the effective loss of information about the agricultural communities of the period and their socio-economic organisation.

These comments on the nature of the Bronze Age evidence also have implications for the recognition of cultivated species in the carbonised record. In particular, spelt is often impossible to separate from emmer on the basis of grain morphology alone (van Zeist 1970,105; Hinton 1982,382); that is, in the absence of chaff fragments, the two may not be distinguishable. Spelt grains can now be distinguished from emmer using electron microscopy (Korber-Grohne and Piening 1980), but these techniques were not available when most of the published material was analysed. The fact that processing residues are scarce in the Bronze Age samples and common in the Iron Age may be an important factor in the recognition of spelt. Without sophisticated identification techniques, spelt grains may have passed unrecognised. Its apparent appearance contemporary with the introduction of grain drying may reflect the changed nature of the surviving carbonised cereal material which allowed its identification.

These points indicate that comparisons between Bronze Age and Iron Age cereal remains must be made with considerable caution. It is generally recognised that different processing technologies appropriate for different crops result in biases in the evidence which make its interpretation difficult (eg. the under-representation of free-threshing cereals). It is suggested here that significant changes occurred in the organisation and techniques of crop processing during the early Iron Age of southern Britain. Although the precise nature of these changes remains uncertain, the appearance of processing wastes may suggest that initial crop processing activities were moved into the domestic settlement area at this time, and that labour was invested in the construction of ovens, presumably to allow grain drying on a larger scale than previously. This has implications both for the organisation of agricultural production and the interpretation of the carbonised evidence for the crops cultivated in later prehistoric and Roman Britain.

4.2.4.iii. Field drainage and the cultivation of heavier soils.

For the adoption of crops which do well on heavy soils to be fully advantageous, the ability to improve soil drainage is needed. Drainage is needed for two principal reasons - to avoid winter waterlogging (which damages autumn sown crops) and to speed the drying and warming of soils in the spring. One result of effective drainage is that the season in which ploughing can be carried out is extended, and less subject to interruption as a consequence of rainfall. Drainage also increases fertility and speeds maturation of crops (Morton 1855 Vol.2,708). The evidence for the development of land drainage in Iron Age and Roman Britain is discussed in Chapter 6 below.

There is a strong relationship between heavy and wet soils, drainage, and the cultivation of the various wheat species. Wheats are much more tolerant of wet conditions at sowing than the other cereals cultivated in Britain, but only if they are autumn sown, when winter frosts mitigate the detrimental effects of wet sowing (Morton 1855 Vol.2,1135,1140-1).

Light land is particularly suitable for emmer cultivation (although it also suits spelt, with its wider ecological tolerance), and it rarely becomes too wet for sowing winter wheat. If however emmer was spring sown, increased soil wetness due to climatic deterioration in the early first millenium BC could have seriously affected its performance on some soils. Spring sowing on wet land results in heavy weed infestation, and the wheat ripens late, according to Morton (ibid), later than if sowing had been delayed until the soil was drier and warmer.

The spring sown crops such as barley, peas and beans need to be sown as soon as possible after the soil is sufficiently warmed and dried. Wilson (1859 Vol.1,109) notes that it is the difficulty in ploughing heavy land early enough in spring which precludes its use for barley, and this is presumably in the context of effective field drainage. The heavy soils preferred for beans had to be dug if they remained too wet to plough (ibid,205). On heavy or low-lying soils, improved drainage could be expected to enhance the performance of spring sown crops considerably (see Table 4.5 above).

The introduction of drainage to enable the use of these soils would also encourage the cultivation of spelt or bread wheat rather than emmer. The marked decline in emmer noted by Jones (1984,122) for the Upper Thames Valley (where there is evidence for field ditches from the middle Iron Age) contrasts with its continuing significant (if declining) presence in Wessex, where much of the evidence derives from lighter chalkland soils (Murphy 1977,216-7). If soil wetness due to declining climate provided an initial incentive for replacing emmer with the more tolerant spelt in the earlier first millenium BC, increased emphasis on heavier soils in the later part would have reinforced the trend. Such general trends towards the occupation of areas with heavier soils in later prehistory have been identified in several areas; some examples of this are discussed in Chapter 6.

Use of heavy soils requires substantially greater labour inputs than lighter land. Effective drainage reduces the labour needed; a nineteenth century estimate was that field drainage reduced by 25% the number of draught animals needed on a farm (Morton 1855 Vol.2,672). However, this implies buried field drains. Open ditch drainage would require labour investment in laying out systems of ditches, and subsequently in keeping them and their outlets clear. Open drains are effective in soils through which water can move rapidly (eg. gravels), but not in soils where wetness is due to surface water impedance (such as clays) (Briggs 1977,94). Clay soils would still require ridging, to allow the water to run into the ditches.

The advantage of the heavy soils, especially clays, is their fertility and robustness. Bread wheat in particular requires these soils if its high yield potential is to be realised. There may be a point in the cultivation of lighter soils in which either increasing demands for production or declining fertility result in the need for such high labour inputs (for instance,in the form of manuring to raise yields or allow shorter fallow periods) that the work demands of the heavier soils become more acceptable. The greater fertility of heavier soils may allow cultivation to be concentrated in a smaller area, resulting in savings in travel time, which constitutes a major labour input in pre-industrial agriculture. This would be significant where agricultural communities increased in size, which could be the result of settlement nucleation as well as actual population growth.

Crop choice, soil types and the pattern of labour investments (long-term) and inputs (annual) are interrelated in a complex way. Their interactions must be expected to have varied with the environmental and socio-economic situation of individual farming units as well as at community and regional levels. Choice of a crop suited to heavy soils may only be viable in the context of techniques to drain these soils for cultivation. These techniques include both drainage through a system of field ditches and the ability to ridge heavy soils, an aspect covered in the discussion of plough/ard technology in Chapter 3. Developments in both areas can be identified in the middle or late Iron Age. The wide range of factors potentially influencing such decisions imply that only a broad view of the situation is likely to lead to an understanding of which were decisive. The environmental factors may act as important constraints on the options, but in isolation from the technological and socio-economic context, they will often prove to be only partial explanations.

4.3. Cereal Crops in the first millenium BC.

4.3.1. Introduction.

There are several discussions of the cereal crops of the first millenium BC (eg. Jones 1981,1984; Green 1981), and the aim of this section is to assess the patterns of exploitation and change which have been identified in terms of their possible significance in the functioning of the agrarian economy.

The geographic range of the crops data available is notably restricted. Jones (1981,6.1) could list for the Iron Age only 3 carbonised seed reports from Wales, 1 from Scotland and none from England north of the Wash. Some significant reports published since include bread wheat from Bronze Age and Iron Age contexts in Scotland (Boyd 1982/3), and a number of records of Iron Age spelt from northeast England, at Coxhoe (Haselgrove and Allon 1982,46), Murton High Crags (Van der Veen 1987a,194) and Thorpe Thewles (Van der Veen 1987b,95). Jones (1981,104,106) suggested that emmer continued as the principal wheat in northern Britain throughout the Iron Age, on the basis of Roman records from central southern Scotland. But at Thorpe Thewles spelt was clearly the main wheat, emmer being present only in small quantities. Van der Veen notes that the crops present were "very similar" to sites of the same date throughout Britain (1987b,95). Given the limited evidence, it seems unwise to assume that innovations in cropping in the Iron Age affected southern

Britain only; Jones noted the absence of a time lag between southern England and even "the more remote parts of Wales" in this respect (1981,104).

Helbaek (1952) had observed that the Iron Age in Britain was marked by an increase in the number of cultivated crop species, with the introduction or re-introduction of spelt, breadwheat, rye, celtic beans and two species of oats. Jones (1981,104) noted that although several of these species are now known from earlier periods,the first half of the first millenium BC remained, in terms of the introduction of new crop types, "the main period of change between the early Neolithic and the 16th century AD". Further evidence led Jones to modify the position; this period saw "a general adoption .... of a range of crops, some of which had been individually utilized for some time in response to particular agricultural conditions" (1984,122). Jones describes a two-stage process of change, "an increase in the scale of arable production, involving a diversification of soils under cultivation and field crops in use" followed by "a specialisation in particular crops" (ibid,123-4). This he contrasted with a decline in other, probably non-cultivated, plant foods, such as apples, hazel nuts and grass tubers, which are found in Neolithic and Bronze Age contexts but uncommon in the Iron Age. He concluded:

"We may be seeing a change in behaviour as much as a change in the plants actually used. It is tentatively suggested that the earlier assemblages are more consistent with the waste from small-scale subsistence use, and that the later assemblages are more consistent with spillage from larger scale agricultural production and distribution" (ibid,122).

Such a fundamental change should surely be reflected in the other surviving evidence for early agricultural systems. It would seem difficult to reconcile a change of this nature taking place as late as the first half of the first millenium BC with the existence of large-scale arable field systems as early as the early or middle Bronze Age (Fowler 1971). Fowler argues that the "first real husbandry" replaced "essentially 'exploitation' farming" during the early or middle second millenium BC (1983,95), a millenium before Jones suggests such a change is recognisable from the carbonised plant remains. However, it is argued in Chapter 7 below that the extensive field systems date rather later, to the late Bronze Age or Early Iron Age, and this is more compatible with Jones' conclusion. Similarly it is argued that the development of a specific arable field weed flora may develop during the Iron Age, reflecting the techniques of cultivation and the nutrient levels resulting from cultivation practices (see Chapter 6). But permanent smaller-scale arable field systems do date from the middle Bronze Age, and the nature of cultivation in these plots and how it differed from later practice is a key question.

Difficulties arise because a number of changes appear to be taking place, involving both changes in the practice of agriculture, the processing of the crops, and the socio-economic organisation of agriculture (see Chapters 7 and 10 below). The limited data for the period and the change in its nature between the Bronze Age and Iron Age make disentangling these processes difficult.

In particular, it is unsafe to argue for change when the preceding conditions have not been shown to have differed. Jones (1981,121) uses the weed species present at each of three Iron Age sites to support his case that "poorer soils were brought into cultivation from the early Iron Age". At two of the sites (Danebury, Micheldever Wood) the poor soil weeds were present throughout the occupation (Jones 1984b,Table 56,488; Monk and Fasham 1980,324-9). At Ashville the question is complicated by the difference between the samples of middle Bronze Age (where crop processing wastes were absent) and Iron Age date. While the most important damp ground species of the first Iron Age phases (Eleocharis palustris) was not represented in the middle Bronze Age samples, these did include some damp soils species, including the common sedge (Carex nigra) (Jones 1978, Table VI,103,105,109). Jones' complementary evidence for decreasing soil nitrogen based on the increased representation of leguminous weeds is convincing, because the change can be seen in successive phases on each of a number of sites. The change occurred later in the Iron Age (Jones 1984,121-2), and is not as yet documented for the first half of the first millenium BC, the period for which Jones infers increasing diversification of soil types cultivated.

4.3.2. Diversity and specialisation in the wheat crop.

Two of the three wheat species cultivated in the first millenium BC were considered by Helbaek (1952) to have been introduced, or rather re-introduced, to Britain at the start of the Iron Age.

Breadwheat has been identified in late Neolithic and middle Bronze Age contexts in the Upper Thames Valley (eg. at Barton Court Farm, Miles 1986,4; Ashville, Jones 1978,103). In that region it seems likely it continued in use from the Neolithic into the Iron Age. However, in Wessex, it is not recorded in the first millenium BC until between the fifth and third centuries BC (Green 1981, Fig.7.3). It is absent from the earlier Iron Age phases at Owslebury and Portway (Murphy 1977, Tables 7.2.1,7.2.2). Jones notes "a greater presence" of breadwheat in the Upper Thames Valley compared to Wessex throughout the Iron Age (1984,122). Bread or club wheat has been recorded for a number of Scottish sites "since at least the Bronze Age" (Boyd 1982/3,81).

The early Neolithic date for the Hembury spelt, disputed by Helbaek (1952,208), is now accepted (Field *et al* 1964,373). There is then a substantial 'gap' before the few Bronze Age records. These include Ashcombe Bottom, Lewes, (early B.A), Bourne Valley, Eastbourne, (middle B.A), (M.Allen., pers. comm.) and Black Patch (late B.A.; Hinton 1982), all in Sussex. In the Upper Thames Valley, spelt was not recovered from the late Neolithic and middle Bronze Age sites which produced breadwheat, or from late Bronze Age sites such as Bray (Bradley *et al* 1980,291-2) and Aldermaston Wharf (ibid,246-7), where its absence was taken to support the view that spelt was an Iron Age introduction. This may represent a regional difference, with breadwheat being the second cultivated wheat species, alongside emmer, in the Thames and Kennet valleys, and spelt being the second cultivated species in central southern England. In each case emmer, which is susceptible to frost and prefers light dry soils, is accompanied by a species with the qualities of being winter hardy and able to grow on heavy soils (see Table 4.1).

The lack of spelt in earlier periods may also relate to difficulties in recognition. It cannot be distinguished from emmer on the basis of grain alone, as there is considerable overlap between the species (Hinton 1982,382). Van Zeist (1970,103-5) noted grains securely identified as spelt (found in spikelets) which closely resembled breadwheat, and others very like rye or indistinguishable from emmer, in the Roman Iron Age samples from Valkenburg (Netherlands). Jones (1978,103 and Fig.68,F) also notes a continuity in form and size between spelt and breadwheat, the species being interfertile, producing types with intermediate characteristics. The grains can be distinguished by electron microscopy (Korber-Grohne and Piening 1980), and use of this technique might supplement the records of early spelt cultivation considerably.

This is important because of the nature of the Bronze Age and earliest Iron Age carbonised material, which often consists only of a scatter of isolated grains (see above, section 4.2.4.ii and Table 4.7). The spelt at Black Patch was identified by the presence of spikelets; it was identified only in 'major' deposits, ie. those recognised during excavation as being deposits of carbonised grain (Hinton 1982,386-8, Fig.15). It was not found in the 'minor' deposits, which more closely resemble the material from other middle and late Bronze Age sites listed in Table 4.7. The Hembury spelt similarly derives from a recognised charred grain deposit; spelt was not found among the grain impressions on pottery from the site. It may be significant that at neither of these sites spelt was identified from sources of evidence other than visible deposits of carbonised grain.

The nature of most of the pre-Iron Age evidence and the difficulty in identifying spelt grains combined with the expectation that Bronze Age wheat would be emmer may at least partly account for its scarcity. For instance, at Albury, the wheat was poorly preserved and spikelet parts were absent; the grain was said to be probably emmer, being therefore "what could be expected from a site of this age" (Harding 1964,14).

Certainly emmer must be regarded as the major wheat crop throughout the Bronze Age. At Black Patch, spelt was a minor component of the cereal deposits in which it occurred, being less than 1% in two of the samples in which it occurred, and only 3% in the third. This contrasts with the later situation; for the Hampshire downland sites, Murphy (1977, Table 7.2.5) has shown that spelt exceeds emmer in both presence and dominance analyses from the seventh/eighth centuries BC onwards. However it would be unwise to assume that Black Patch represents a late Bronze Age norm even for the downlands of southern England. Crop choices may have varied between sites in this period in the same way as is known to have happened later.

During the Iron Age, all three wheats are established in both regions; breadwheat appears in Wessex in the fifth to third centuries BC, and spelt in the Upper Thames Valley in the period mid sixth to late fourth centuries BC (Green 1981, Fig.7; Jones 1978, Table VI). In Wessex, emmer almost always occurred along with spelt in the Iron Age; in the Upper Thames Valley it showed a "marked decline" (Green 1981,132-3; Jones 1984,122).

For Jones' second stage, "specialisation in particular crops" (1984,124), the evidence is probably most clearly shown in Green's analysis of the Wessex crops. He noted that there is no great change in the occurrence of either wheat or barley in the Iron Age or Romano-British periods (1981,139), but within that overall similarity some changes in the pattern of their cultivation are clearly seen. One is the decline in the cultivation of spelt and emmer and the increase in breadwheat (ibid, Fig.7.3). Emmer was less important than spelt throughout the period considered, and nearly always occurred with spelt. They could have been grown as distinct crops, or possibly mixed. Beaven (1947,48-9) notes the advantages of mixing types in achieving good yields. Although spelt ripens before most emmer varieties, the same applied to some recent commonly grown barley mixtures (ibid,50). If breadwheat was replacing spelt as the wheat usually chosen for heavy soils, the distinction between spelt and emmer based on their suitability for cultivation on such soils would become less important. The two are processed in the same way; Helbaek's suggestion (1952,209) that spelt required parching but emmer did not is incorrect (van Zeist 1970,153; Hillman 1981, Figs.6,7).

Bread wheat was present on none of the earliest Iron Age sites (pre-fifth century) Green considered, although the limited number of sites and the likely under-representation of the free-threshing cereals mean its cultivation in this period cannot be excluded. Its presence increased during the Iron Age, although its adoption was patchy (Green 1981, Fig.7.3,139), and in the Roman period it exceeded that of emmer. As many Romano-British sites grew only spelt and/or emmer as bread wheat only. Green's analyses showed that in the last two centuries BC and the Romano-British period a number of sites specialised, cultivating either barley or breadwheat only, or the two glume wheats together (ibid,Fig.7.5).

The interesting question is how this specialisation is to be interpreted, there clearly being several possibilities. One would be that an increasing number of sites found their crops choices constrained by environmental factors, as if for example the increased exploitation of a wider range of soils led to a number of settlements having access only to soils which were for some reason unsuitable for the full range of cereals. Another possibility is that the demands of crop processing became crucial, with an advantage deriving from cultivating crops with the same processing needs; those of the glumewheats, free-threshing wheats and hulled barleys differing (Hillman 1981, Figs.5-7). While processing was carried on on a small scale as produce was needed for consumption, a variety of processing needs might be unimportant. But if larger scale processing were needed, a single processing method might prove more efficient in terms of the inputs of equipment, time and labour. This could reflect a situation in which grain was being prepared for consumption away from the production unit, being either sold or exchanged or removed in some form of taxation or tribute.

Green (1981,133) was able to suggest that bread/club wheat may have been a "specialist crop to serve a particular urban requirement" in the Roman period. He noted that two sites in or close to Winchester adopted bread/club wheat as a specific crop earlier than some more distant rural sites. If this can be recognised as a recurrent pattern, it raises the question as to whether the barley only or glume wheat only sites of the later Iron Age are capable of similar interpretation. Breadwheat is of course especially suitable as a traded crop; unlike barley and the glume wheats it does not need additional processing to separate the grain. Jones (1981,107) notes that reduction of bulk and hence transport costs would be an important factor in trade, and Miles (1986,29) states that spelt still in the hulled state is twice as bulky as naked grain. However, the spelt/emmer only and barley only sites of the later Iron Age clearly precede the appearance of breadwheat only sites, and it would be misleading to overemphasize breadwheat in discussing the specialisation of the crop.

Cultivation of a single crop species also carries disadvantages, as the crop is more vulnerable to species-specific pests and diseases, and similarly there can be a narrower range of tolerance to weather and soil conditions. Use of a variety of species can be important as a work-spreading technique, allowing spring and winter sowing seasons and an extended harvest period. Change from diversity has implications in terms of all three fundamental agricultural resources - land,labour and draught power. One question which can be raised is whether the visible specialisation was in fact accompanied by currently undetected change in other areas, such as for example the cultivation of legume crops, or where arable specialisation was demanding increased draught power and manuring, the cultivation of fodder and forage crops. Understanding why the disadvantages of specialisation became outweighed by its advantages for some sites (but not for others) may be critical in understanding the economic pressures on and opportunities open to Iron Age and Romano-British agricultural communities.

4.3.3. The barley crop.

Barley is an adaptable species with varieties suited to a wide range of climatic and environmental conditions. Most traditional barleys are mixtures of different types. Beaven (1947,50-4) notes that natural selection will tend to produce a fairly uniform aggregate where conditions such as soil, climate and cultivation methods remain constant. However in real situations variations in conditions between different years allow other types to persist within the mix. A consistent change in conditions (in Beaven's example, by transferring seed to a different area) will result in the proportions of the types in the aggregate changing, resulting in a mix in which a different type becomes dominant. An implication of this is that changed climatic conditions would be expected to change the character of the barley crop, even in the absence of deliberate selection of types suited to the new conditions. Marked fluctuations in weather conditions could result in a more heterogeneous crop, with no one type being more suited to all the weather variations, and hence no one type coming to dominate to mix.

The evidence indicates that later prehistoric and Romano-British barley crops were genetically very mixed. Analyses of barley from Ashville (Jones 1978,104-5) showed that the barley was all of a six-row hulled variety, but very diverse with respect to ear laxity. Green's analysis of the barley from Wessex confirmed this diversity, and indicated that distinct lax and dense eared varieties only appeared in the late Saxon period (1981,139-40).

Green (1981,139) notes that assertions that barley was a more important crop than wheat in the Iron Age are not substantiated in the evidence from Wessex, which does not allow the point to be resolved. Dennell (1976,18) detected a regional distinction emphasising wheat in the heavier soils of Somerset and barley on the chalk downlands, a pattern said to have continued from the Neolithic to the end of the Iron Age, but Green notes that the evidence from Old Down Farm does not support Dennell's view that barley was extensively grown on the chalk downs (1981b,154). The question is complicated by the differences in processing between barley and the glume wheats, reflected in the scarcity of barley chaff. The presence figures give little indication of change in the occurrence of the two, but Green notes that hulled barley may increase from the third century BC, on the basis of evidence from Portway and Old Down Farm. At Portway, dominance analysis showed increased barley and decreased wheat in succeeding phases, but wheat remained better represented in presence and dominance terms throughout (Murphy 1977, Table 7.2.2).

Both wheat and barley were clearly important crops in the Iron Age, and the question of which was 'more important' may not be particularly significant, especially in the absence of evidence indicating whether they had similar or distinct uses. Green notes there is no evidence to suggest that barley was grown for malting in the Iron Age or Romano-British periods (1981,139). Present evidence for malting seems to relate largely to spelt (Hillman 1982; Helbaek 1964,163-4). Wheat is better for bread making because of the low gluten content of barley (Hill 1952,320). Without understanding their roles in the agrarian economy, comparisons of the quantities grown, even if possible, would add little to the understanding of the producer societies. The increasing evidence for marked variation in cropping practices, even of agricultural settlements "within an hour's walking distance of one another" (Jones 1984,123), also suggests the questions must be more complex if the answers are to be useful.

Hulled barley is clearly the most important type during the Iron Age, even taking into account the possible underrepresentation of the naked types in the archaeological record. There are regional distinctions; in the Upper Thames Valley naked barley disappeared entirely during the Iron Age (Jones 1984,122); in Wessex naked types persisted throughout the Iron Age and Romano-British period but never exceed a presence value of 15% (Green 1981,139, Figs.7.7,7.4); in Somerset naked barley is also known from the Romano-British period (Rahtz and Greenfield 1977,373).

Naked barleys as recently cultivated in Britain have usually produced poor yields. They are not suited to the climate, requiring short hot summers and rapid growth to give high yields (Wilson 1859, Vol.1,105). They are characterised by weak straw and brittle ears (Beaven 1947,322), which is important in relation to harvesting techniques. Given Beaven's comments (referred to above) on genetically diverse barley crops, a shift in importance from naked to hulled barley could be related at least in part to natural selection in response to climatic change.

One question is whether the naked and hulled barleys formed separate crops during the Iron Age. Green (1981,Fig.7.4) records one late Iron Age (and one early Saxon) site where only naked barley occurred, and this may indicate that naked barley was cultivated as a separate crop by the later Iron Age if not before. Hulled barley requires extra processing (Hillman 1981, Figs.6-7), but it has the advantages of lower losses in harvesting and, based on recent British data, better yields. There seems to be no evidence for an association between hulled types and brewing; the evidence for malting from prehistoric and Roman Britain relates mostly to spelt wheat (see above). Beaven stresses the value of naked barleys as food grain (1947,321-2), and its persistence into the Roman period and beyond in certain areas may require deliberate cultivation as an explanation.

There may be two processes at work; climate induced change in a genetically diverse barley crop originally incorporating hulled and naked varieties, and the emergence of naked barley as a distinct crop.

Some characteristics of six-row barleys can be briefly noted. They are described as very hardy and capable of good yields; it is their malting quality which is poor (Percival 1900,482; Wilson 1859 Vol.1,107). This results from their high protein content, as malting barleys need a high carbohydrate:protein ratio in the endosperm (Hill 1952,320; Beaven 1947,109). Comparisons of food values based on recent analyses of cereals need to take into account that barley varieties are now selected for a lower protein content. Higher protein content implies greater food value for people or livestock, but despite their higher protein content, six-row barleys are still not well suited to bread making because of their low gluten content (Hill 1952,320).

4.3.4. Oats and Rye.

Many of the problems referred to above recur in discussing oats and rye. The difficulties in identifying to species from grains alone applies to both, making it difficult to distinguish between wild and cultivated oats (Green 1981,140). In the case of rye, recognition is hindered by its tendency to mimic the characteristics of other cereal crops it grows with (Hillman 1978,167-8). This may lead to rye not being recognised where it is not expected (Chambers and Jones 1984,221-2). It is free-threshing and likely to be substantially under-represented in archaeological samples (Hillman 1978,169-70).

In addition to the characteristics of the crops themselves, different usage will determine differences in the treatment they receive before use. Crops intended as animal fodder may be stored in stacks on the straw, without threshing; they are probably unlikely to be artificially dried. However assessing the relationship between the cereals, their usage and their representation in the archaeological record can easily slip into circular argument.

The limited number of middle and late Bronze Age carbonised seed analyses implies that species which first appear in deposits of the late Bronze Age/early Iron Age cannot be assumed to have been newly introduced at that time. The rest of the Bronze Age evidence, largely seed impressions on a single pottery type, is simply too restricted in both location and date (Dennell 1976,17) for that to be a reasonable inference.

Early records of oats include Fengate (dating from the middle Bronze Age onwards: Wilson in Pryor 1984, Appendix 5), Aldermaston Wharf (a single grain, dating from c. 1100-800 bc: Bradley et al 1980,246-7), and Maiden Castle (two cultivated oat species recognised in material dating from c. 800-400bc: Jones 1984,122). Green (1981,140,Fig.7.2) records the presence of oats in all his Iron Age and Romano-British phases, with presence values of 20 to 45%, and notes "a general increase" in its occurrence. He stresses the difficulty in defining when oats was being cultivated in its own right.

Rye was also present at Maiden Castle in samples of the eighth to fifth centuries bc (Jones 1984,122) and at the early first millenium BC site at Myrehead, Falkirk

(Barclay and Fairweather 1984) where it was "considered as reflecting an intrusive weed element rather than as an indication of serious cultivation". In Wessex samples reported by Green (1981,Fig.7.2) rye does not appear before the second century BC; it was present on about 20% of the sites of the last two centuries BC, but found on only one Romano-British site.

These records for carbonised rye can be augmented by pollen analyses, summarized by Chambers and Jones (1984) who cite a number of radiocarbon dated records from 3500 bp onwards. Rye is unusual among the cereals in producing large quantities of wind dispersed pollen, which is also identifiable to species. Its presence in early deposits has generally been assumed to indicate the cultivation of other Cerealia species, the rye itself being taken to be a weed (ibid,222). This is reason for Barclay and Fairweather's interpretation of the Myrehead rye. However, Hillman (1978,168) states that rye, as a weed, is "never very successful at infesting crops of barley, oats or glume wheats", its preferred hosts being the bread and club wheats. This suggests that the presumption rye was a weed (by implication of spelt, emmer or barley) when it appears in the early carbonised records must be open to question. The later Iron Age rye in Wessex could reflect the increasing cultivation of bread wheat in that period, except that in the subsequent Roman-British and Saxon periods breadwheat continues to increase in importance and rye virtually vanishes (Green 1981, Figs 7.2 and 7.3). As weed-rye mimics the size and shape of the breadwheats (Hillman 1978,168) its eradication as a weed would have been difficult. This presumably also increases difficulties in identification.

Helbaek (1971,269-271) has firmly associated the spread of rye as a cultivated crop in Europe with the Roman army, regarding all earlier finds as weeds; he suggests, on the basis of the malted grain from Caerleon (Helbaek 1964) and the low status Pliny accords to rye as a food crop, that its use was in brewing. However, use as a component of a fodder crop is perhaps more plausible. The spread of *Agrostemma githago* in Roman Britain might reflect the use of rye, as it is closely associated with rye crops (Godwin 1975,479); it is also known from a late Iron Age context at Barton Court Farm (Robinson 1981,275), a site characterised by its "innovative agriculture" (Jones 1986,120).

Both oats and rye were therefore present in Britain and potentially cultivated species from at least the late Bronze Age, even though there is at present no strong evidence either formed a crop species rather than a weed. Another possibility is that they were used as part of a mixed crop, either for human consumption or as part of a mixed fodder/forage. As the different uses affect the nature of the evidence they leave for their exploitation, the questions cannot be separated.

4.4. The leguminous species.

4.4.1. Introduction.

Despite the lack of attention they have received, the role of the leguminous plants, as crops or weeds, is of substantial importance in understanding later prehistoric and Romano-British agriculture in Britain, and in particular in assessing its productivity and stability. Three main areas are considered here. These are the occurrence of leguminous weed species; the importance of the large-seeded legumes in arable economy; and the small-seeded legumes and their possible use as fodder crops.

4.4.2. Leguminous weeds and earlier agriculture.

In discussions of prehistoric agriculture there is a marked divergence between the 'optimistic' assertions of a labour intensive but highly productive agriculture (typified by work based on the results of the Butser experiments (Reynolds 1981,1987,1988), such as Mercer (1981)) and some indications that this period may have seen a decline in agricultural productivity due to deteriorating soil fertility. Understanding the role of the leguminous crop and weed species in agricultural economies may prove to be central to establishing the limitations of these systems, and hence estimating the extent to which potential productivity ('Butser yields') could have been realized.

Jones (1979,99,109) interpreted an increase in the occurrence of carbonised seeds of leguminous weed species during the Iron Age at Ashville as the result of overcropping, leading to depleted soil nitrogen and hence an increase in the nitrogen-fixing weed species. He subsequently identified this trend in the evidence from four other Iron Age sites in central southern England (Mount Farm, Winnall Down, Gussage All Saints, and Old Down Farm). He concluded that "such a pattern, if extensive, could reflect a widespread ecological stress related to the diversification of crops and an extension onto less favourable soils" (Jones 1984,121-2). [Jones' inference of increasing use of poorer soils from weed seed evidence is discussed in Chapter 6 above - one problem is a lack of evidence that this represents change from an earlier situation].

A link can be made between Jones' results and the suggestion by Hubbard (1980,61) that increased evidence for the cultivation of legumes as food crops in the Iron Age reflects a scarcity of animal protein. Such a shortage would be accompanied by a lack of animal manures for the fields, resulting in nitrogen deficiency. The case for an increase in bean and pea cultivation during the Iron Age is discussed in section 4.4.3. below; it is not strong, given the exceptional nature of the Glastonbury and Meare finds.

Further evidence for declining fertility of arable land is provided in Bell's analyses of colluvial deposits from the South Downs (1983). Bell documents substantial soil losses resulting from early agriculture, and also noted that a significant change in soil type may have accompanied this, as much of the eroded soil was of loessic origin. The fields would also have become stonier. He considered it possible that "as soils thinned, some areas became progressively less able to sustain intensive agriculture" (ibid,147-8). However, colluviation is "by no means ubiquitous on the chalk", and Bell refers to several investigations which found none (including one of his trenches). His three study areas are all "well known archaeologically", and it could be that very local intensive use is reflected. Colluviation was often intermittent, presumably reflecting different intensities of land use (Bell 1982,138). Bell's review of the British evidence for colluviation showed that the date of its initiation varied greatly, from Neolithic to post-mediaeval (1982,138, Fig.3). The question remains how widespread and damaging this colluviation was: whether it constituted a general drain on fertility, or was a feature only of certain favoured localities cultivated for long periods.

Cunliffe (1984b) has argued for a period of stress, around 200 to 100 BC, due to increased population and declining soil fertility on the Wessex downlands. This is based on "some evidence to suggest an increase in the number of settlements in the middle Iron Age" and the increased proportion of sheep (57% up to 66%) at Danebury, accompanied by an increase in their rates of peridontal disease (ibid,31). The relevance of the sheep to agrarian stress is established by his interpretation of their role. He asserts their prime use was to manure the arable: "without such an explanation it is difficult to see why such large numbers of sheep need have been reared". This view defines wool-production as "a by-product of the agrarian economy", despite his acceptance of wool as one of the two bulk-produced commodities in Iron Age Wessex, and the acknowledgement that woollen fabrics may have had considerable economic significance in exchange systems (ibid,32). He describes the stress developing against a static agricultural background: "even by the early IA" agriculture "had reached a degree of equilibrium and changed little throughout the early and middle periods" (ibid,28,30). Interestingly, the weed seeds from Danebury do not suggest any decline in the fertility of the areas cultivated; Jones (1984b,495) notes the absence of any change through time in the weeds present. This argues against serious loss of soil fertility; the changes in the sheep population may relate directly to the importance of wool.

These complementary inferences, taken together, could clearly form a case for agricultural stress during this period. Yet other interpretations are possible. An understanding of the nature of the arable economy is essential if the questions raised are to be resolved. The leguminous weeds are an important source of evidence, and it is their interpretation which is considered here.

Although the leguminous weed species are known to be commoner in nitrogen-poor soils, it is not entirely clear how the archaeological data should be interpreted. On the unmanured plots of the Broadbalk continuous wheat experiment, the presence of the leguminous weeds was initially suggested as an explanation for the plots' ability to remain productive (that is, the nitrogen-fixing weeds were suggested as the source of soil nitrogen). But removing weeds from parts of the field using chemical weedkillers did not result in any decline in yields, indicating this was not the case (Rothamsted Experimental Station 1968,9). In the unmanured plots, characterised by high levels of leguminous weeds such as Vicia and Medicago species (ibid,189), the yields of wheat fell to around 50% of their initial levels over 70 years of continuous cropping (ibid,41-2, Table 3.15). However the introduction of a fallow cycle (one fallow year in five) returned the yields to their original levels. [In fact, the yields were slightly higher than the 1850s yields, but factors such as changes in cultivation and weed control and the varieties of wheat under cultivation must be assumed to have affected this outcome (ibid,23-5).] Clearly the unmanured weeds with their leguminous weeds were producing less than their potential, as manuring with farmyard manuring resulted in yields at least twice as high at Broadbalk, but on the robust Rothamsted soil, with a fallow cycle, the unmanured plots did not show any indications of decline or exhaustion. The nitrogen content of their soils remained "remarkably constant" (ibid,100).

The incidence of nitrogen-fixing weeds may therefore indicate the existence of a stable agricultural regime which did not involve the heavy manuring needed to maintain high soil nitrogen levels. Soil nitrogen will have declined from initial levels, but serious and continuing fertility decline need not be implied. Now although substantial manuring is often inferred from the evidence of artifact scatters on fields and their accumulation within lynchets, estimating the quantity or regularity of manuring is problematic. Much material incorporated in lynchets may derive from disturbance of earlier occupation deposits; it is sometimes demonstrably earlier than the lynchet itself. These problems are discussed in Chapter 6.

It is possible to interpret this evidence not as a decline in productivity of an established agricultural system but as the establishment of a different stable system. The increase in leguminous weeds would then represent the development of a weed flora specific to the cultivation practices of the period, and need not be interpreted as an indication of agricultural stress.

Certainly land under cultivation will decline in productivity unless measures are taken to restore its fertility. But using methods such as fallowing, a stable and effective agricultural system is possible, even if yields are substantially less than could be achieved using heavy manuring (Reynolds 1981,110, Tables 1,3). The contradictions between the 'optimistic' and 'pessimistic' views of later prehistoric agriculture may arise from overestimating the intensity and/or scale of earlier (ie. early and middle Bronze Age) agriculture, and consequently misinterpreting the changes in soils and weed flora seen in the Iron Age. Possibly the tendency to see highly intensive and productive cultivation as the norm by the middle Bronze Age (exemplified by the early dating of the coaxial field systems and inference of systematic heavy manuring) may be resulting in indications of the establishment of large scale systems of cultivation being misinterpreted as signs of stress and deterioration.

The ideas put forward in these paragraphs are still tentative. However they seem to allow integration of a range of data, without, so far, obvious contradictions. Two other factors suggest a change in the nature of arable fields may have been occurring during the early and middle Iron Age.

In addition to the increase in leguminous species, other characteristics of weed seed assemblages may be informative. There is a qualitative difference between the range of weed species recovered from archaeological deposits and those recognised as weeds of arable fields currently. Archaeological assemblages derived from cereal cultivation regularly include species now associated with grassland rather than arable land. This has been recognised from late Bronze Age and Iron Age sites, as at Black Patch (Hinton in Drewett 1982,386) and Ashville, where Jones (1978,105) explained the seeds as either intrusive from adjacent arable land or residual from earlier land use. They might equally be used to suggest that later prehistoric fields more closely resembled grassland environments than is characteristic of recent arable land.

One species which provides an example of this is the Heath Grass, _Sieglingia decumbens_, which has been identified as an arable weed in deposits of Iron Age to mediaeval date from north and west Britain, but does not occur in arable land (Van der Veen and Haselgrove 1983,24; Hillman 1981,145-6). Hillman suggests this may be the result of change in cultivation methods, with the introduction of the mouldboard plough. He notes that a number of other weed species would be affected, favourably or adversely, by that change. Salisbury's survey of historical sources (1961,146-7) detected "no striking qualitative changes" in cornfield weed flora until quite recently. Between c. AD 1400 and the nineteenth century the weeds recognised as major pests remained essentially the same. Of the seventeen "worst weeds" of 1809, only 3 were perennials (generally worst affected by the mouldboard plough) and two of these (couch grass and field thistle) are cited by Hillman as benefiting from mouldboard ploughing because of their ability to reproduce vegetatively from small pieces.

Potentially an earlier change in the techniques or intensity of agriculture might be similarly reflected in the weed flora of the cultivated land. A number of sites have a greater number of weed seeds recorded in Iron Age than in earlier samples. However, the difference in the nature of the carbonised plant remains discussed above is again crucial here. Only if samples from like sources could be compared would inferences about changes in weed flora be convincing. Green (1981b,131-2,154) noted an increase in weed species at Old Down Farm. There was a particular increase in quantity and variety of weed seeds in the middle Iron Age phase 5, compared with earlier phases. As the material from both this and the preceding early Iron Age phase 4 derived from crop processing wastes, there should be less bias due to the nature of the samples, and a real change is likely to be represented. Pre-Iron Age samples which are not from processing wastes or stored crop products cannot be assumed to relate to the arable environment, and may derive from a wide range of sources, such as fodder or bedding for livestock, animal dung (Bakels 1984,17-19), fuel, thatch or plants growing in and around the settlement. The latter environment is likely to have been nitrogen-rich, and an assumption that material derived from it indicated the nutrient status of cultivated land could be extremely misleading.

Similarly a distinction can be inferred between prehistoric and recent arable land from the analysis of land snails. Two of Evans' open country indicator species are now rarely found in arable environments, but have been recorded in abundance from some Iron Age contexts suggestive of heavy cultivation (<u>Pupilla muscorum</u> in Iron Age ploughwash at Pink Hill, Evans 1972,312,Fig.116; <u>Helicella itala</u> in Iron Age lynchets at Fyfield and Overton Down, ibid, 320-1,Figs.120-1). While Evans suggested climatic change and increased competition as possible explanations for this apparent change in habitat preference, it may be a change in the habitat itself, ie.

in the nature of arable fields, which is responsible (ibid 147,182,21-2).

The characteristics of snail assemblages from cultivation derived deposits or buried ploughsoils are potentially valuable sources for assessing change in the arable environment. One problem is the limited number of relevant securely dated assemblages. But the key question is the relationships between the open country species and their environmental preferences and limitations, which are still unclear. Evans (1972,198) suggests these relationships could be crucial in understanding the early land use of the chalk areas of southern Britain. Because of the present lack of established non-intensive farming environments these factors may remain elusive. One trend which has been identified by Evans is for _Vallonia costata_ (a species which cannot tolerate intensive cultivation but is a good coloniser able to withstand periods of woodland regeneration) to decline while _V. excentrica_ (a poor coloniser but much more tolerant of the disturbance of cultivation, and hence common in present day arable) persisted. This decline occurred "perhaps in the Iron Age" (Evans 1972,153-164).

Another problem is that 'grassland' snails found in eroded material from arable fields could plausibly derive from either generally grassier conditions during cultivation, from interspersed periods of grass ley, or from the lynchets themselves if they formed uncultivated grassy strips between fields.

There are clear indications of a change in the nature of arable fields between the Iron Age and the present day. The question is whether another change in the nature of arable fields and the habitat they provided also occurred at an earlier period. The increase in weed species and the changed occurrence of the _Vallonia_ species suggest this may be so. Such a change might be due to specific change or changes in the technology or techniques of agriculture, or represent the result of gradual long-term effects of agriculture on the land. The arable field is a human creation; it can be expected to have evolved as the practice of agriculture developed. Identifying the changes which occurred during later prehistory would significantly add to the understanding of agrarian economies.

Certainly there are at least two possible interpretations of evidence such as the increase in leguminous weeds and in soil loss during later prehistory. The first is that intensive cultivation in extensive field systems with manuring levels high enough to maintain good yields were established by the middle Bronze Age, but culminated in overcultivation and seriously decreased fertility and productivity in the Iron Age. The second is that there was a change in the nature of cultivation, with greater demands being made on the land. Although this was accompanied by some fertility regulating measures, this was not characterised by manuring at levels sufficient to realise the full productive potential of the land. The Rothamsted experiments show this would generally still have been a sustainable and productive regime. The cultivation of low nitrogen demanding leguminous crops would be particularly advantageous under such a system.

It is suggested in later chapters than Bronze Age agriculture used small field groups around settlements; enclosing livestock within the settlement would have enabled manure collection and the maintenance of fertility on heavily used plots. The layout of extensive coaxial field systems (it is suggested in Chapter 7 this began in the early Iron Age) and the lack of evidence for systematic manuring (Chapter 6) may reflect a different type of agricultural system, based on more extensive land use and relying on fallow or grass leys to sustain fertility. Limitations within the Bronze Age system may have brought about change; in particular there may have been limits to expansion based on distance factors and the demands of manuring.

Clearly there is a need for more information on the detail of agricultural practice and land use during the Bronze and Iron Ages. While the prevention of erosion and fertility decline must have been constant concerns in agricultural societies, these are not yet convincingly documented as widespread problems during the Iron Age. However a wider perspective will probably be necessary to evaluate the two probabilities fully. A fundamental question is whether the evidence for social and economic structures and change in the later prehistoric period is more readily interpreted in terms of a society under productive stress or one underpinned by a stable and productive agricultural base.

4.4.3. The cultivation of larger-seeded legumes.

4.4.3.i. Introduction.

The role of the larger seeded legumes (peas and beans) in Iron Age and Romano-British agricultural economies is of interest for a number of reasons. One question is whether they formed a staple product stored for for year round consumption or were used only as a seasonal fresh vegetable. This is important not only because of their intrinsic food value and the effect their cultivation would have on the scheduling of the agricultural cycle, but because their cultivation may relate to other aspects, notably questions of crop rotations. As noted above, if Iron Age agriculture was characterised by low levels of soil nitrogen, the nitrogen-fixing abilities of these crops would have been particularly valuable. They may therefore be important in understanding the nature, and in particular the stability, of later prehistoric and Romano-British agricultural systems.

The cultivation of peas and beans could have played an important part in the agricultural economy. Legumes have tended to be overlooked in models of agricultural productivity in British prehistory. Little attention is paid to beans in the Butser experiments, the interest lying solely in their value in rotations (Reynolds 1988,49). In contrast, Henneberg and Ostoja-Zagorski's model of Hallstatt agricultural communities of c. 500 BC in Poland assumes that grain and legumes were of equal dietary importance (1984,59). The Roman agronomists imply that 40 to 50% of the area cultivated annually in Roman Italy was sown with legumes (Columella XI.II.47, II.XII.7; Pliny XVIII.XLVIII.173). Hubbard (1980,60) suggested that the lesser cultivation of pulses in north and west Europe compared with the south was not a result of poorer climatic conditions, but reflected the greater availability of animal proteins in these areas, compared with Mediterranean regions where summer grazing is often poor and limited. The difficulties in feeding livestock in the summer months are a recurring topic in the Roman texts (Columella VI.III.4-8; White 1970,222,283-4).

Green (1981,141) suggested that beans are unlikely to have been a field crop in Britain, on the grounds that celtic bean plants, being tall, need shelter from wind and rain and are vulnerable to weevil and aphid attack. If Reynold's views on the labour intensive nature of Iron Age agriculture are accepted, the former is less of a difficulty. From nineteenth century data, beans and cereals produce similar yields per hectare (McConnell 1883,121-2,107-112); unfortunately the beans yields are not quoted from the Butser experiments (Reynolds 1988,49). However, according to Henneberg and Ostoja-Zagorski, dried beans have roughly three times the protein content of wheat flour (1984,60), and more intensive cultivation might be justified for that reason.

Weevil infestation of beans is known from the Iron Age; many of the beans from Meare (West) had clearly preserved holes where the weevils had emerged. Caseldine (in J.M.Coles 1987,223-4) has identified the bean weevil _Bruchus rufimanus_ from Meare Village East. Weevils were not present in other samples from Meare East, suggesting that the beans had not been deliberately burnt in response to infestation. Badly affected beans are unfit as either food or animal fodder, but will often still germinate, though the plants may be sickly. Re-infestation can be prevented by steeping beans briefly in brine or hot water, or by storing the seed until the second year before sowing. Chalky districts suffer worse from weevil infestation, because the weed species there provide alternative food for weevils. Later sown crops are more readily attacked. These points apply to both peas and beans (Wilson 1859,236-8,260). Aphids affect both badly, and the bean aphid can totally devastate the plant. Attacks can be limited by cutting off and burning the heads of bean plants at the first sign of attack; but this does not apply to peas because of their trailing growth (ibid,234-5,259). Both beans and peas suffer "great injuries" from these pests in some years (ibid,257).

The weevils from Meare seem to be the earliest example of insect infestation of stored food, cereal grain pests appearing to be a Romano-British introduction. Grain beetles such as _Oryzaephilus surinamensis_ and _Sitophilus granarius_ survives in Britain only in grain stores, and are more successful either in heated stores or where heat is generated by fungal attack or the presence of large numbers (Osbourne 1978,34). The Bruchids (pea/bean weevils) differ in an important respect, as infestation does not depend on the provision of an artificial storage environment; the eggs are laid into the young peas or beans in the fields, although the injury is not seen until the legumes have been stored and the insect emerges. This, incidentally, seems to imply that the weevil infested beans from Meare West do indicate the storage of beans; this is important as it has been suggested that prehistoric pulse crops may have been cultivated for consumption as a fresh summer vegetable rather than stored for later use.

Legumes can play an important role in crop rotations. Jones (1981,113) claimed that "the use of legumes may in itself imply rotation", although he may be using the term rotation rather loosely. He has argued that the presence of beans and flax in the cereal assemblage from a corn-drying oven at Barton Court Farm indicates crop rotation, as flax is unlikely to be intercropped with wheat and does not survive for long as a cornfield weed (1981,113). Smith (1979,101) suggested (somewhat less convincingly) crop rotation in his reconstruction of the Iron Age economy at Fisherwick on the basis of one possible pollen grain of Vicia faba. Roman agricultural writers recognised the fertilising effects of legumes (eg. Cato XXXVII). Pliny noted that a crop of lupine, vetch or beans could replace a fallow year in need. He described several rotations, including a wheat-beans-fallow sequence, with alternating crops of beans and wheat without fallow being possible in rich soils (Natural History, XVIII.L, XVIII.LII). Either rotation allowing continuous croppings or a sequence of cultivation of different crops in order of their declining demands for soil fertility should have resulted in an increase in the productivity of land.

Hubbard (1980,61) has suggested that "the exploitation of pulses is merely inversely proportional to the availability of animal protein". He noted a "sudden and pronounced increase in pulse crops in the Iron Age in northern Europe", possibly attributable to "demographic or cultural factors or both". Hinton (1982,389) applied this interpretation to the beans from the late Bronze Age settlement at Black Patch.

However the limited data base on which Hubbard's analysis rests must be taken into account. His prehistoric British data are derived solely from Helbaek (1953) and Jessen and Helbaek (1944). Murphy (1977,227) noted that beans were underrepresented in pre-Iron Age contexts as the evidence for these was largely from pottery impressions; Dennell (1976) listed only two pre-Iron Age carbonised seed analyses from Britain, against 139 pot impressions. Peas and beans are almost certainly underrepresented in pot impressions. Helbaek (1952) could list none, although impressions of beans do occur occasionally: Curwen (1938,137-8) cites examples from late Bronze Age and Roman Iron Age contexts in Denmark, there are Anglo-Saxon examples from Mucking (M.U. Jones 1985, 13), and Hillman (1981b,188) refers to a bean impression in a late Neolithic sherd from Wales.

Hence the apparent difference between Iron Age and earlier use of beans may to a large part be an effect of the nature of the evidence. Certainly more recent work on pre-Iron Age carbonised seed deposits changes the picture.

4.4.3.ii. Beans and peas from later prehistoric and Roman Britain.

There is an increasing quantity of evidence for cultivation of peas and beans before the Iron Age. Hillman (1981b) notes a bean impression on a late Neolithic sherd from Ogmore. A carbonized pea was found in the middle Bronze Age midden at Grimes Graves (Legge in Mercer 1981,92), and at Brean Down (noted by Caseldine in Coles 1987,225). At the Dartmoor settlement of Holne Moor carbonized beans were associated with a radiocarbon date of around 1200 bc (Jones 1984,122). Beans of late Bronze Age date were recovered from a ditch of the Springfield Lyons Ring (M.U.Jones 1985,15), and as plant impressions from the Isle of Wight (Green 1981,141). At the late Bronze Age settlement at Black Patch (Hinton 1982) the beans were confined to a large deposit of pure grain, "the produce of at least half a field" (ibid 838,837). Only 14 were identified. Their presence in one of the two pure grain deposits and absence from samples containing only scattered seeds and or hearth refuse is probably significant. In view of the conclusions reached in section 4.2.4.ii above about the character of most Bronze Age seed samples, this may account for the scarcity of bean records for the Bronze Age.

Green (1981,141) has argued that the evidence from Wessex "possibly indicates a real increase" in the cultivation of beans from the third century BC. He bases this on comparison with later mediaeval Winchester, where a documented increase in bean cultivation is accompanied by an increase in the quantities recovered from excavations. But legumes may have been more important as a peasant crop throughout the mediaeval period than either the documentary or archaeological record suggests (ibid,151,295), and the increase noted may reflect their changed economic position as well as a straightforward increase.

The best known and largest finds of beans are from the Iron Age sites of Glastonbury and Meare, where the quantities found provide a clear statement of their economic importance. These are discussed in the Appendix to this chapter and in section 4.4.3.iii below. The sites were occupied from around 200 BC onwards (J.M.Coles 1986,27).

Other Iron Age records include Owslebury, where beans occur from the first phase of the site (ie. third century BC onwards), though they were present in only four of the 64 Iron Age samples analysed by Murphy (1977, 58,Table 7.2.1). None of the other Hampshire chalkland sites considered by Murphy (ibid) produced beans or peas. He suggested that this may be due to soil conditions, beans being one of the few crops for which he considers these to have been an important factor in the area.

However, beans and possibly peas were recorded from middle Iron Age contexts at Winnall Down. There were few samples from earlier periods (one late Bronze Age sample, with one cereal grain; three early Iron Age samples, all crop processing wastes, in which the evidence from Meare and Black Patch suggests legumes can be expected to be still further underrepresented). The legumes were fragmentary and in deposits characterised by a high proportion of weed seeds (but not in the single identified 'stored crop' sample). There were possibly also peas, again fragmentary, at Micheldever Wood (mid/late Iron Age) (Monk and Fasham 1980,332,327). At these two sites, material before the third century BC is absent or sparse, so comparisons between earlier and later periods are of little value.

Murphy (1977,258) found that beans were present on 15% and peas on none of the 40 Iron Age sites he listed. A number of other Iron Age records of peas and beans can be added to the list compiled by Murphy (1977,250). They include Bishopstone, where a pea from a third century BC context was from a "large cache of seeds", mostly wheat grains (Arthur 1977). Peas were also identified in late Iron Age contexts at Maxey (Green 1985,229). Two beans were found at Gussage All Saints (Evans and Jones 1979, 172); the sample contained no cereal grains. Carbonised beans from Marnhull (<u>Proceedings of the Dorset Natural</u>

History and Archaeological Society 82,1960,85) formed a two inch thick layer at the bottom of a pit of probable Iron Age or Romano-British date. This suggests the beans were a stored product.

Helbaek (1964 162) commented that "nothing indicates that it [V.faba] was grown or utilized by the Romans in Britain" and regarded it as "an accidental admixture" possibly of "foreign origin" at Caerleon and at Verulamium. However, Applebaum regards both beans and peas as probable field crops at this time. Murphy's tabulation of seed remains from 70 Romano-British sites produced a presence of 11% of beans and 6% for peas (1977,254,258).

Beans and peas are now known from a variety of Romano-British sites. These include villas such as Chew Park (beans, late C3 to mid C4; Rahtz and Greenfield 1977, 372-3) and Barton Court (beans; Miles 1986, microfiche 9,E13); and other rural settlements such as Owslebury (peas and beans, post 250AD; Murphy 1977, Table 7.2.1), Faccenda Chicken Farm, Alcester, (bean, late first to second century AD; Foreman and Rahtz 1984,40) and Maxey (beans, peas and lentils, late first to early fourth centuries AD; the site is described as "at the lowest possible level in the agricultural economy of the region"; Green 1985,230,232). This work does not attempt a complete list, but it is clear there is a spread in terms of both date and socio-economic status of these rural sites. Peas and beans also occur on urban and military sites; finds additional to Murphy's list (1977,254) include peas from Caerwent (Boon 1978,114) and from a first century ditch at Carmarthen (Hillman 1978,109 and Table A) belonging to the early military occupation.

4.4.3.iii. The carbonized beans from Glastonbury and Meare.

The carbonised beans from Glastonbury and Meare are much the largest quantities so far recovered in Britain, and seem to a considerable extent to underlie the view that beans increased in importance in the Iron Age. It therefore seems useful to consider these deposits more closely, and especially in terms of the following questions:-

(i). In what contexts do the beans survive?

(ii). Must the quantities recovered reflect unusual economic importance, or could they be attributable simply to unusual conditions of preservation?

(iii). What sort of evidence might exploitation of this kind have left if environmental and depositional conditions had been different?

(iv). How different in their exploitation of pulse crops are these sites from other Iron Age sites, and how does the Iron Age evidence differ from that found in earlier periods?

Detailed discussion of the beans from the excavations of Bulleid and Gray is given in the Appendix below. The main conclusions are that the beans appear to derive largely from domestic activity contexts, or as dumped refuse. The crop may have been stored in the houses; although there is some evidence for specific storage locations, it is not strong enough to resolve the question of function of the Glastonbury rectilinear structures. The preservation of the beans is due to factors additional to carbonization; all are either from the waterlogged black earth deposits between mounds, sealed by clay floors, or covered by alluvial deposits.

The beans and cereals recorded by Bulleid and Gray were deposits recognised during excavation, which may explain why beans were recovered more frequently than cereal grains, and the latter rarely noted in small quantities. These deposits can probably be assumed to derive form the cleaned crop, in storage or use.

Most recent evidence for carbonised seeds is in contrast derived from systematically recovered samples. Usefully, for Meare there is also this kind of evidence from recent excavations by the Somerset Levels Project. This allows comparison of the information recovered in these two different ways, and possibly provides an indication of what might have been recovered from a settlement where beans were of obvious economic importance, but where environmental conditions and house building practices had not resulted in the exceptional recovery seen at Glastonbury and Meare.

Two reports on the carbonized seeds from Meare West have been published. The first (G.Jones 1981) analysed four samples from the occupation phase black earth deposits. Beans were recovered from two of these samples. Jones noted that there was "no positive evidence for the cultivation of beans" (ibid,35), but did not comment on the marked contrast between this conclusion and the recognition of substantial quantities of beans by Bulleid and Gray.

Table 4.8. Occurrence of Beans in samples from Meare West. Source: G.Jones 1981,1986.

Sample source	No. of samples	No. of beans identified
Too small for attribution	2	0
Crop cleaning residue	9	1
Cleaned crop	1	14

Analysis of the cereal remains from the samples indicated that one sample represents the cleaned crop, while the other three are likely to be crop cleaning residues, possibly burnt as fuel (ibid,34). All but one of the 15 beans recovered are from the cleaned crop sample.

Jones (1986) identified six further samples as crop processing residues; none contained beans.

At Meare East, the carbonised seeds from charcoal patches in mound 19 were predominantly beans (Caseldine in J.M.Coles 1987,223-5, Table 6.2). The source of the charcoal deposits was not entirely clear, and they may be material redeposited during construction of the mound. They also contained "possible burnt basketry" (Orme _et al_ 1983,60), associated with the beans (J.M.Coles 1987,168). This might reflect the storage of the beans prior to their burning. There is a contrast with other samples from the site; charcoal patches in mound 20 did not contain beans, and they were absent from earlier samples from this site examined by Caseldine.

Beans were found "in considerable numbers" in the 1984 samples from Meare East (Housley in J.M.Coles 1987, 226). These samples produced a restricted range of weed seeds compared with that recovered by Jones (1986) from Meare West, which Housley describes as "a real distinction reflecting different patterns of human activity". In addition, comparison of the proportions of weed seeds, chaff and grain showed a dominance of grain in the assemblage, most samples consisting of 60 to 70% grain (ibid, Fig.6.3). This is regarded as surprising by Housley, grain being the "part of the harvest least likely to be treated as waste material" (ibid,228). This supports the evidence from Meare West suggesting that beans are more likely to be recovered as a stored crop, or in a stored cereal crop, than as a component of processing wastes.

Because of differences in the processing required, beans are likely to be underrepresented in the archaeological record. This may account for the clear implication here that systematic treatment of soil samples may be unable to detect the deliberate cultivation of beans on sites where conditions did not lead to the survival of recognisable deposits of carbonized seeds. The beans also seem to be particularly underrepresented in the cleaning residues in comparison with the cleaned crop samples. While the straw of 'prehistoric' type cereals is also palatable to animals, the chaff may have been used chiefly as a fuel. In contrast, bean pods are a valuable animal fodder, and probably unlikely to have been burnt.

4.4.3.iv. The Glastonbury and Meare beans and the cultivation of legumes in later prehistoric Britain.

The assessment of the evidence from Glastonbury and Meare was intended to aid interpretation of the significance of the carbonised legumes from other Iron Age and earlier sites in Britain.

The comparison of the recent systematically obtained samples with the quantities for earlier excavations is particularly informative. The indication from the Meare analyses that beans are more likely to be recovered from stored crop deposits than from processing wastes is supported by the evidence from Black Patch and Bishopstone referred to in section 4.4.3.ii above. In section 4.4.4 below, the occurrence of legumes at Owslebury is compared with the quantities of cereal grains also in the samples. Both peas and cultivated vetch are found only in the samples with a high quantity of cereals (over 500 grains); this was not true however of beans, which were mostly in samples with less than 100 grains. The largest concentration of beans (15 whole and 22 fragments) was from a sample with very few (6) cereal grains.

This section has not attempted a thorough analysis of the contexts of the legume finds cited above. But there are strong indications that legumes are more likely to be found in the context of stored product samples (either of the legumes themselves or as minor contaminants of cereals) than in crop processing residues. The quantities of peas or beans recovered are always small (with the exception of Glastonbury and Meare, and the uncertainly dated Marnhull find), and the small numbers from the systematic samples at Meare reinforce the point that this may in no way reflect their economic importance.

Similar factors in the recovery of beans and peas are seen in the carbonised seeds from Northern France described by Bakels (1984). Large-seeded legumes were identified from three of the sites discussed. Peas and lentils came from an "ashy patch", possibly a hearth, at the Neolithic site at Evensdorff. Bronze Age deposits from Le Fort-Harrouard contained peas and beans; this material was collected as recognised during excavations early this century, and Bakels notes it was clearly "the result of a real fire" rather than "ordinary refuse" or "small accidents" (ibid,7-8). Both here and at the Gallo-Roman site at Champlieu, Orrouy (which produced peas and lentils, again recognised during excavation) the seeds were "certainly part of storages of food intended for human consumption" (ibid,25). No legumes were firmly identified from any of the sites discussed where retrieval was by systematic sampling.

Another example of the discrepancy which can occur between different classes of evidence for the exploitation of beans can be seen in the results from Feddersen Wierde. Stems and pods of celtic bean plants were found, sometimes in thick layers, from all the occupation phases (first to fifth centuries AD) of this waterlogged site. However, very few carbonized beans were recovered (Korber-Grohne 1967,174).

Two points emerge. Firstly, the increase in bean cultivation during the Iron Age does not seem to be well documented, if the Meare and Glastonbury finds are accepted as exceptional because of their conditions leading to preservation. The lack of earlier comparative evidence and the differences in the nature of the Bronze Age samples (often isolated scattered grains) are important biases in the record. Unfortunately many of the pre-Iron Age beans are not fully published yet, and their contexts therefore cannot be assessed. Secondly, drawing from the Meare evidence, even where bean cultivation was of significant economic importance, the evidence left may be very slight, in the absence of the destruction and preservation of stored beans themselves. The question is whether this then implies that the recovery of a few (on many sites, a single) peas or beans, can therefore be taken to indicate these were important cultivars. Where the beans or peas occur in stored grain deposits, and could be interpreted as volunteers from the previous use of the field, this might support the view that the legumes were a field crop rather than a minor 'garden' species.

Beans are now known in Britain from the Neolithic onwards, and peas from the middle Bronze Age. There seems no reason to assume they were not an economically significant crop throughout later prehistory. Their different characteristics (Table 4.2) suggest they may have formed alternatives depending on soil conditions, peas thriving in light dry soils and beans preferring deeper well drained clays. Hillman (1981b,188) suggests climate is unlikely to have been a limiting factor, as pulse cultivation is known from as far north as Sweden during the Neolithic. But apart from Glastonbury and Meare, the evidence for their cultivation in quantity is lacking. It seems clear that only a better understanding of the nature of the evidence for the carbonized legumes can resolve the problems. The likelihood is that both peas and beans were more important as a crop and a staple food than has generally been assumed. To go further and suggest they approached cereals in their importance or that they were grown on a scale allowing regular crop rotations (and hence had a noticeable effect on cereal productivity) could not at present be justified. Nevertheless the role of the leguminous species is one of the most interesting and important questions to be resolved about crops in later prehistoric and Roman Britain.

4.4.4. The small-seeded legumes.

This section discusses the evidence for the cultivation of the small-seeded legumes, especially the vetches (*Vicia*), vetchlings (*Lathyrus*) and lentils, and their possible uses in agricultural economies.

Several writers have noted that a variety of small-seeded leguminous plant species may have been valued rather than regarded as weeds even where they were not deliberately cultivated (eg. Monk and Fasham 1980,326). Many of these plants have at times been cultivated. They have three principal uses, as a fodder or forage crop, as green manures or for ley period cultivation on arable fields, and to improve the nutritive value of permanently grazed grassland, especially on thin chalky soils. All three uses were known to the Roman agronomists; for example, Columella discusses the use of vetch in establishing pasture and meadowland and describes a number of leguminous fodder species (II.XVII.3-7; II.X.24), and Pliny describes the use of vetch to enrich soils (*Natural History* XVIII,137).

A wide range of these plants will grow in Britain, some only in the south, and the agricultural texts of the past 250 years list a large number of useful species (eg. Mills 1762,473-483; Low 1838,406-10,419-422; Thomas and Davies 1938,82-112). According to Berrie (1977,82) "almost all the small seeded legumes could be thought of as potential forage crops", providing they are able to recover after cutting or grazing, acceptable to animals (unusual taste or hairiness lead to rejection) and not poisonous. This discussion will however be limited to the _Vicia_ and _Lathyrus_ species. A number of these (especially of the genus _Lathyrus_) have poisonous seeds, but these does not prevent them from being good fodder crops (Low 1938,421). Vetches and vetchlings used for hay are cut while still in flower.

The cultivated vetch or tare, _V. sativa_, was regarded as an important fodder species in the nineteenth century and earlier, but is not now an important crop (Berrie 1977,79). Its seed was reckoned "nearly equal to corn as food for livestock" (Morton 1855 Vol.2,1068-9). It is a quick growing catch crop, sown in winter for spring forage or in spring for summer cutting. Yields as hay were said to be around 3 tons/acre, and Morton regarded it as superior to meadow hay, though more easily damaged by rain. It is difficult to dry because of its succulent stems (Robinson 1947,101). Two or even three cuttings a year were possible (Low 1838,409). Vetch was often sown mixed with oats, which provided support for the plants (Mills 1762 Vol.1,479; McConnell 1883,125). Mixtures of cereals and vetches or other legumes grown for animal feed are described by Roman writers (Varro 1.31.5; Columella II.X.31-2; Pliny XVIII,142-3). Pliny states that one form of mixed forage was "obtained from the refuse of wheat ... sown very thick". This was presumably the mixture of smaller grains and weed seeds discarded in cleaning the crop; vetch seed was sometimes added to it.

Vetches have been used as green manures for arable land (eg. Mills 1762,85-8) but experimental work at Woburn and Rothamsted produced the "wholly unexpected results" that this was "almost ineffective" in terms of its benefits to succeeding wheat crops. Clover, in contrast, produces a marked increase in subsequent crop yields (Russell and Voelcker 1936,302-5). Experiments at Rothamsted also showed that the leguminous weeds were not the source of the soil nitrogen in the unmanured plots of the continuous cultivation experiments (Rothamsted Experimental Station 1968,9).

One disadvantage of using _Vicia_ species as a ley crop in cereal cultivation is that they can become serious weeds, with _V. hirsuta_, the 'Strangle Tare', being particularly noxious and said to be able to destroy entire crops (Salisbury 1961,268). The four vetches most usual as arable weeds in Britain are _V. sativa_, _V. angustifolia_, _V. tetrasperma_ and _V. hirsuta_; all are annuals. _V. sativa_ is probably the cultivated form of _V. angustifolia_, to which it is very similar (Robinson 1947,98). Since cultivated vetches will have undergone substantial modification, attempts to distinguish between these _V. sativa_ and its various forms and _V. angustifolia_ may be meaningless in the context of prehistoric and Roman plant remains.

Cultivated _Lathyrus_ species were known in nineteenth century Britain, but were evidently regarded with some suspicion because of their poisonous seeds which can cause paralysis in humans or animals if consumed in quantity. However they were "esteemed for fattening" livestock in France and Spain (Low 1838,284), and the seeds were added to bread in France (Morton 1855 Vol.2,216), where poor cereal harvests often resulted in too many being used to augment the grain, leading to cases of poisoning (lathyrism). A number of species were used in Britain, the principal being _L. sativus_, the grass pea or chickling vetch. According to Helbaek (1964,161), this is the cultivated form of _L. cicera_, but unlike _L. cicera_, it is not winter hardy in Britain (Morton 1855 Vol.2,216-7). As with _V. sativa_ and _V. angustifolia_, the distinction between _L. sativus_ and _L. cicera_ may not be useful in this context. It is the plant cicera cultivated in Roman Italy, featuring in Columella's list of fodder species (II.X.24) but described as less useful than alternatives such as the bitter vetch, V. ervilia (II.X.35).

Lentils (Lens esculenta) were also cultivated as fodder for cattle and horses in some parts of southern Britain, but declined in importance during the nineteenth century (Low 1838,283). Morton regarded them as unwholesome ("so flatulent as to kill horses"). They were stored in the husk, and threshed out only when needed (Morton 1855 Vol.1,760-70). Lentils were a common crop in Roman Italy, where they were "too valuable as a human food to be used as animal fodder" (White 1970,216). They are more suited to climatic conditions in the Mediterranean countries, and may not achieve adequate quality as a food when grown in Britain.

It is worth noting that in the Romano-British period conditions may have been more favourable to the cultivation of the leguminous species than in the recent past. Kenward et al (1986,265) note that the insect evidence from a late second-mid third century AD well in York indicates a mean July temperature at least 1° higher than now. A few plants recorded from York, including Lathyrus aphaca, are now restricted to more southern areas (Kenward and Williams 1979,88-90; Kenward et al 1986,265), although they could derive from grain imports.

Carbonised seeds of the Vicia and Lathyrus genera are difficult to identify to species level as this depends on the characteristics of the hilum (Jones 1978,99; Murphy 1977, 47,Fig.3.1.1), which is usually lost (Helbaek 1964,160). Jones noted greater differences in the dimensions of the hilum between carbonised and modern examples for V. sativa than for the other vetch species, although it is probably identifiable by the wedge shape of its hilum (1978,99). The difference probably relates to subsequent modification of the species; the modern _V. sativa_ is very variable, with numerous different forms.

Cultivated species of _Vicia_ and _Lathyrus_ will, like other legumes and also cereals cultivated for fodder, tend to be under-represented in archaeological deposits because they are less likely to have become carbonised during processing. Vetch, like peas, was however sometimes kiln dried in mediaeval England; Harvey (1965,37-8) notes that at Cuxham these were dried in a cool, slow-burning oven probably used chiefly for malting. However, some characteristics of vetches imply that their cultivation is still likely to leave traces.

One feature of vetches is the long dormancy period of their seeds (this is a reason why they are so difficult to control as weeds, since a bare fallow year does not eliminate them). Self-sown plants therefore appear in subsequent crops. The seeds are also difficult to separate from cereal grain because of their similarity to it in size. In the Rothamsted experiments, _Vicia_ species were the main contaminant of the grain (Rothamsted Experimental Station 1968,198-204). Although _Vicia_ species are rarely likely to be identified from traces of their own cultivation and processing as a separate crop, these attributes mean their use is nevertheless likely to be represented in the archaeological record. Distinguishing the indirect traces of their use from the results of weed infestation is of course the difficulty.

Table 4.9 lists some records of _Vicia_ and _Lathyrus_ species from Britain. The small number of Bronze Age examples do not include any vetches identified as _V. sativa/angustifolia_, the only identified species being _V. tetrasperma_ and _V. hirsuta_. Of the three records of these species, two are from deposits identified as stored crop

Table 4.9. Records of Vicia and Lathyrus species from some Bronze Age, Iron Age and Romano-British sites.

Species: Vicia 1	2	3	4	5	6	Lathyrus 7	8	9	Site	
									1. Middle or late Bronze Age.	
		/							Itford Hill	(Helbaek 1952,230)
		X							Aldermaston Wharf	(Bradley *et al* 1980)
	X	X							Black Patch	(Hinton 1982)
				X					Ashville	(Jones 1978,T.VI)
									2. Iron Age.	
		X							Fifield Bavant	(Helbaek 1952,230)
/		X		X			X		Ashville	(Jones 1978,99,106)
			X						Glastonbury	(Reid 1917)
		/	X						Gussage All Saints	(Evans and Jones 1979)
X			X						Owslebury	(Murphy 1977, T.7.2.1)
/	X	X	X						Portway	(Murphy 1977, T.7.2.2)
/			X						R27	(Murphy 1977, T.7.2.3)
				X					Danebury	(Jones 1984a, T.56)
									3. Romano-British.	
/									Wickbourne	(Helbaek 1952,230)
X*									Downton	(Rahtz 1963)
X									Bishopstone	(Arthur 1977)
				X					Faccenda Chicken Farm	(Foreman and Rahtz 1984)
X	X		X						Owslebury	(Murphy 1977, T.7.2.1)
					X*				Fishbourne	(Greig 1971,376)
X	X	X				X	X	X	#Caerleon	(Helbaek 1964)
/		X		X			X		Ashville	(Jones 1978,99,106)
X		X							Caerwent	(Boon 1978,114)
/			X						R27	(Murphy 1977, T.3.4.0)
X	X	X						X	#York	(Williams 1979,T.14,62,77)

Key:
- X present
- / identification not certain
- X* context suggesting deliberate cultivation or collection of seed
- # possible imports

Species:
1 *Vicia sativa/angustifolia*
2 *Vicia hirsuta*
3 *Vicia tetrasperma*
4 *Vicia* species
5 *Vicia* or *Lathyrus* species
6 *Lathyrus* species
7 *Lathyrus sativus/cicera*
8 *Lathyrus nissolia*
9 *Lathyrus aphaca*

products (from Itford Hill and Black Patch), which is unsurprising given the nature of the Bronze Age carbonised seed evidence and the tendency of Vicia species to contaminate the grain. It might be expected that V. sativa would also have been present in these samples if it had been present in the fields where the grain was grown.

The Iron Age records are in contrast predominantly from crop processing wastes. Larger seeded vetches, possibly V. sativa/angustifolia, are present at Portway in samples of the fifth to third century BC, and the positively identified examples of V. sativa from Owslebury are from the first century BC. Despite some doubts due to differences between the carbonised seeds and modern specimens, it is also probably present in the Iron Age samples from Ashville. This contrast between the vetches represented in the Bronze Age and Iron Age samples suggests that V. sativa was introduced to Britain in this period. Godwin (1975,180) notes that the species originated in western Asia; it had been introduced into eastern Europe by the Neolithic (Renfrew 1973,188-9). The plant could have been introduced to Britain in three ways; as an accidental weed contaminant, as part of a mixed crop, or as a crop in its own right.

V. sativa is found on most of the Romano-British sites where any Vicia or Lathyrus species have been recovered and identifiable to species. The evidence from Caerleon (see below) may suggest that a wider range of cultivated fodder legumes was in use by around 100 AD. From later in the Romano-British period, there is evidence suggesting the deliberate cultivation of fodder legumes. V. sativa seeds from a late third to mid fourth century corn drying oven at the Downton villa were interpreted by Arthur (1963,328) as a deliberately cultivated pulse crop; they formed 15% of the seeds in the deposit examined. The tendency of vetches to contaminate grain means caution is necessary, but in this case it was virtually the only non-cereal species present (the rest of the sample was wheat, with 3 grains of barley and one seed of Galium aparine), and this supports the interpretation. At Farmoor, vetch-eating varieties of beetles of the genus Apionidae were found in Romano-British (but not Iron Age) contexts (lambrick and Robinson 1979, Table 13). The Roman period may have seen an increase in meadowland (as opposed to grazed pasture) at this site (ibid,118-9), which also produced a large scythe (ibid,61-4), and the use of vetches in fodder crops here seems entirely likely. The pot of Lathyrus seeds from Fishbourne (late third century in date) probably implies this was a cultivar also, although they could have been collected for their poisonous qualities. Plants which also occur as weeds may only be certainly identified as cultivars where this kind of exceptional deposit is found; another example is the middle Iron Age pot with brassica seeds from Old Down Farm (Green 1981b,131-2).

The records of lentils from Roman Britain are mostly from contexts where they may have originated as imports. Two records are from urban destruction levels of 60 AD. The Colchester deposit included seeds used for flavouring (coriander, dill, anise) and also figs, which must certainly have been imported. The site was interpreted as a shop, selling imported pottery and a range of fruits and seeds (Murphy 1977,87). A deposit of grain from a building (also interpreted as a shop) in the Forum site in London included lentils, bitter vetch and einkorn among its contaminants. This strongly suggests the grain was imported; it is the only British record of bitter vetch, and the only Romano-British record of einkorn (Straker 1987,151). Lentils were also recovered from a waterlogged late second century AD pit in St. Thomas Street, Southwark. Here they were associated with a variety of other seeds (including olive, fig, cucumber, and grape) but not cereal grains, and seem to be present as a food item in their own right (Willcox 1977,279).

In contrast to these finds from urban sites are the lentils from Maxey. These occur, along with peas and beans, in late first to late second century AD contexts. The site was a farmstead "of remarkably low status" and "at the lowest possible level in the agricultural economy of the region" (Green 1985,230,232).

The carbonised legumes from the Roman fort at Caerleon are unusually well preserved, although the cereals in the deposit had apparently been malted and were largely unidentifiable. The deposit dates to the period c.80-130 AD. Helbaek (1964) considered the main interest of the sample to be that about a quarter of the legume seeds were of species he regarded as Mediterranean/south European crops or weeds, at least two (lentil, Lathyrus cicera) of which he considered unlikely to have been unable to acclimatize successfully in Britain.

Helbaek suggests this grain was imported, and its context makes this entirely plausible. However, there is another possibility. The high proportion of the legumes, and especially of the potentially cultivated varieties (Table 4.10), suggests they may represent the previous crop of the field rather than simply weeds (Helbaek suggests this of the oats present). The Isca legumes could reflect the cultivation of fodder for the horses of the Roman army. It has already been noted that the agricultural innovations which can be attributed with any confidence the immediately post-conquest period appear in military contexts (Rees 1979,741; see Chapter 3 above). These include scythes, rakes and iron tipped pitchforks, and the use of scythes and the import of seed of leguminous fodder species may both reflect the need of the Roman army for efficient fodder production.

Table 4.10. The Isca legumes.

Species	No. of seeds present	Regarded as introduction by Helbaek	Iron Age records since known	Comments and occurrence as cultivar in Britain
Vicia faba	3			Celtic bean
V. hirsuta	1			Small tares - weed species.
V. tetrasperma	24			*V. hirsuta* is a noxious weed.
V. cracca	1			occasional C19th cultivar.
V. sativa	3			*V. sativa* is the main cultivated
V. angustifolia	14			vetch, and is probably a form of *V. angustifolia*
Lens esculenta	c.40	yes	Gussage All Saints	Cultivated as fodder crop in C18 and C19th.
Lathyrus aphaca	6	yes		Recorded as cultivated for forage in C19th.
L. nissolia	11	yes	Ashville	Weed species
L. cicera	1	yes		Not certain if from mediterranean weed *V. cicera* or cultivated form *L. sativus*. Both were C19 cultivars.

Comparison of cultivated and non-cultivated species.

Seeds of cultivated species : seeds of non-cultivated species	
Vicia	21 : 25
Lathyrus	7 : 11
All legumes	68 : 36

Source: Helbaek 1964, Table 1.

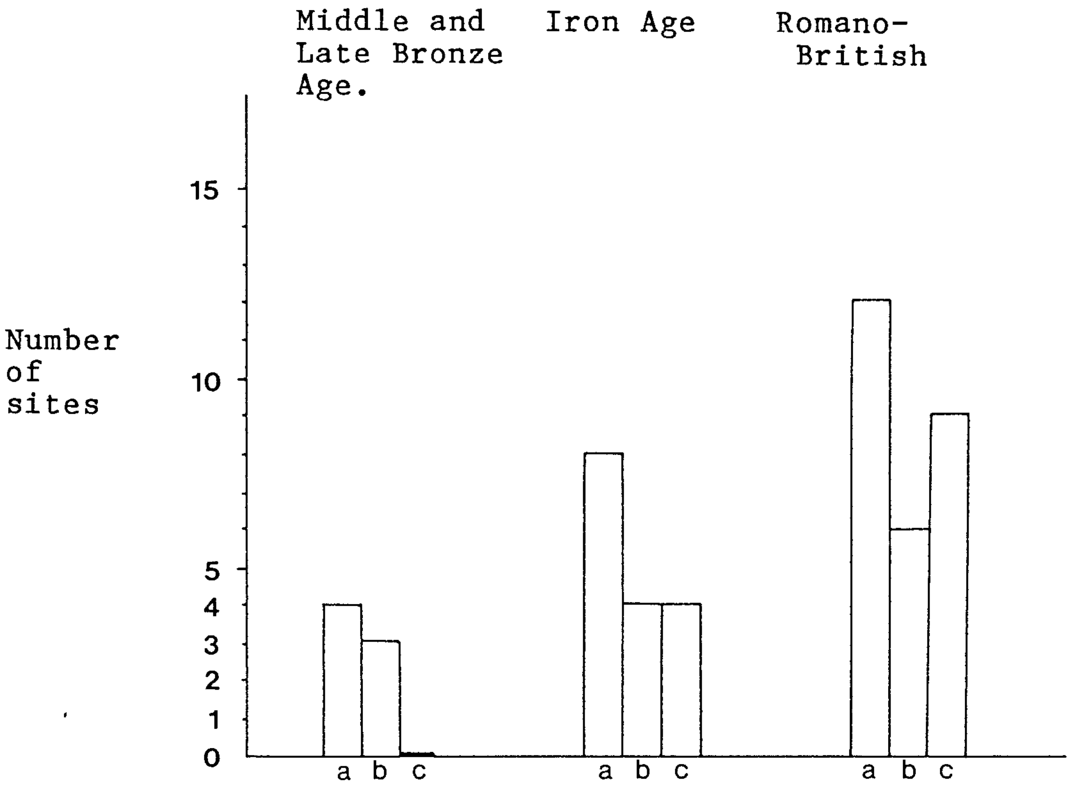
Lentils recorded from Roman Britain seem mostly to derive from three distinct sources, occurring as an imported foodstuff, a contaminant of imported grain, and an introduced fodder crop, particularly associated at least initially with the Roman army. The exception is Maxey, where local cultivation may be implied; assessment of the role of lentils in the agricultural economy in Roman Britain will require more evidence.

There is a possible Iron Age record of lentils, from Gussage All Saints (Evans and Jones 1979,172). Murphy (1977,47) notes that vetches can be identified by their "distinctive overall form" even when the hilum is missing. However, it was the size of the Gussage specimens which suggested the identification as lentils. This could therefore be erroneous; the Colchester lentils were only 2.5 to 3.3mm in diameter, and so within the size range of vetches identified from Hampshire sites by Murphy (1977,70). However, vetches and lentils are potentially distinguishable, as the flattened form of the lentil differs from the spherical form of vetch seeds. The lentils occurred in a sample with "very many" cereal grains, and can be interpreted as either weeds or volunteers from a previous season's cropping.

The evidence for the utilisation of the small seeded legumes is summarised in Table 4.11 and Figure 4.1. While it is difficult to be confident on the basis of the evidence at present available, it is very suggestive of the exploitation of V. sativa during the Iron Age. The question is interesting because of its possible implications for livestock management, which in turn relates to arable production because of the role of animals as suppliers of draught power and manure.

But there are problems in trying to take the question further. The main difficulty is defining a criterion for

Fig. 4.1 Summary of occurrence of vetches.



a *Vicia* and/or *Lathyrus* species present
b *V. hirsuta* and/or *V. tetrasperma* present
c *V. sativa/angustifolia* present

Figure includes probable and positive identifications.

Table 4.11. Summary of dating evidence for the occurrence and utilisation of small-seeded legumes: lentils, vetches, and vetchlings.

Date	
1000 - 500 BC	V.sativa apparently absent.
C5 -C3 BC	Appearance of larger-seeded vetches, probably V.sativa/angustifolia (Portway, Ashville).
C1 BC	Positive identification of V.sativa (Owslebury) and possible occurrence of lentils (Gussage All Saints).
Roman period	Numerous records of V.sativa.
Late C1/early C2 AD	Lentils, probably or possibly imported (Colchester, London Forum site), possibly cultivated (Maxey?). Other potentially cultivated species, probably or possibly imported (Caerleon, London Forum site)
late C3 AD	Evidence suggesting V.sativa and a Lathyrus species were deliberately cultivated.

inferring that a plant constituted a deliberate crop. A species' occurrence as the only species recovered from a site is often taken to indicate that it constituted a separate crop rather than a contaminant; but Green (1981,133) suggests this criterion may be too rigid for even the free-threshing cereals. It is inappropriate for these species, which may have been used chiefly for hay, with only small quantities of seed collected for the next sowing; they are likely to be recovered mainly as weeds of the succeeding cereal crop. There is a range of other species which are both potential cultivars and arable or waste ground weeds, and it is only chance finds of pure deposits of their seeds which indicate their exploitation, if not necessarily their cultivation.

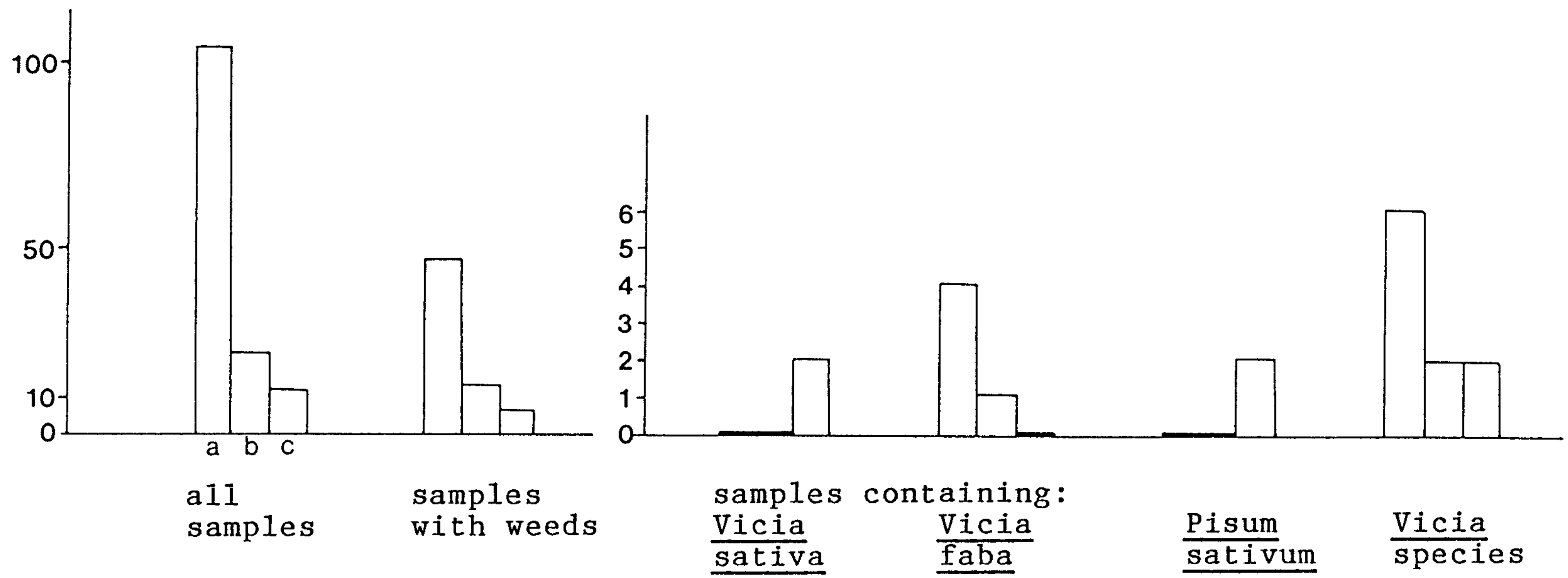
The data from Owslebury provide some information on the contexts from which V. sativa was recovered. It occurred only in the 9% of samples which contained large quantities (more than 500 grains) of cereals (Fig. 4.2). The same was true of the peas, but not of the celtic beans, despite the fact that at several other sites they can be shown to occur chiefly in deposits interpreted as deriving from stored crop products (see Chapter 4.4.3 above).

For the vetches, a change in the proportion of species present in samples might indicate cultivation. Figure 4.1 shows clear changes between Bronze Age, Iron Age, and Romano-British contexts. The increase in V. sativa in the Iron Age samples could be accounted for by its spread as a weed, since it appears to have been introduced to Britain during this period. However, it becomes more frequent that the other Vicia species in the Roman period, and this does suggest it was by then a cultivated plant.

Fig. 4.2. Occurrence of cereal grains and legumes.

Data from dated samples at Owslebury, from Murphy 1979, Table 3.2.0.

a samples with less than 100 cereal grains
b samples with 100 to 499 cereal grains
c samples with 500 or more cereal grains
Note: samples were of differing sizes



Note: 'with weeds' implies the presence of one or more of the following: Ranunulcus spp, Brassica/Sinapis spp, Agrostemma githago, Valerianella denticulata, Chenopodium spp, Atriplex spp, Rumex spp, Polygonaceae, Galium aparine.

Indications that other fodder crops were being cultivated would support the suggestion the legumes were also used in that way. One problem is that exclusive 'fodder crops' are rare, and any of the cereals could be grown for hay or forage. Green has demonstrated an increase in the presence of oats in Hampshire in the Iron Age (1981,142,Fig.7.2). This is potentially a valuable food crop and not just a fodder species. A clear relationship between oats and vetches might reflect their use as a mixed forage/fodder; but since both are characteristic contaminants of grain (Rothamsted Experimental Station 1968,198-204), their association in cereal deposits would not be unexpected.

Murphy's presence analysis for Hampshire sites does not suggest a correlation between the occurrence of oats and the larger seeded vetches (1977, Fig.7.2.3). For the two sites where comparison is possible, oats and vetches were in no cases recovered from the same context.

The evidence from Gussage All Saints is suggestive of an interest in fodder species, with both oats and legumes increasing in occurrence during the Iron Age (Evans and Jones 1979,172-3). [Unfortunately there are inconsistencies between the text and Fig.110 and Table XLVI; this discussion is based on Table XLVI.] It is assumed that only features listed in the text as producing oats did so (Table XLVI combines oats and grasses). Five of the seven features with oats (71%) also included legumes, as opposed to only fifteen out of the total of 51 features which produced carbonised seeds (29%). Considering individual layers rather than features, the figures are 40 and 30%. This does not seem to be due simply to the quantities of cereals present, but could be a product of their similar occurrence patterns as weeds. Interestingly, although the two phase 1 and 2 features which contained oats included cereals in quantity, two of the phase 3 features with oats and legumes in the same layer did not produce any wheat or barley. This could suggest they formed a distinct fodder crop at that time; but the small number of samples (and "very few" seeds from the samples in question) means little confidence can be placed in such an inference. The lentils appear to have been present as a contaminant of the cereal crops.

At Gussage All Saints, the importance of horses in the economy could have been the stimulus for cultivation of fodder crops. Analysis of the animal bones suggested that five to ten percent of the animals represented at the site were horses, and the metal working debris produced evidence for the manufacture of 50 sets of harnesses and vehicle fittings, although much of this will have been for distribution rather than use on site (Wainwright 1979,189,140,191). If Gussage did see the introduction of lentils as a fodder crop, it may be in the context of an economic specialisation rather than as part of the general agrarian economy. The parallel with the Caerleon situation is obvious.

Recognition of the cultivation of fodder crops is potentially an important step in understanding the dynamics of agricultural systems. While hay made from established meadow might leave no detectable traces, sowing of fodder crops may be recognisable. Yet the difficulties are considerable. The main evidence to be expected is the contamination of subsequent cereal harvests; and yet the evidence for this is essentially similar to that for simple weed contamination. Indeed, given Pliny's comments of using cereal waste as the seed for fodder crops, the fodder crop would be identical with the species which typically contaminate grain because of their seed size and growing habits. If seeds of other species (such as clover) were added, their characteristics mean they would not be significant as contaminants of the following crop, and would not be detected. Only the fortuitous discovery of a 'pot of seeds' or similar pure deposit would indicate their exploitation in this way.

It has been argued above that systematic manuring was unlikely throughout later prehistory, on the basis of both the present evidence for manuring practices and the absence of evidence for the kinds of livestock management which would enable significant manuring regimes to be maintained. The cultivation of improved and higher yielding fodder and forage crops would greatly aid both winter housing in pens or byres for manure collection and folding livestock on the arable (which only constitutes a net transfer of nutrients if animals are either given supplementary food or folded overnight after grazing elsewhere during the day).

The evidence it has been possible to assemble here is far from conclusive. The question of whether the appearance of *V. sativa* in the Iron Age represents the spread of an introduced weed or the introduction of a fodder/forage crop is unresolved. Indeed, if cereal processing wastes formed the basis of the seed sown for fodder crops, the two processes may not be distinct. Similar arguments could be applied to oats and Brome. The Caerleon seeds suggest that fodder crops may have been introduced in Roman military contexts, but the grain may have been a straightforward import, as the grain from the London Forum site appears to be. Later in the Romano-British period, the vetch from Downton and the *Lathyrus* from Fishbourne seem strongly indicative of the exploitation of these species.

Chapter 4.
Appendix: The carbonised beans from Glastonbury and Meare.

4A.1. Problems in interpretation.

The major problem encountered in assessing the evidence from the Meare and Glastonbury Lake Villages is the poor quality of the stratigraphic information available from Bulleid and Gray's excavations (Bulleid and Gray 1911,1917,1948; Gray and Bulleid 1953; Gray 1966). Artifacts and carbonised foodstuffs are often described only as being from or from near to a particular mound. This causes two specific problems. It is often not possible to be certain whether cereal or legume deposits were associated with structural elements; and as the location of artifacts within multi-floored mounds is often not specified, changes in the function or intensity of use of these mounds can usually not be recognised. Although Clarke (1972,814) stresses the interest of the "restricted and repeated direction in chains of succession of usages" at Glastonbury, he apparently identified only three such changes (mounds 44,70,75) and for two of these, there are ambiguities in his text or between text and phase plans (ibid, 814-825, Figs.21.2-5). The 'black earth' deposits between the mounds contain virtually no stratigraphic distinctions; at Meare East Avery (1968,30) noted that artifact types of different dates were mixed throughout them. These deposits were at least intermittently waterlogged and subject to disturbance by a variety of agents during the occupation of the Meare villages (B.J. Coles *et al* 1986,56).

Another difficulty arises from the often contradictory reinterpretations of these sites based on re-analyses of the work of Bulleid and Gray or on more recent but smaller scale excavation.

At Glastonbury, Tratman (1970) identified a phase of smaller (c.3m square) timber buildings preceding the construction of the round houses on the clay mounds. Bulleid and Gray had inferred the existence of earlier rectilinear buildings on the basis of re-used timbers in the substructures of the clay mounds, but had failed to identify the location of any of them (1911,56-7,60). Clarke's more sophisticated analysis defined the same structures as granaries or storehouses, frequently rebuilt, but contemporary with the occupation of the circular houses (1972,824-5).

At Meare, the function of the clay mounds as floors for buildings or workspaces was challenged by Avery (1968), whose excavations at Meare East led him to interpret them as "arbitrarily placed dumps" (ibid, 34) of rubbish post-dating the excavation of the round houses. This would clearly make nonsense of attempting to relate legume deposits to mounds and their functions, as the material would all be secondary refuse. Work by the Somerset Levels Project at Meare West initially suggested that the clay mounds were natural in origin (Orme _et al_ 1981,22-3,67), although subsequent work at Meare East re-established them as deliberately created platforms. Even without these recent results, Avery's conclusions can be disputed in detail on the basis of Bulleid and Gray's excavations at Meare West. As a general point, it is interesting to note the way in which conclusions of earlier work based on substantial excavation (admittedly poorly carried out: J.M.Coles 1987,15) was confidently discounted (Orme _et al_ 1981,67) on the basis of limited and often peripheral (ibid,14) re-excavations.

Following the publication of Bulleid and Gray's excavations at Meare West by J.M. Coles (1987), the reassessment of Glastonbury and Meare by the Somerset Levels Project (ibid,16) should provide answers to some of these problems of interpretation. For Glastonbury, Orme _et al_ (1983,73) favoured the Clarke (1972) model of settlement modules, while noting the question could not be firmly resolved.

4A.2. The context of the carbonised beans.

The context of the carbonised legumes is discussed with particular reference to four points, their relationship to storage structures, differences in recovery between cereals and legumes, conditions allowing recovery, and the differences between deposits recognised during excavation and material recovered by sieving soil samples from the more recent excavations at Meare.

The legumes from Meare and Glastonbury are all assumed to be beans; Bulleid and Gray (1911) noted both peas and beans at Glastonbury, but Reid (1917,629) considered them all to be beans, and this can probably be accepted (Godwin 1975,180-1), although Gray (1966,384) describes the material from Meare as peas. There is no clear indication that more than one species is present, and only beans have been identified from more recent work at Meare.

4A.2.1. Glastonbury.

The dispute over the interpretation of the rectilinear structures was noted above. Bulleid and Gray had noted the existence of timbers from rectangular buildings, but also that "in every instance the pieces of worked wood were met with amongst the timber in the foundation underlying a circular dwelling mound" (1911,56). they concluded that "rectangular and round buildings were not coexistent" (ibid,60). Possibly timbers not incorporated in this way failed to survive. Bulleid and Gray failed to identify the site of any rectilinear building (ibid,57), perhaps because they expected something more substantial than the structures later recognised by Tratman and Clarke. Tratman noted that most of the oak piles were "quite clear of" the mounds (1970,144), and although he uses this to disassociate the two, it seems at least as readily to suggest avoidance as independence, that is to suggest that the rectilinear structures were built in spaces between the mounds. Certainly his argument that since some are "overlain by even the earliest floors", none are contemporary with the occupation of the mounds is fallacious (ibid,157).

Tratman (1970,157) explicitly rejected the possibility they were grain stores, stating that no grain was found associated with them. But Clarke (1972,824-5) identified them as granaries, stating that

"The granary signature was usefully stereotyped; in its most complete form an area uniquely devoid of artifacts, roughly ten by ten feet, with a scatter of cereals or legumes, is set with nine, six or four regularly spaced sugar-loaf piles driven through mortice holes in horizontal timber ground plates."

Gent also regarded these structures as food stores, although he noted that they were to the large end of the size range of stores from other Iron Age sites (1983,250,Fig.3).

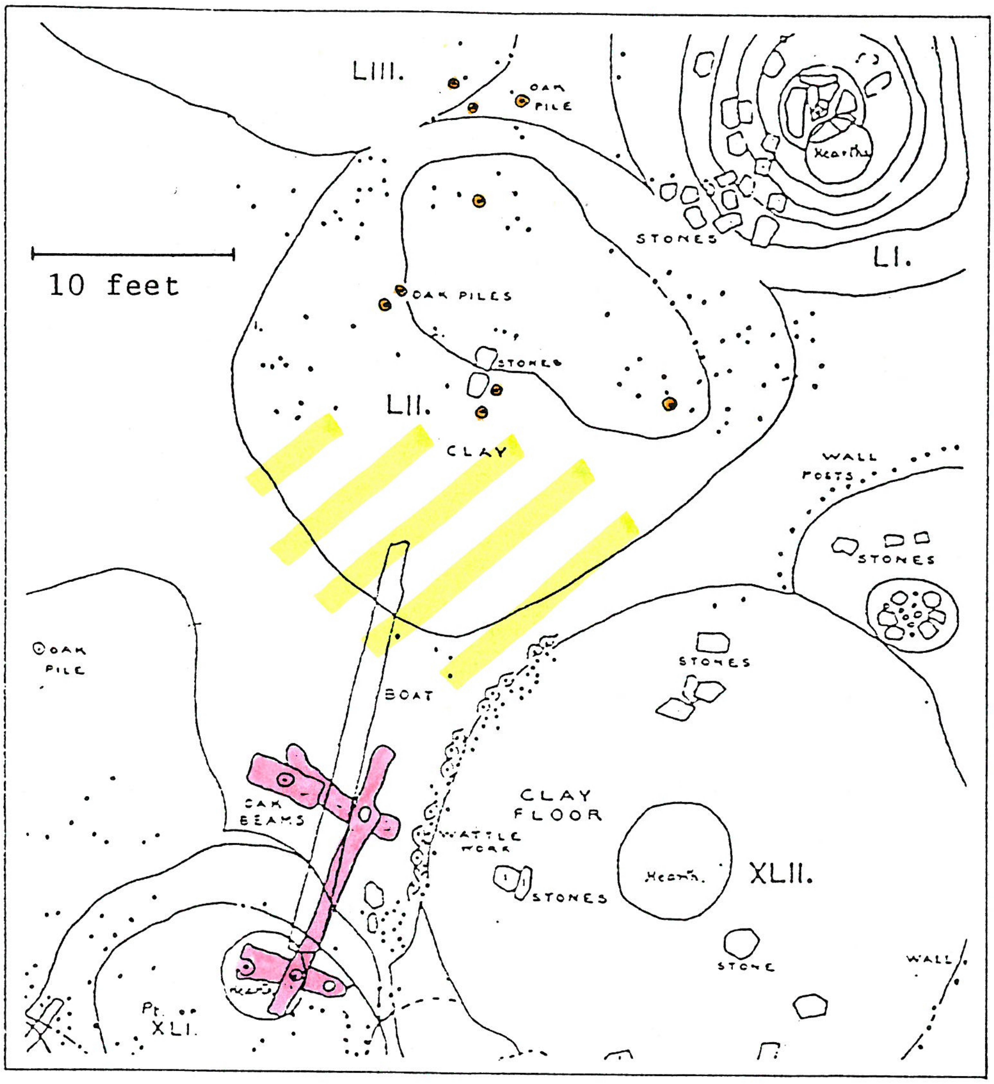
The evidence for the association between these structures and the cereal and legume deposits is assessed below. In addition to the stratigraphic problems, Bulleid and Gray presented their report in the form of a description of each mound. This causes particular difficulties in considering the relationships between recorded finds of cereals or legumes and the rectilinear structures located in the gaps between the mounds. An example of this is the "large number of peas and beans ... found at the E side of Dwelling-mound XXVI" (Bulleid and Gray 1917,629). The location of these is not shown on the plans, and it is not clear whether they are on the mound or (as is probably the case) in the black earth beside it. In the latter case, can they be taken to be associated with the possible rectilinear structure (5 surviving piles) between mounds 19 and 26, which is one of Clarke's granaries? As beans were also found "in trenching the ground E. of Dwelling-mound XXVII", they may have been.

Gent (1983, Fig.3) illustrates four structures "showing possible associations with cereals and legumes". His example (b) (Fig.4A.1) is partially underlying the clay floors of mound 41, forming part of the substructure of the mound. The beans were found on the south side of the surface of the brushwood foundation to mound 52, and between it and the west side of mound 42. It is difficult to accept this as a good association with the rectilinear structure; the legumes seem to relate to the earliest use of mound 52. At both Glastonbury and Meare, there are often clay hearths and other signs of occupation directly on top of the brushwood surfaces.

In Gent's example (c), (Fig.4A.2) some of the beans are lodged in cracks in the in situ oak beam taken to be an element of a rectilinear building. However the beans are carbonised and the beam is not - that is, they did not burn where they survive. It is possible that the beam being low and wet survived when the building's superstructure burnt. The beans are described as being at the southeast and north east margins of mound 65, shown in the plans as in the black earth rather than the mound. Whether any beans underlay the upper clay floor (as the beam partly did) is not stated. However the beans may well relate to this structure, and also to another piled structure slightly to the north.

For Gent's example (d) there is little to justify associating the beans and the eight-post structure. The beans were "scattered over the west quarter of the floor"

Figure 4A.1.
Rectilinear structures and finds of legumes: examples from Glastonbury, (i).



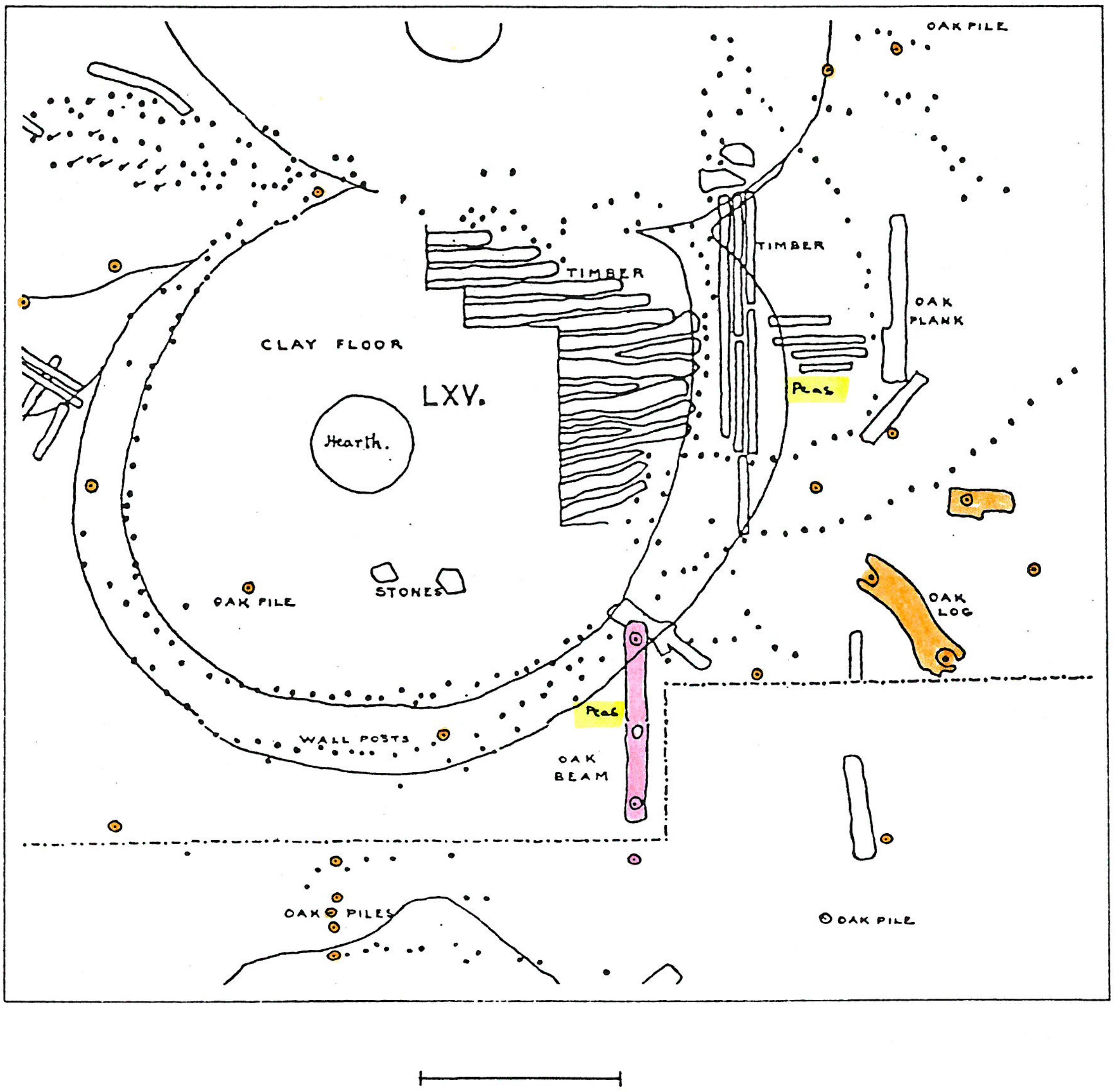
Source: Bulleid and Gray 1911, Plate XX and Page 129.
Bulleid and Gray 1917, 629.

Key: in-situ timbers or piles identified by Gent.

other in-situ timbers or piles.

extent of layers containing carbonised grain or legumes (from text descriptions by Bulleid and Gray).

Figure 4A.2.
Rectilinear structures and finds of legumes: examples from Glastonbury, (ii).



Source: Bulleid and Gray 1911, Plates XX and XXV.

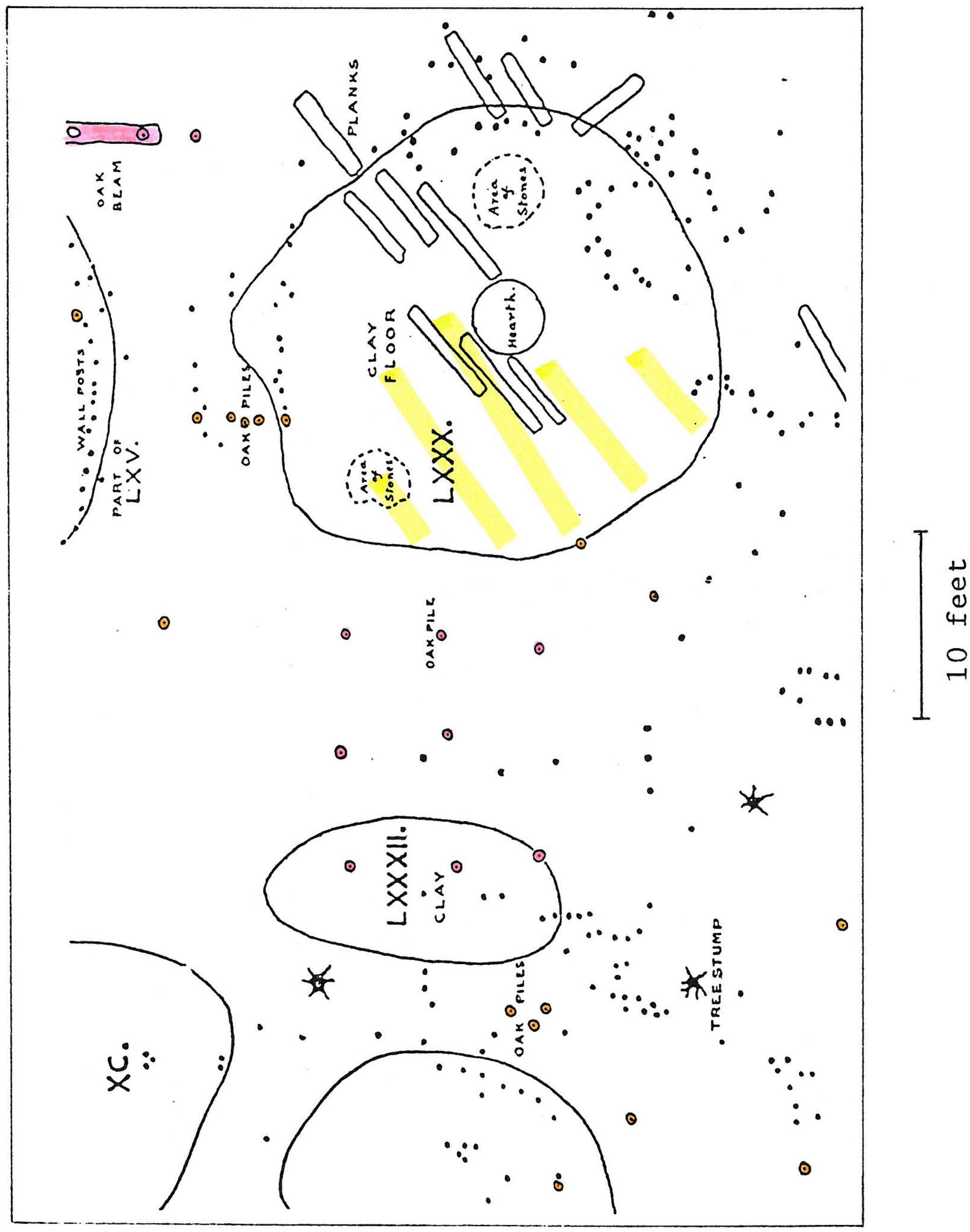
of mound 80, and there is no suggestion they extended into the area around the piled structure (Fig.4A.3).

Gent's example (a) shows a stronger possible association. The structure lies between mounds 60 and 61. The beans are described as lying over the lower floor of mound 60 (especially at its west side), with another patch on the floor of mound 61. The area of 'peas' shown on the plan is not mentioned in the text, and its relationship with the rectangular structure is therefore not certain. There are discontinuities in the outline of the distribution of the 'peas' corresponding to the join between two of Bulleid and Gray's plates (Fig.4A.4). This example could clearly be interpreted as a rectangular store in the space between two mounds. If so, it was disused when the second clay floor was laid covering both mounds. The structure itself is not recorded as showing any signs of burning.

If the rectangular buildings are granaries or storehouses, it is interesting that, despite Clarke's comments, they are not consistently associated with burnt grain or beans. there are three reasonably good associations: with the structure between mounds 60 and 61, the structure east of mound 65, and possibly the structure between mounds 19, 26 and 27. Figure 4A.5 is based on Tratman's plan of in situ piles and timbers, with the finds of beans and cereals added following descriptions and plans given by Bulleid and Gray. Although the mound-based nature of the Glastonbury report must be distorting the evidence to some extent, the finds give a strong impression of relating to the occupation of the mounds, being either on or in the mounds, or in the black earth deposits along their margins.

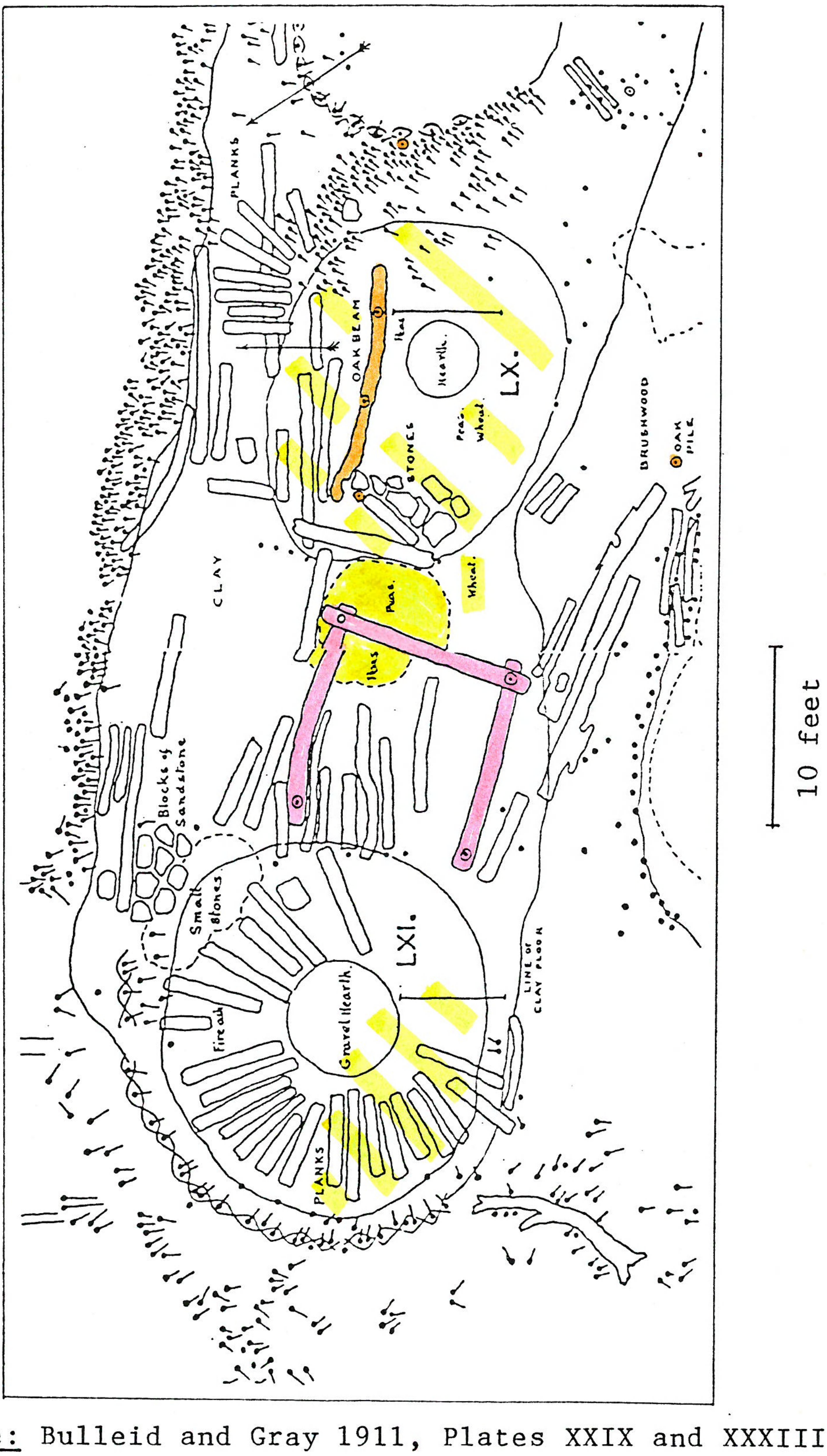
Comparing the distribution of cereals and legumes with Clarke's inferred functions for the mounds (Figure

Figure 4A.3.
Rectilinear structures and finds of legumes: examples from Glastonbury, (iii).



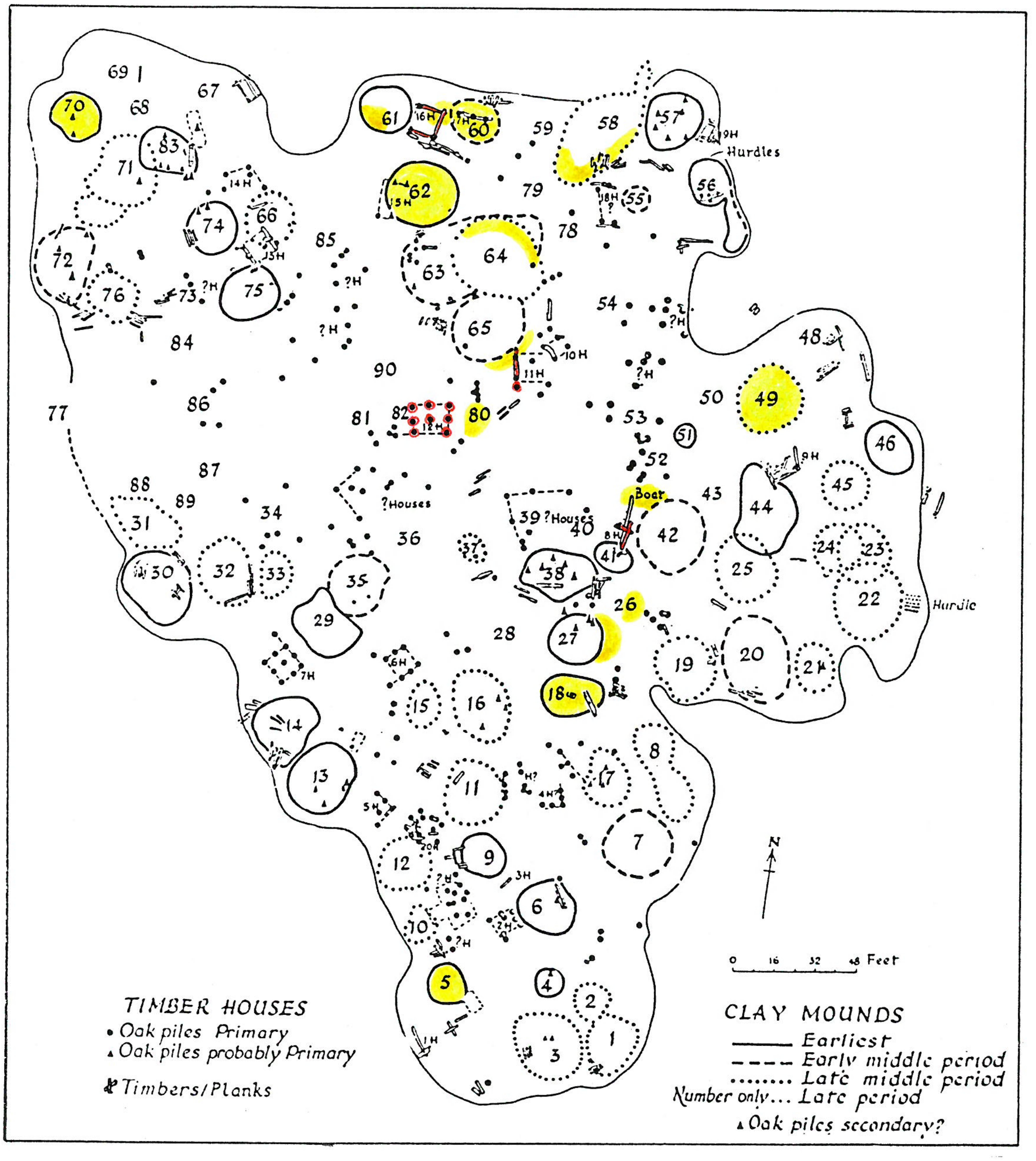
Source: Bulleid and Gray 1911, Plates XX and XXIX.

Figure 4A.4. Rectilinear structures and finds of legumes: examples from Glastonbury, (iv).



Source: Bulleid and Gray 1911, Plates XXIX and XXXIII

Figure 4A.5. Glastonbury: cereals, legumes and possible storage structures.



Key: cereals and/or legumes — possible storage structures

Sources:

Plan and identification of rectilinear structures: Tratman 1970, Plate 16.

Data on cereals and legumes: Bulleid and Gray 1911, 73,92, 129,139,141-2,146, 148, 155; 1917, 629-630.

Possible storage structures: Gent 1983, Fig.3.

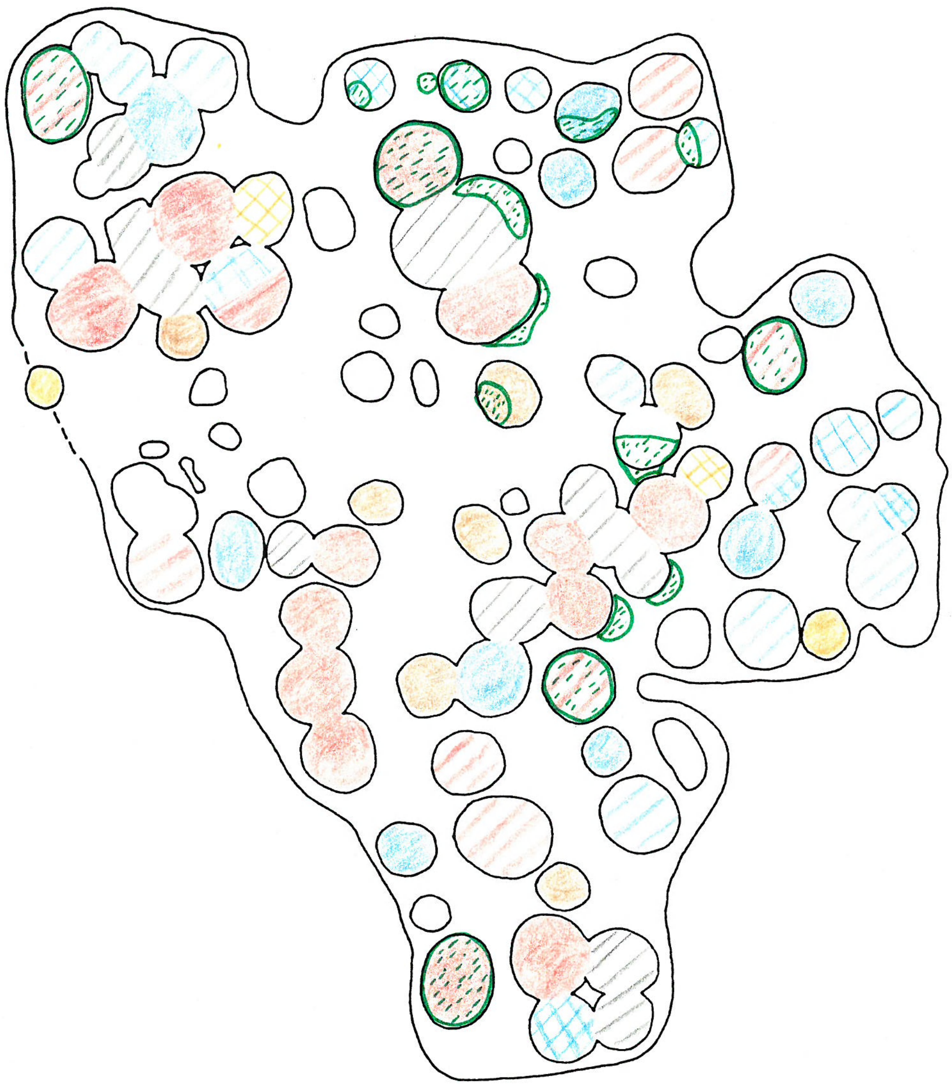
4A.6; Table 4A.1) suggests that the strongest association is with mounds with intensive domestic use - the 'major' and 'minor' houses. Six (possibly seven) of the major houses (out of 14) have deposits in them, or in the black earth or courtyard immediately adjacent. Three out of nine minor houses also had bean deposits, while only four out of 28 of the other huts did. Perhaps surprisingly only one of the seven 'baking huts' produced cereals or legumes. As noted above, there seem to be only three or four cases of possible association with 'granaries', of which Clarke states there are at least 25.

Beans were recovered more frequently than cereal grain, which was only once, and then in large quantities, recognised in a context which did not also produce beans (from 'minor house' 70). Cereal grain was only once noted in small quantities. This probably reflects easier recognition of the larger seeds.

There are three contexts in which the carbonised beans occur. They were found in the black earth deposits between the mound, subject to waterlogging; sealed below clay floors in the mounds; or on the upper clay floors, sealed by alluvial deposits. In each case an additional factor has aided preservation.

All the seeds within mounds are associated with evidence for burning, being in layers of varying thickness of black earth. Structures on three of the mounds producing seeds had burnt down at some stage, but only for mound 70 (which produced the large grain-only deposit) is it specified that the seeds were in the fire destruction level. However since beans are unlikely to have been processed in a way which would have led to their accidental burning, some explanation for their carbonisation, often in large quantities, is necessary. It seems likely that some of the thicker levels of ash and

Figure 4A.6. Glastonbury: cereal and/or legume deposits and Clarke's interpretation of the uses of the mounds.



Uses of the mounds: after Clarke 1972.

major houses	baking huts
minor houses	guard huts
ancillary huts	annexe huts
workshop huts	work floors
courtyards	clay patches

cereal and/or legume deposits

Source: Clarke 1972, 814-824.

Bulleid and Gray 1911, Fig.3.

Table 4A.1. Legumes finds and mound functions.

Mound function (after Clarke)	total mounds	No. with legumes and/ or cereals	Usage (after Clarke)
Major houses	14	2 (+3)	Full range of male and female activities
Minor houses	9	3	Focus of female activities and residence
Ancillary huts	9	1	Female activities - ? stores, milking parlours
Workshop huts	8	2	Male manufacturing
Courtyards	7	1 (+1)	Male artifacts, especially related to horses and waggons
Baking huts	7	1	Female activities
Guard huts	2	-	
Annexe huts	2	-	Little evidence
Work floors	12	1	Male and female craft
Clay patches	17	1	

Note: (+1) indicates number of additional mounds where legumes were recovered from adjoining black earth.

Proportion of mounds with cereals/legumes in or adjacent.

Major houses	6/14	43%	(both courtyards with legumes adjoin major houses)
Minor houses	3/9	33%	
Other huts	4/28	14%	
Open floors	4/36	11%	

Source: Clarke 1972, 814-824, Figs.21.2-21.5
Bulleid and Gray 1911.

charcoal between clay floors in the mounds could have derived from smaller fires, possibly in thatched roofs, which did not become sufficiently well-established to cause damage resulting in the deposits of burnt wattle-marked clay which Bulleid and Gray (1911,55-6) took to indicate a conflagration. This raises the possibility of storage within the houses, possibly in some form of attic or in baskets or sacks suspended from roof timbers.

4A.2.2. Meare.

Gent identified one possible rectilinear storage structure at Meare West (1983,Fig.3e). Figure 4A.7 shows this structure,which underlies mound 21, and adjacent mounds together with the location of legume and cereal deposits based on Gray and Bulleid's plans and text (1953, 148,159-60,177 and Pl.XXXIII,XXXV). Unfortunately, while for five of the other six mounds which produced cereals and/or legumes, these were stated to be in black earth layers on the clay floors, in this case the text is unclear. The beans were

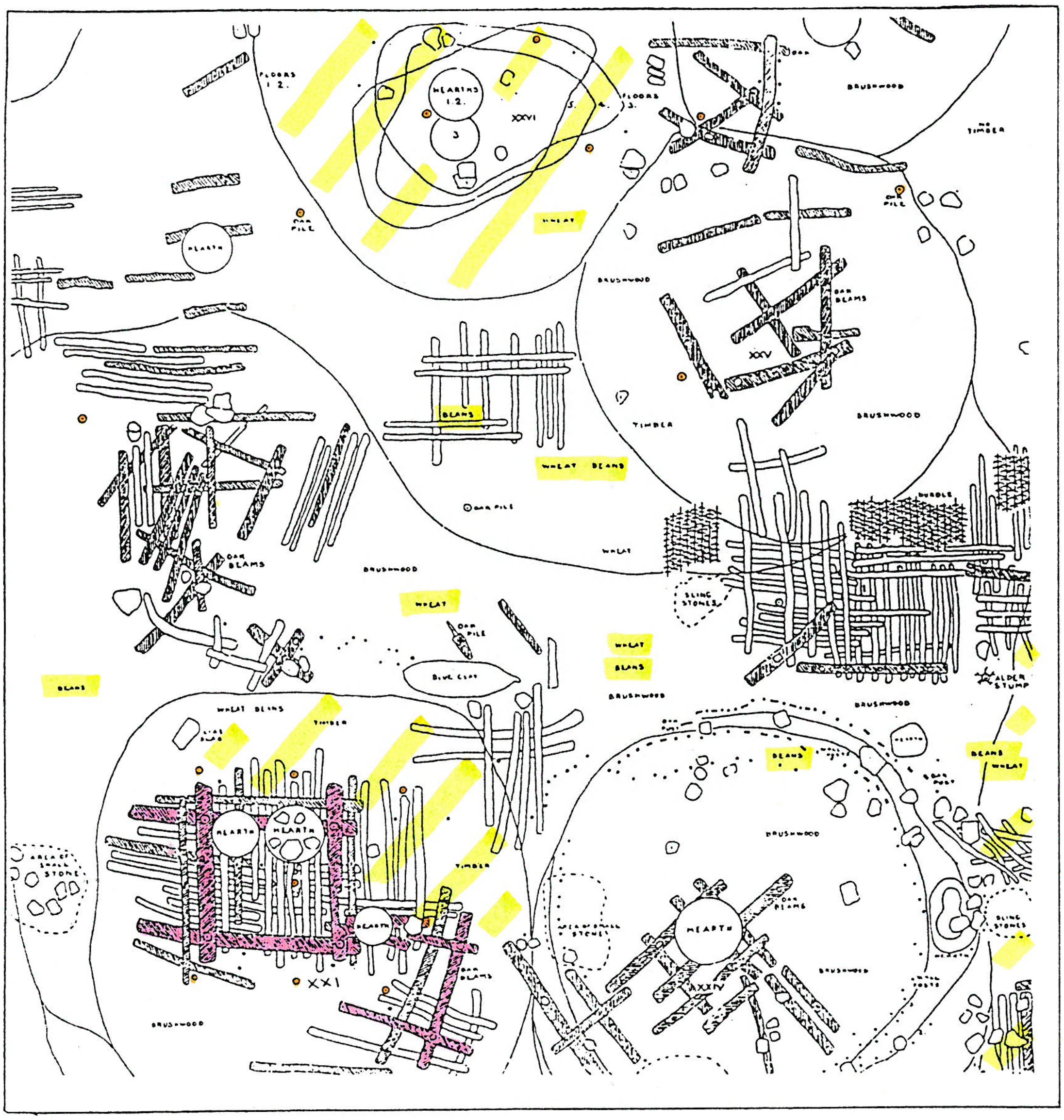
".. found scattered in the black earth over the E and NE aspects of the mound, and also in the black earth along the SE margin of the mound" (Gray and Bulleid 1953,148).

The square structure formed part of what Gray and Bulleid described as the "substructure" of the mound, the "interstices between the timbers" being "filled with Brushwood and peat". Black earth was recorded as a layer over the substructure, between the clay floors, and between mounds. Stratigraphic relationships are frequently difficult to establish from the Meare and Glastonbury reports, but it seems most probable that the beans should be associated with occupation of the substructure surface or the three succeeding clay floors rather than with the square structure in the substructure.

The beans at Meare West are in similar contexts to those at Glastonbury, sealed by clay floors or alluvial

Figure 4A.7.

Rectilinear structures and finds of legumes: example from Meare.



10 feet

Source: Gray and Bulleid 1953, Plates XXXIII and XXXV.

deposits, or in the black earth between mounds, where no stratigraphic relationships with the mounds are established. Areas of deliberate dumping, with carbonised beans and grain amongst the refuse, have been identified in the more recent work at Meare (B.J.Coles _et al_ 1986,35,42). These may be peripheral to the main occupied areas.

The beans and grain are "invariably found accompanied by charcoal and sometimes fire-ash" (Gray 1966,381). In two cases there was evidence for more serious burning; in mound 31 the floor surface appeared to have been "exposed to fire", and in mound 34 the beans and grain were accompanied by burnt wattle marked clay and the probable remains of a burnt loom (Gray and Bulleid 1953,167,177). Although there are some grain-only deposits shown on the plans, they all appear to be from areas of blackearth which also produced beans.

In order to obtain further information about the context of the beans, the next sections relate their occurrence to the range of artifact types found in the same mounds, and the presence or absence of hearths.

4A.2.2.i. The range of artifact types.

The artifact lists for the mounds list only items which were individually described, and certainly for commoner artifact categories at least this does not represent the totals found (eg. for pottery, see Gray and Bulleid 1953,130,141). This is why the assessment uses only the number of artifact categories and not the numbers of objects recorded. There are often indications that the function of a mound changed during its period of use (one floor may have no hearth, another a series of hearths probably associated with metal working), but the lack of stratigraphic information on the finds means this cannot be taken into account.

It can be seen from Figure 4A.8 that mounds with legumes tend to have an above average number of artifact categories present. This is explained by the fact that these mounds also have an above average numbers of floors (3.5 as opposed to an average 2.7 for all the mounds), and the number of artifact categories is roughly proportional to the number of floors in the mound.

When the presence of legumes is compared instead with a more limited range of artifacts, selected as indicative of domestic activities, there is a clear indication that legumes tend to be recovered from mounds where these 'domestic' items were well represented. Considering associations with specific artifacts, six of the seven mounds with legumes produced querns, compared to 12 out of the 33 without legumes. The possible burnt loom in mound 34 suggested an association with textile production; six of the seven mounds with legumes had at least two of the three types of textile production artifacts (spindle whorl, weaving comb, bobbin), compared with 18 of the other 33 mounds.

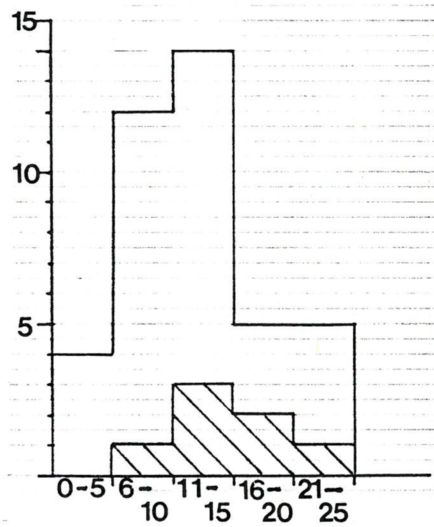
The numbers of mounds is small (40 in all, 7 with legumes) and the confidence which can be placed in the inferences drawn correspondingly small. The indications are that the legume deposits within mounds are associated with domestic and textile crafts activities rather than separate storage locations (but see discussion of mound 31 below).

All the mounds with legumes at Meare were in the eastern part of the excavated area. There is nothing to suggest differences in conditions leading to preservation, or that a single conflagration destroyed part of the site. It seems most likely it reflects differences in recognition or recording during excavation. The analyses above were repeated using only the eastern part of the

Figure 4A.8. Meare Lake Village: relationships between finds of carbonised legumes and artifacts.

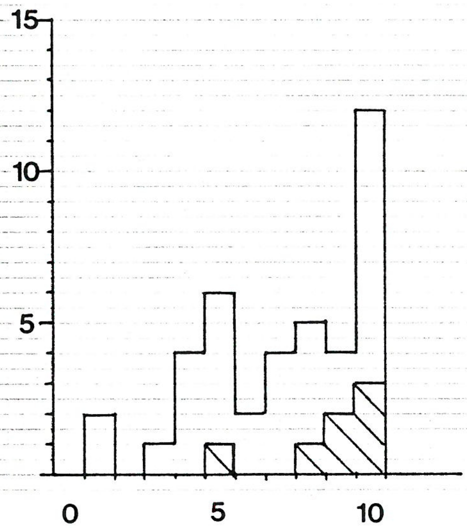
a) all individually noted objects.

No. of mounds



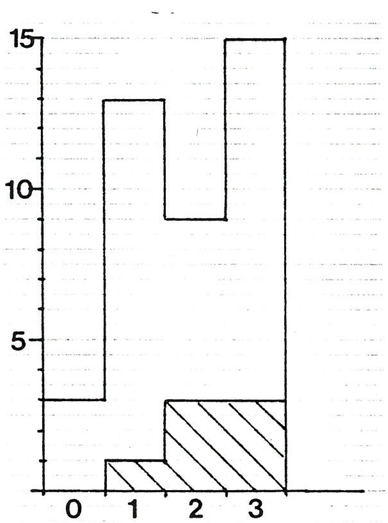
No. of categories (maximum 27)

b) range of 10 selected 'domestic' categories.



No. of categories (maximum 10)

c) spindle whorls, bobbins and weaving combs.



No. of categories (maximum 3)

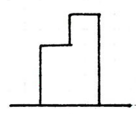
d) querns.

6/7 mounds with grain or legumes have querns.

6/22 mounds with querns have grain or legumes.

1/18 mounds without querns have grain or legumes.

Key:

all mounds 

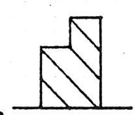
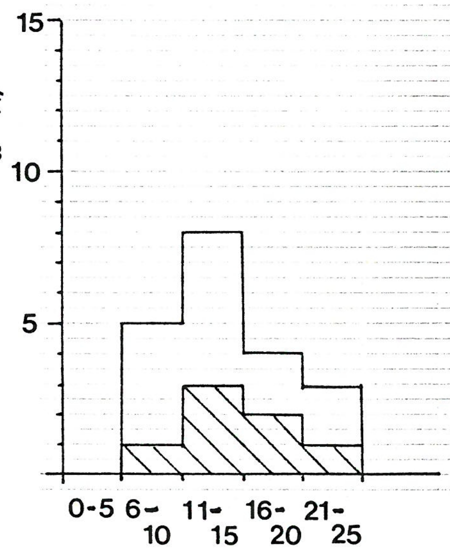
mounds with grain or legumes. 

Figure 4A.9. Meare Lake Village: relationships between finds of carbonised legumes and artifacts.
Eastern excavated area (mounds XXI to XL only.

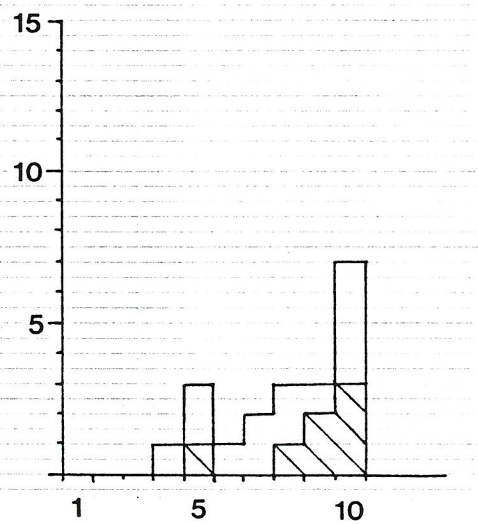
a) all individually noted objects.

No. of mounds



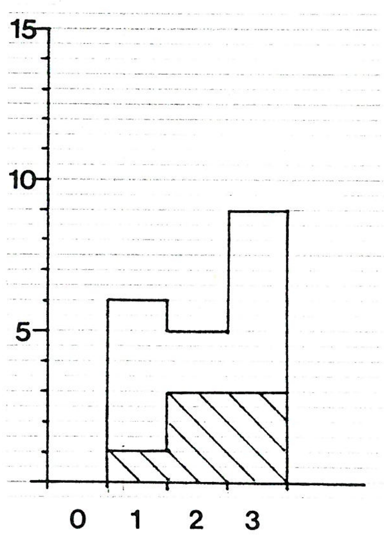
No. of categories
(maximum 27)

b) range of 10 selected 'domestic' categories.



No. of categories
(maximum 10)

c) spindle whorls, bobbins and weaving combs.



No. of categories
(maximum 3)

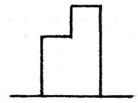
d) querns.

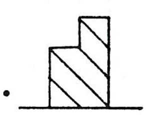
6/7 mounds with grain or legumes have querns.

6/12 mounds with querns have grain or legumes.

1/8 mounds without querns have grain or legumes.

Key:

all mounds 

mounds with grain or legumes. 

site (Fig.4A.9). The relationship with domestic activities remains strong, but the possible relationship with textile making equipment is weakened.

4A.2.2.ii Hearths.

Of the nine mound floors which produced beans, all except two had hearths. These were floor (i) of mound 31 (see below) and the upper floor of mound 32; Gray and Bulleid (1953) noted that upper floor hearths were often destroyed.

4A.2.2.iii. Storage and the context of the Meare beans.

Mound 31 had hearths on its substructure surface and its other clay floor, but floor (i) had no hearth despite "the appearance of having been exposed to fire". The mound produced a noticeably limited range of artifacts compared to the other mounds with legumes; it was for example the only one without a quern. The beans formed the largest accumulation found in a mound; they were concentrated "especially at the centre of the mound over an area some 10 ft. in diameter", in a layer up to 2.5 inches deep. This is quite suggestive of the destruction of a specific storage location, although there is no structural evidence suggesting a special storage structure for this phase of the mound (Gray and Bulleid 1953,166-8). Some accident of this scale presumably accounts for the carbonized wheat recovered from the peat between the two Meare villages - the quantity was sufficient to fill four wheelbarrows.

There are some indications from Meare East that the grain and beans may have been stored in wicker or basket work containers. Avery (1968,29-30) found a roughly circular layer, about 6m across, of burnt legumes, grain and charred wattling. Orme *et al* (1983,56,60,69-70) recognised the remains of a possible basketwork container associated with carbonised seeds, especially beans (J.M.Coles 1987,168).

As at Glastonbury, the suggestion is that most of the carbonized grain and beans are from domestic occupation areas, although there is a good case to be made for mound 31 being used as a storehouse for part of its period of use, and there are also the dumped refuse deposits, peripheral to or outside the main occupied area. It is probably not surprising that most occur in the domestic areas, as the risk of burning may have been greater there. The survival was again due not only to carbonization but also to the beans being sealed under clay floors or alluvial deposits, or being incorporated into the waterlogged black earth.

Chapter 5.
Livestock and the arable economy.

5.1 Introduction.

The interrelationships between the arable and pastoral elements of the rural economy may form an important key to understanding the arable sector, particularly in regard to questions of fertility maintenance and productivity. This chapter considers the the management of livestock in later prehistoric and Roman Britain and how it reflects the needs of the arable sector, especially the need for draught power and manures. The consideration of livestock is restricted to these aspects.

Among the areas in which material evidence for livestock management may be sought are provision for penning, housing and watering livestock, cultivation or collection of fodder crops and litter (discussed in Chapters 3 and 4 above), and the collection and use of manures (discussed in Chapter 6). The emphasis in this chapter is on the provision of housing and penning.

The reasons for penning or housing livestock can be roughly divided into four groups:

(i). protection of the animals; to prevent them from straying, and protect them from predators, theft and extreme weather.

(ii). control of animals; to prevent damage, especially to stored or growing crops, but also to soil structure due to trampling in wet conditions.

(iii). to allow better care of the livestock, maintaining good condition, growth or milk production, or regulating breeding. Improved care is likely to include improved feeding, and the fodder and litter it requires must be provided by collection or cultivation. Control of livestock to ensure an adequate supply of grazing or fodder throughout the year is essential.

(iv). to aid the arable sector, in two main ways:

(a). by facilitating the collection of manures. The required fodder and litter may largely consist of unwanted by-products of the arable sector, such as straw, chaff and grain cleaning residues, although specific fodder crops may be grown. In some historical cases, manure production was the primary reason for keeping cattle; in nineteenth century Lincolnshire, cattle were "machines for converting the straw into dung", and the sale of the animals was not itself expected to be profitable (Pusey 1843,300-1).

(b). by maintaining the draught animals in good strength and health. Fitness for spring ploughing would demand a better than maintenance diet, with either the addition of grain to the straw which could supply a maintenance diet, or cultivated fodders. Working animals might also be penned or housed for easier handling.

These distinctions are obviously oversimplifications, and the categories are not mutually exclusive, but they provide a starting point for interpreting and assessing the implications of the limited evidence for housing and penning in later prehistoric and Roman Britain.

Although climate is clearly an important factor in determining the need for livestock housing, a summary by Grundy (1970) of patterns in livestock housing in England and Wales in the 1950s also emphasized relationships with soils and the arable economy, in particular the availability of straw for litter. One crucial point is the need to protect land from damage due to cattle treading. This applies to pasture as well as arable: "Not many pastures are dry and sound enough to bear the tread of an ox in winter." (Potts 1807,s.v."Ox"). High summer rainfall and heavy poorly-draining soils are the two factors encouraging housing: "winter housing not only protects the cattle from severe weather but also safeguards the next summer's grazing" (Grundy 1970,3). On light soils, and in chalk and limestone areas of southern England in particular, fewer cattle were housed, and for shorter periods (ibid, maps 1,4).

Rainfall is important in determining the type of shelter provided (open yards are unsatisfactory where rainfall is high), but this was also related to the arable economy. Yard housing requires a plentiful supply of litter, and was therefore more popular in areas of heavy arable land use. Cowsheds are more economical of litter, and in the 1950's were almost universal in northern and western England and Wales, where higher rainfall and less available straw made yard housing difficult.

Table 5.1. Provision of litter for cattle.

Housing	Straw supplied daily per animal.	
Open yards	22kg	
Covered yards	11kg	
In box (1 ox)	9kg	- dung and litter allowed to accumulate.
In stalls	6kg	- better drainage uses less straw but wastes some liquid manures.

Sources: Morton 1855, Vol.2,318; McConnell (1883,65).

Efficient manure production depends on the supply of litter (Table 5.1). "The basis of farmyard manure is straw" (Loudon 1825, paragraph 4580), but other absorbent vegetable materials are also used. The same point was stressed by Pliny; if manure production was too low, this was because the farmer was "slack in providing litter for his stock" (XVIII.LIII). In open yards with a good supply of litter, manure could accumulate to a depth of a metre or more over the winter (Pusey 1843,300-1).

The important points are that farmyard manure is not simply collected dung (see discussion of Bignor estimates in Chapter 2), and that effective large scale manure production depends on particular forms of housing or penning and the supply of litter. The distinction between keeping animals in enclosures or in yards is essential; the definition used here is that an enclosure is essentially a small field, with its boundaries unusually well defined in comparison with other field divisions. Though dung could be collected and litter might be spread in a restricted area, such as a sheltered space where animals congregated, the size of the enclosure would suggest that an overall spread of litter for efficient manure collection would be impracticable. A yard or pen is a more confined area, which might be provided with drainage and/or a cobbled or paved surface. Provision of a layer of litter would allow efficient manure collection.

There are three levels of problems in assessing the archaeological evidence for livestock accommodation.

(i). A particular area or structure has to be identified as a stall, shed or pen for livestock. This process is made difficult by the absence of recurring sets of features defining animal housing, a fact well recognised for the Iron Age, but perhaps surprisingly still a problem in the Romano-British period. Distinctive types of yard do occur, but are not general throughout Roman Britain. Enclosures are almost routinely referred to as for livestock where no evidence for domestic or industrial uses has been recovered; positive indications of this use are less frequent.

(ii). Once the identification is made, the nature and intensity of use has to be inferred. A building, pen or enclosure may be used for a range of purposes relating to the four reasons listed above; the uses are clearly not mutually exclusive, and identifying them is often very difficult. Sometimes a use may be suggested (eg. bones from neonatal animals implying use in the breeding season, as at Danebury; Grant 1984,507,509) or excluded (eg. winter waterlogging of enclosures excluding use for winter housing, as at Farmoor; Lambrick and Robinson 1979,134). The evidence is generally insufficient for confident attribution, and the range of possibilities and their implications should be assessed. Small-scale provision close to the settlement may often relate simply to keeping draught animals secure and accessible.

Allied to this is the question of which livestock were involved. There is frequently little direct evidence; stalls may indicate cattle or horses, and pigsties could perhaps be distinguished by their form and size. For buildings without subdivisions, and pens and enclosures generally, structural indications are likely to be entirely lacking, and other evidence such as bones or livestock related artifacts would be needed. In any case many enclosures, pens and sheds must have been used for a variety of animals, whether at the same times or separately.

(iii). The next set of problems involve interpreting the uses of livestock accommodation in terms of the functioning of the agricultural system. Conflicting explanations are often possible for similar practices. It would for example be easy to regard the introduction of winter housing for cattle as an improvement in their management. But it can equally be a response to adverse conditions, and the need to maximise the value of scarce winter fodder or to protect fragile soils from damage. Housing can result in injuries,infections and disease (Baker 1984,254-6) and the weak state in which cattle are historically known to have left their winter quarters illustrates the problems faced in keeping livestock fed and healthy.

Slicher van Bath (1963,282-3) lists four reasons why livestock was important to farmers in early modern times:-

a). Production of commodities for market (meat, milk products, hides, wool).

b). Production of these for household use.

c). Use of larger animals for draught.

d). Production of manure.

He points out that the order of importance for livestock farmers (a to d) was precisely reversed for arable farmers. Different priorities in livestock management reflect the different economic bases and contexts of farming units. The balance of advantages and costs of different livestock regimes will also vary according to both the opportunities and restraints provided by the physical environment and the economic context in which the farm exists. It is for these reasons that the management of livestock is an important issue in interpreting the arable economy also. It is another case where attempting to consider one aspects of agricultural practice in isolation from others is likely to be inadequate.

This chapter attempts to assess the evidence for housing and enclosing livestock in Iron Age and Roman Britain, and to consider how it might reflect the needs of the arable economy as well as care of the livestock and management of grazing land. This relates closely to the evidence for fertility maintenance practices discussed in Chapter 6; where cultivation depends on heavy systematic manuring, the livestock must be managed to allow the collection of wastes and production of manures. If evidence for this, in the form of livestock housing or penning, is lacking, or seems to be on too small a scale, this must influence the interpretation of the evidence for fertility maintenance practices.

The discussion of housing and penning is divided into two sections. The first relates to pigs, horses and sheep. For pigs and horses, it is argued that the needs of the arable economy is unlikely to have been a significant factor in their management. In the case of sheep, the value of their manure may have been an important consideration, but likely methods of utilizing it are probably largely undetectable archaeologically. The management of cattle, with their triple role of draught animals, manure producers and livestock product, is potentially more informative. The evidence for the uses and care of cattle and more general questions relating to the recognition of livestock accommodation are discussed in the second section.

5.2. Housing and the management of livestock: sheep, pigs and horses.

5.2.1. Sheep.

Sheep may have been important as contributors of manure throughout the period in question, but this is difficult to assess. It has been suggested that the size of "celtic fields" relates to their being manured by sheep (Fowler 1981,214) but it is difficult to see how this could be tested. Such direct manuring lacks the 'markers' of domestic refuse which allow the recognition of manures accumulated in farmyard dungheaps and middens. Sheep are unlikely to have been housed; this is rarely needed for protection against the weather because of their hardiness, and while trampling by cattle can seriously damage wet arable land (or pasture), treading by sheep is unlikely to cause damage and can enhance the condition of light soils (Briggs 1977,96; Grundy 1970,3; Campbell 1983,35). Examples of the collection and spreading of sheep dung are not common. Campbell (1983,34-5) records that during the thirteenth century AD dung from the night pens of marshland grazed sheep in Norfolk was spread onto fields in nearby areas. But the collection and transportation was costly and "extremely arduous", and Campbell suggests the method was used only because the distances between arable land and grazing prevented direct folding. The cases of collection of dung from overnight pens cited by Ryder (1983,735) involve the use of dung as a fuel rather than manure.

For folding sheep on the arable to have a fertilizing effect, there must be a net transfer of nutrients (cf. Christiansen 1978). This can be achieved either by overnight penning of animals grazed elsewhere in the day, or by continuous penning with fodder supplied. This need was recognised by Roman agronomists; for example, Cato recommended folding sheep onto land to be planted, and feeding them leaves or forage crops (De agri cultura XXX). The density of folding required is considerable; figures from Dorset given by Stevenson (1812,408-9) range from 1200 to 2000 animals per acre; the animals must be closely penned to get an good spread of dung (ibid,407-8). Folding was carried out from late March until Christmas, and a field might be folded four or five times, but it was regarded as most beneficial in the weeks before sowing. Injury to both the sheep and the grazed downland was recognised; the sheep took "a year longer to attain their usual size and value" (ibid,408,410-1).

Evidence for buildings or pens specifically for sheep is very sparse. Morris (1979,50) cites one Romano-British example, Applebaum's interpretation of buildings 66-68 at Bignor. The size and layout of the buildings resemble buildings identified as sheepfolds at some German villas, and most of the animal bones from the site are from sheep (Applebaum 1975,119-20,Fig.1). The buildings are in an outer walled courtyard, compatible with Morris' assessment that work areas and livestock accommodation were normally situated in outer yards and that yards surrounded by domestic buildings should be seen as courtyards rather than farmyards (1979,53-4). This implies that the scarcity of structural evidence for livestock management on villas can be accounted for by its location outside the areas usually excavated.

While there is no direct evidence for this use of Bignor buildings 66-68, it is difficult to envisage structural criteria for recognising pens or buildings specifically for sheep. Association with sheep bones, especially neonatal, may be the best indicator of use; enclosures at Danebury have been interpreted as for use in lambing on this basis (Cunliffe 1984,507,509,555). At Barton Court villa, an enclosure was probably used for sheep in the mid-late fourth century AD. Two pairs of sheep shears were found in the enclosure, and the skeleton of a ewe, skinned but not butchered, was found in a nearby ditch (Miles 1986,33). Where the bone evidence implies sheep were economically important, livestock enclosures may be reasonably interpreted as sheepfolds, as suggested at Barnsley Park (Noddle in Webster et al 1985,83-4).

This interpretation has been challenged by J.T. Smith (1985), who interpreted the round structures as dwellings, in the context of "joint proprietorship" of the villa by a kin-group. Neither this interpretation nor its rejection by Webster and Smith (1987) has a strong basis, as comparisons with the stone built houses and yards from Northumberland (Jobey 1960, 1973a) demonstrate. From the structural evidence, it seems that the smaller structure R, with a hearth, could be a house, but that the larger structures J, F and Q (the last two having very narrow entrances) were probably pens.

Seasonal use, during shearing and lambing, is what might be expected taking into account the needs of sheep husbandry alone, and the needs of the arable economy are unlikely to have resulted in the provision of pens or sheds for sheep.

However, one category of sheep are likely to have received a closer level of care. Morris (1979,50) suggested penning would have been used in the Romano-British period "where introduced strains were being kept for breeding or fine wool". Frayn, reviewing the evidence from Roman Italy, noted the special care given to the "jacketed" fine wool sheep (1984,12-2). As well as jackets to protect the sheep, they were housed in stone-paved stalls or folds, kept cleaner than the pens of the rough-fleeced sheep. Columella stated that sheep kept for wool were more delicate than other breeds, and it is clear from his descriptions that raising fine-wool varieties was very labour intensive (VII.IV.1-5). If Bignor buildings 66-68 are sheepfolds, they may have been used for fine wool types.

It seems unlikely that fine wool types were present in the Iron Age, although Ryder (1983,370) follows Wild (1970,10) in suggesting that the Belgae might have introduced sheep with improved fleeces into Britain. The section of Strabo cited (4.4.3) seems rather, as Wild later commented (1982,113), to reflect the rapidity with which Roman farmers moved into newly conquered Gallic territories with their improved-fleeced flocks. Harding (1974,85) noted there is no evidence for shearing in the Iron Age in Britain.

The limited structural evidence for management of sheep is likely to relate to the needs of sheep husbandry, with manure as no more than an occasional by-product. The importance of sheep in fertility maintenance is therefore difficult to evaluate. There are two possible strategies, folding and grazed leys. Experimental work has tended to discount the value of grass leys (Dyke 1964,101; Boyd _et_ al 1961,179), but these are set in the context of available fertilisers and where the productivity of the ley crop itself is an important consideration. Leys are likely to have been of much greater value in pre-industrial agriculture, but the additional value of grazing is unclear. Experiments by the Rothamsted Experimental Station produced average yields in the subsequent wheats crops which were virtually identical for grazed and conserved leys (Boyd et al 1961,T.1).

Folding in contrast is clearly a valuable technique. Recent practice tended to fold the animals on cultivated forage (roots, cereals and grass/clover mixes) with large amounts of supplementary feeding in winter (D.H.Robinson 1979,644). Traditional practice (described above) relied on night penning. For sheep to have had the importance to the arable sector envisaged by Cunliffe (1984b,31-2), folding must be implied. The animals must have been penned closely, usually with hurdles which could be moved each day; the pens must be sufficiently secure to prevent sheep gaining access to adjacent fields with growing crops. Assuming supplementary feeding was not practised, sheep must have been moved through the fields to the grazing daily. Increased understanding of field systems and their boundaries may allow the likelihood of folding to be assessed. The method is labour intensive, but there is no reason to consider it could not have been important during the Iron Age. Yet to attach great significance to a specific technique for maintaining fertility which is not yet demonstrated, and perhaps not demonstrable, also carries the risk of misinterpreting the agrarian economy.

Cunliffe related the proportion of sheep in Iron Age Wessex to an increasing area of arable, expressing the view that otherwise "it is difficult to see why such large numbers of sheep need have been reared" (1984b,31). This is despite his inference of "massive production" of woollen cloth, and his acceptance of its possible economic and social significance in exchange systems (ibid,32). Cribb (1985) applied a dynamic simulation model of herd structure to three Iron Age sheep bone assemblages. He inferred that the Iron Age sites used a herding strategy "aimed at conserving the adult population" but with some specialisation in wool. Maltby (1981,173-5) had largely discounted an Iron Age emphasis on wool production, and Cribb makes the point that high indices for wool may be misleading because of the low wool productivity expected from Iron Age sheep. Soay sheep yield fleeces of around 0.5kg, and Shetland sheep (before nineteenth century breed improvements) yielded around 0.75kg (Ryder 1983,708,539, 497). A flock of 20 Soay sheep should produce enough wool to cloth a family of five (Heslop 1983,23). Clearly prehistoric yields could have been lower, with subsequent fleece improvement. Mediaeval yields were also low; fourteenth century figures given by Ryder are from as low as 0.3 kg, and yields of 1.0kg were high. 0.7kg may have been an average fleece (ibid,452-3,459). But the importance of the mediaeval wool trade would not be discounted on this basis. Cunliffe's view of wool as "best seen as a by-product of the agrarian system" is difficult to accept; it must surely have been an important product in its own right, even if sheep did also contribute significantly to arable productivity.

5.2.2. Pigs.

Pigs may be valuable in arable economies as a source of manure and in weed control, used to grub weeds from the fields. They can be fed on surplus by-products of food processing, such as chaff, bran, brewing and cheese making residues. Evidence for housing might suggest how significant these factors were in determining pig management.

Ashdown and Evans (1981,216) suggested that Iron Age pigs were "forest pigs", running wild and foraging for food. Strabo's description (4.4.3) of the pigs of the Gallic Belgae is cited in support of this, although these were said to be exceptional in height and dangerous to approach, and must therefore have been in marked contrast to the "very small" animals indicated by the bones from Skeleton Green (Ashdown and Evans 1981,208). At Danebury, the animals were apparently bred in or near the hillfort, as there is a large number of neonatal mandibles (Grant 1984,515,518).

Morris (1979,52) was able to list a few possible Romano-British pigsties. The slightly sunken building from Gorhambury (Neal 1978,48,Fig.15) provides little indication of its use, and is as readily interpreted in other ways. Applebaum (1972,177-80) identified pigsties at North Wraxall and Pitney villas. These are long thin buildings, with no evidence for subdivision. The importance of individual sties for farrowing sows is stressed by Columella (VII.IX.9-10), and subdivision in villa pigsties might be expected. Morris rejected Applebaum's suggestion for one of the three Pitney villas because it was adjacent to the main dwelling, and livestock buildings were in general absent from villa courtyards. This may account for the lack of excavated sties, but at present there is no strong structural evidence for large scale intensive pig rearing on villas. No recognisable pigsty type occurs, unless an internal building width of around eight feet is, as Applebaum implies, an adequate criterion.

There may have been a 'background level' of non-intensive domestic pig-keeping, dependent on the local availability of foodstuffs and needing little particular care. The relationship between environmental conditions and pig keeping noted by Ashdown and Evans (1981,216-7) and King (1978,216,Fig.7) may reflect this, and Grant's description of the Portchester Castle data ("the sort of pattern where pigs are kept as part of the household ... and killed of as they are needed"; 1975,399) may typify the evidence left.

In contrast, Applebaum (1972,182,187) has emphasized the importance of grain-fed pigs in the economy of some villas. But the evidence cited does not seem adequate to infer such practices confidently. Neither of Columella's two pig-raising strategies (producing suckling pigs near towns and salt meat from mature animals on farms further away: VII.IX.4) seems to involve rapid fattening by supplementary feeding; it is lactating sows which were grain fed and kept in sties (VII.IX.9,13). Other pigs were to be enclosed only overnight and pastured in woods and marshes, and given food only if this source of food ran out (VII.IX.6-8). Obviously this evidence need not apply to Britain, but it seems unwise to suppose the Romans introduced practices more intensive than they are known to have used elsewhere without positive evidence for these.

Pigs may have been a source of manure from overnight pens or sties, but it seems unlikely this was a major factor in their management, or that pig manure made a major contribution to fertility maintenance. Availability of foodstuffs, and especially foodstuffs of little other value, is likely to have been the main determining factor in pig keeping. The importance of foraging can be seen in the trend for the proportion of pig bones in assemblages to be greater in lower lying wet and wooded areas in both the Iron Age (Ashdown and Evans 1981,216-7) and the Romano-British period (King 1978,216,Fig.7).

5.2.3. Horses.

Horses have potentially two important roles in the agricultural economy, as draught animals and as a source of manure. From the bone evidence, it has been inferred that horses were treated differently to other livestock during the Iron Age. Harcourt (1979,158) noted the lack of immature horse bones at Gussage All Saints and Longbridge Deverill, and suggested that horses were obtained by capture from a wild population, removing the need to feed and maintain breeding stock and animals too young to work. A similar pattern has been recognised on other sites, such as Winnall Down (Maltby 1985,106), Danebury (Grant 1984,521) and Thorpe Thewles (Rackham 1987,106,108). Maltby (1981b,149) noted that other explanations are possible; there was a similar lack of young cattle bones at Old Down Farm. At Danebury, Grant suggested that there may have been a change to controlled breeding during the later Iron Age phases; in addition to an increased proportion of bones from immature horses, the observed decrease in mean size and size variation could be attributable to more restricted breeding (1984,521-2).

Grant has commented on "the ambiguous status of horse as a domestic animal", noting its higher representation in "special deposits". If horses had special status, a sacrifice would then be "a very grand gesture", but it would also be of less economic importance than the loss of a cow, pig or sheep (ibid,543). A parallel to this might be the Romano-British foundation burial at Bradley Hill, where a ram's skull was accompanied by coins which were no longer of any monetary value at the time they were buried (Leech 1981,210). While horsemeat was eaten in the Iron Age (Maltby 1981,184) and at some sites horse and cattle carcasses were treated similarly (eg. Winnall Down; Maltby 1985,106,138), at others they received different treatment. Although horses were butchered for meat at Danebury, in some cases the heads appear to have been used for special deposits, while the rest of the carcase was abandoned (Grant 1984,522). Differences in butchery were also recognised at Gussage All Saints (Harcourt 1979,160) and Thorpe Thewles (Rackham 1987,106).

An important question is whether horses were used as draught animals in Iron Age and Romano-British agriculture. The assumption that horses were not used for utilitarian draught purposes is often based on the erroneous assumption that deficiencies in harnessing techniques meant they were incapable of pulling heavy loads. Goodchild and Forbes (1956,515) inferred that a horse "could pull a maximum of 62kg - only a quarter of the modern figure". However experiments by Spruytte with improved reconstructions of early harnesses have disproved this view; limitations on traction are imposed by the size of the horse and the weight which can be supported in motion by wooden axles, rather than by the use of a breast collar (1983,9-16,98-105).

The small size of Iron Age horses (Maltby 1981,192) may have been the more significant factor in draught. Against this, Iron Age cattle were also small, and donkeys and mules were used for agricultural haulage and ploughing light soils in Roman Italy, their value rather than their size being the chief discouragement to this (White 1970,299; Columella VI.XXXVII.11).

Horse bones from some Iron Age sites have shown the pathological alterations (seen also in cattle) thought to be the result of use for draught. At Gussage All Saints, five examples of this were recognised in horses and only one in cattle, despite cattle outnumbering horses three to one in the bone record. Gussage may be exceptional. The industrial debris from metal working represents "about fifty sets of pony harness and chariot fittings" (Wainwright 1979,191), and the evidence for draught use of horses may relate to a specialised function of this site as producer and distributor of these items. A possible relationship between the economic position of horses at this site and the occurrence of legumes in the carbonised seed assemblage was discussed in Chapter 4.4.4 above.

Stables were identified from the Iron Age occupation of Hod Hill, where Richmond interpreted "huts with annexes" as "dwellings furnished with stables". Use for livestock was inferred from thick layers of dark trampled earth, which was a foot thick and 14 by 7.5 feet in area in the annexe to hut 56. About 8 of the 26 huts identified had such annexes. In both of the excavated examples, finds of harness-fittings were associated (1968,9,20-1,25, Fig.13). In view of the difficulty in identifying livestock buildings in Iron Age Britain (eg. Fowler 1981,139-141; see section 5.3 below), the fact that these buildings are interpreted as housing horses (and perhaps high status animals, chariot horses) may be significant.

The evidence from the Roman writers is that horses were not regarded as a normal part of the farm livestock. They were bred for sale or used to breed mules and hinnies, though both activities were restricted to large estates or specialised breeding establishments (White 1970,288). Donkeys and mules were agriculturally important, used for carriage, haulage, light ploughing and milling (ibid 299), and small British horses could have been used in this way. Evidence for donkeys and mules from Britain is too sparse to suggest economic importance, although their bones may have been incorrectly identified (Maltby 1981,161).

On balance it seems likely that horses did not play a significant role in Iron Age and Romano-British agriculture, ploughing and carting both being done by cattle. The provision of fodder and litter for horses can therefore be regarded as an additional and external demand on the agricultural system. The needs of horses could have acted as a stimulus to agricultural development, encouraging the cultivation of special fodder crops. Where riding and light draught animals were of value, they might have received closer care than most farm livestock, and stalling through the winter months would have allowed manure collection. But it is probably unlikely to have been a major consideration in their management where their role was essentially non-agricultural.

White (1970,290) noted that the Roman writers accepted it was better for horses to be kept outdoors all year round, and to be stabled only when cold damp conditions made this essential; this would clearly be more frequent in Britain than in Italy. Keeping the horses hooves dry seems to be the major concern in stabling (Columella VI.XXX.1-2) and manure collection may have been subordinate to the need to keep floors clean and well-drained.

Morris (1979,51) commented that the best evidence for stables from Roman Britain comes from military sites. In contrast, Pitts and St.Joseph, discussing the fort at Inchtutil, noted that "attempts to identify stables ... are beset with problems, and convincing evidence is extremely rare" (1985,181). No stable block has been identified in a legionary fortress in Britain, despite the fact that a legion would have required "perhaps a thousand or more" horses and mules. Wells (1977) suggested that the animals were kept out at grass most of the time, and that stables as such were not provided. He dismisses the interpretation of buildings at Hod Hill as stables for cavalry horses; Morris (1979,51) had described these as the "most useful" evidence for Romano-British stables. Richmond's identification (1968,83,Pl.30B) was based on the presence of two darkened worn patches in the subsoil, but Wells (1977,661-2) notes that these are too close together to be the result of wear by the feet of riding horses. Pack animals, mules or small ponies, could be represented.

Wells (ibid,663) suggests that internal divisions were unnecessary, and that it would have been more efficient to tether the horse in a row along the length of the building. This seems to have been the practice at in some Roman forts in northwest Europe, as at Nieder-Bieber. Well's doubts about the reconstructed stabling arrangements at Kunzing are shared by Breeze (1977,454-5), and the scheme was heavily influenced by the Hod Hill stables, with little direct evidence. A building excavated in the fort at Wallsend had no internal partitions (unlike adjacent barrack blocks) and contained several drains; it was identified as a stable on this basis (Britannia 11 (1980),355, Fig.5). The building was about 46 by 8.5m in size, and could have held around 60 horses in two rows.

The evidence from military sites is less likely to "help identify stables on civil sites" than Morris hoped (1979,51). Wells (1977,664) suggests that plans without subdivisions have "at least as much right to be regarded as the standard pattern, if there was one" as the arrangements from Hod Hill. This lack of necessity for subdivision and the contrast between the perceived scarcity of accommodation and the estimated need may be the most important points to emerge, and may have implications for livestock housing in general.

Morris cited a few stables from civil sites (1979,51-2). Dung was present at two of these, forming the prime evidence for the identification at one. The stables at the commander's house at Housesteads had drains and stone-lined water-troughs. Stalls were identified at two villas, but otherwise the evidence was "insufficient". Morris suggests that where stalls are recognised in the wings or courtyards of prosperous villas (as at Northleigh and

Gadebridge Park) they are likely to have been for riding horses rather than other livestock. This has implications for considering the evidence for cattle housing.

5.3. Housing and the management of livestock: cattle.

5.3.1. Cattle housing in the Iron Age and the use of phosphate analysis.

The scarcity of evidence for prehistoric livestock housing has been widely noted (eg. Fowler 1981,138-141) and contrasted with the evidence from elsewhere in northwest Europe (Bradley 1975,272). Waterbolk (1975,393) suggests that the coastal areas of continental northwest Europe are unique in having later prehistoric cattle housing, which he considers to be absent from Britain and Central Europe. Livestock housing cannot be consistently recognised even within northwest Europe; for example, Nasman notes that in Norway, byres occur in the longhouses of the late Roman/early Germanic Iron Age (fourth to sixth centuries AD) but not in the preceding or following centuries, when "obviously they were detached and so constructed that they have not yet been found or identified" (1983,63,65).

A small number of stone-built animal sheds and byres are known from later prehistoric Scotland. These include the Bronze Age byre from Jarlshof (Curle 1935,87-95), and later Iron Age buildings from Clettraval, where a rectangular building was interpreted as a byre belonging to a circular farmhouse (Scott 1948,53-5). At the Allasdale, Barra, a wheelhouse was accompanied by a number of outbuildings including a barn/byre, the byre end of which had covered drains (Young 1952-3,88,Fig.3).

Some Iron Age timber structures have been identified as livestock accommodation. At Walesland Rath linear ranges of timber structure immediately inside the enclosure bank (dating to the second and third centuries BC) were described as providing "ample roofed accommodation for livestock" as well as a variety of domestic and industrial activities. There is however no evidence to support this interpretation (Wainwright 1971,62,64,66,100). At West Plean a jumble of postholes in the Iron Age enclosure were interpreted as a roughly rectangular byre, again without any direct evidence for function. The site also had a sunken cobbled yard, with its own entrance through the enclosure bank and ditch, and this seems likely to have been used for livestock (Steer 1955-6,235-7).

It is interesting that the best known Iron Age livestock building from England (the annexe to Hut 56 at Hod Hill) is interpreted as a stable. This may be compared with Morris' suggestion (1979,52) that stalls in villa courtyards were for riding horses not farm livestock.

Reynolds (1979a, 50; 1979b) has suggested that four post structures may have been used as byres. Poole suggested that at Danebury some of these and similar rectangular post built structures may have had two storeys, housing animals below and storing hay above. There is little to support this. Most of the structures were identified by analysis of plans rather than during excavation, and many were in areas where erosion had removed floor levels. Although one example (PS 1) did have a recognised floor surface showing signs of wear, the wear was no greater than in the area outside the building; stalled livestock and manure removal would be expected to result in greater wear. This was a five post structure, and Poole suggested that such additional posts could relate to internal partitions, although no indications of these survive (1984,94-8,Fig.4.42).

In terms of size, most four post structures would be suitable for stalling cattle or horses. The Iron Age stalls from Holland and Denmark discussed by Waterbolk (1975,386,Figs.1-3) were mostly from 0.75 to 1.04m wide, with partitions up to 1.25 long (although the actual length needed by the animals would be longer). A four poster of the modal size identified by Gent (about 7 sq.m or 2.5m square) would therefore allow ample space for two oxen. Various ways of dividing the space could be suggested, but a yoke of oxen could have shared a single stall. Waterbolk's examples allow much less space for the animals than the figures given by the Roman writers; Columella (I.VI.6) recommends a width of nine or ten feet, Vitruvius (VI.C.VI.2) ten to fifteen feet and a depth of at least seven feet, for a yoke of oxen. Size difference may play a part, but this may chiefly reflect the difference between general overwintering of livestock and the stalling of working animals. The accommodation described is for draught oxen, and the stall must allow "the oxherd to move around it in performing his duties" (Columella I.VI.6).

However if four posters and similar structures had been regularly used as byres, some confirmation in the form of trampled or hollowed surfaces (such as are often associated with cattle yards and mediaeval byres) would be expected. Gent's (1983) analysis of these structures firmly supported their interpretation as storehouses or granaries, and in the absence of direct evidence for their use as livestock accommodation, it seems unwise to regard them as indicating the housing of animals.

Attempts to recognise byres clearly rest on expectations of what byres should look like. Waterbolk (1975,385,393) listed criteria for identifying byres within rectangular houses, and noted that he did "not see a reason" to consider the round huts from later prehistoric Britain as byres, a view subsequently emphasized by Bradley (1979,272). Morris (1979,3,42) lists some criteria used to identify Romano-British stalls; these emphasize drainage, partitioning and conformity to standard sizes, the latter being particularly stressed by Applebaum (1972,142-150; 1975,118-121). Rectangularity is implied. Perhaps because of these expectations, the possibility of circular animal houses tends to be overlooked.

One group of round houses has however been identified as incorporating cattle housing on structural grounds. These are the mid first millenium BC ring-ditch houses from northeast England and southeast Scotland. The buildings have a distinctive plan, with a level central area surrounded by either a continuous ditch or two concentric rings of scooped depressions, often paved. All have three concentric structural rings (ring-grooves or circles of postholes) (Hill 1982,12). It has been suggested that the two rings formed cattle stalling, the scooped depressions resulting from manure removal and the paving to assist drainage or to prevent wear (Jobey and Tait 1966,14; D.M.Reynolds 1982,47-54). The central area could have been used for fodder storage or living accommodation. Reynolds estimates the ring-ditch house at Broxmouth could have held 30 cattle in its two rings. Hill (1982,12) notes that although there are biases due to differences in survey cover and ease of recognition, the distribution of ring-ditch houses may be concentrated on fertile lower land; an association with arable cultivation is therefore possible.

A round structure at Thorpe Thewles may also have been a byre. It was one of a number of smaller circular buildings, defined like the main dwelling by circular ditches, and described as sheds or outhouses. It lacks evidence for walling or door supports. The subsoil within the ditch was yellow-grey, not the clean orange seen elsewhere on the site, and Heslop suggests this might reflect its use for livestock (1983,21,Fig.8). These smaller structures were "generally devoid of discarded objects" (Heslop 1987,117). He suggests that during the occupation of the settlement (mid/late Iron Age to first century AD) "specialised functions for structures and spaces were evolving" (1983,21).

This process can be seen in the enclosures on the settlement, which evolved continuously, from settlement within and then beyond an enclosure ditch to an open settlement (Heslop 1987,9). Much of the area within the enclosure may have been used for "corralling of livestock" (1983,21); when the enclosure ditch was filled in, there was a "proliferation of small enclosures around the periphery of the settlement" (1987,119). Heslop suggests this demonstrates "more regulated, precise and home-based management of the stock". Two ditches of this period also suggest a double-ditched trackway (ibid,114), and this may reflect these changes also. The association of trackways with settlements in the later Iron Age elsewhere in Britain is discussed in Chapter 6.

Phosphate analysis provides some additional evidence for the housing of animals in round buildings. Craddock _et al_ (1985) summarize the evidence from two sites. At Cat's Water (Fengate) a series of mid/late Iron Age round houses were investigated. High phosphate levels enabled a number of these to be identified as animal housing, and these were also shown to have fewer artifacts and to lack the patterned distribution of artifacts seen in dwelling houses (ibid,365-6). Pryor comments:

"The rather surprising conclusion is clear: animals were kept inside the ditched enclosures, probably in round buildings in which they overwintered, whereas people occupied identical buildings spaced round the periphery of the settlement" (1984,218).

The proportion of the buildings used for livestock was apparently high. On the basis of artifact patterning, Pryor identified 50% of the round buildings as domestic, and 40% as used for livestock, figures confirmed by the phosphate and magnetic susceptibility results (ibid,216,223). The site also produced a variety of other structures, probably "farm buildings of one sort or another" (ibid,223).

At Maxey, East Field, phosphate analyses suggested differences in use between two similar Romano-British structures defined by ring-gullies. One, with high phosphate levels and an absence of finds, was identified as animal housing. The other, with lower phosphate levels, was interpreted as a house, from which domestic refuse had been cleared into an adjacent ditch complex which showed substantial phosphate enrichment (Craddock et al 1985,368-9).

These results suggest a markedly different picture of the occurrence and importance of stock buildings during the period than would otherwise have been inferred. It will be interesting to see if other sites produce a similar ratio of dwellings to livestock houses if examined in this way (the question is considered for some of the small number of Romano-British settlements with structural evidence for cattle housing below). As Pryor notes, the results have major implications for estimating settlement populations (1984,223). It undermines Waterbolk's assertion about the function of circular buildings, and makes it essential to reconsider the differences in the relationships between field systems, livestock management and fertility maintenance practices inferred for Britain and northwest Europe by Bradley (1979).

But it is interesting that neither Maxey nor Cat's Water seems to be associated with cereal production, and it therefore cannot be suggested from this evidence that the housing of livestock reflects the fertility demands of cereal cultivation. At Cat's Water, Pryor considers it probable that the cereals were brought to the site ready threshed; although an increase in cultivation in the mid/late Iron Age is inferred, this may have excluded cereals. The economy on the site seems to have been based on livestock and the exploitation of aquatic resources (1984,224-5,229). At Maxey, evidence for the primary cleaning and processing of cereals is absent (Green 1985,228-232). Analysis of Romano-British sherds recovered in field walking suggested the presence of a midden in the area of yards and the manuring of a restricted area bounded by ditches of the enclosure system (Pryor et al 1985,47,50,53,Fig.47). Green (1985,230) suggests the manured plots could have been used for cultivating legumes; peas, beans and lentils were all recovered from Romano-British phases at Maxey.

The reason for housing livestock at these sites therefore probably does not relate to a need for manures for cereal cultivation. Although at Maxey the manures were exploited in the Romano-British period, the needs of livestock husbandry, and in particular the need to protect pasture in areas of poor drainage (Grundy 1970), were probably the determining factor at both these sites.

Phosphate analysis has identified a few other examples of livestock accommodation. The potential of the method in answering specific questions can be seen in the case of Building E from Cefn Graeanog, Gwynedd, a Romano-British hut group (Conway 1983,123-4). The analysis confirmed the suggestion that the rectangular building with a drain had functioned as a byre divided longitudinally into two stalls. Lower phosphate levels at the west end of the building suggested the presence of a manger preventing animals from trampling the soil in that area.

Results in some other cases have been contrary to expectations. 'Banjo' enclosures have interpreted as primarily used for livestock, because of their situations, layout and lack of evidence for domestic occupation from excavated examples (Perry 1972,71-2). Both phosphate and magnetic susceptibility techniques were used at the 'banjo' at Tadworth, Surrey. This site has been so severely ploughed that little evidence for its function could be expected to have survived, but phosphate analysis of the topsoil was still able to indicate its usage (Clark 1977,187,189; Craddock et al 1985,363). The electromagnetic survey suggested that the main enclosure had been used for domestic activities, magnetic susceptibility being particularly enhanced by burning. But enhancement of phosphate levels, suggesting regular use by animals, occurred chiefly in, or in the approach to, a small circular annexe to the main enclosure (Clark 1977,190-1).

Use of phosphate analysis as part of initial survey or site location is potentially of particular value in considering questions of animal management. Areas of phosphate enhancement appear to retain their definition well despite plough action, and topsoil analysis has therefore enabled recognition of occupied areas (Clark 1983,128-9). Discovery of the Cat's Water settlement resulted from phosphate survey, the site lying outside the area recognised from air photographs (Craddock et al 1985,365). It is often suggested that livestock were housed outside areas excavated, and structurally insubstantial livestock accommodation might be located by use of these methods in areas where other survey methods fail to detect features.

Phosphate analysis has obvious potential in the dual problem, of locating livestock buildings and identifying their function. The results so far published support the suggestion that expectations of what byres should look like are impeding their recognition where they do not conform to these expectations. But recognition of livestock buildings - or pens and enclosures - clearly requires the definition of appropriate criteria, whether based on structural forms, artifact patterns or phosphate data, and establishing these should be a priority for work in this area.

One type of Iron Age feature which might be tentatively associated with cattle is working hollows. Detailed discussion of these by Bersu (1940,64-78) led him to conclude they provided a clean working area for crop processing. But as Wainwright (1979,19) has noted, there is no objective evidence for their use in this way. The frequent cutting and recutting of new hollows through older ones filled with ash and refuse (as in the "large dark patch" at Little Woodbury) seems surprising if the aim was a clean area. There is no indication why such features should have been short-lived and frequently replaced.

At Little Woodbury the hollows are described as shallow, irregular quadrilaterals, with floors generally level and always covered with a layer of pulverised chalk, sometimes with trodden chalk surfaces at higher levels in their fill. Concern with drainage seems important; they were always dug around a pre-existing pit, which presumably acted as a sump (Bersu 1940,64-5). This is a feature also seen on other sites (Wainwright 1979,19-20). There is occasionally evidence for shelter; a hollow at Tollard Royal has a line of stakeholes along its edge (Wainwright 1968,111-2,Fig.7).

Bersu inferred that "the hollows had a definite function in the settlement, since they appear frequently and always in the same way" (1940,69). Holding livestock is one possible use. As well as being slightly sunken, they could have been sheltered by hurdling or walls of turf. Dung and litter could have been removed periodically, contributing to their general irregularity. If livestock, perhaps the draught oxen, were tethered or penned in these over the winter, it would explain the need for drainage in a way which summer use for outdoor crop processing does not seem to. Once the animals left the hollows for the pastures in the spring, they could be filled in. The cleanliness noted by Bersu need not argue against this use, as pure dung can leave no traces (Lambrick and Robinson 1979,71) and it is the absence of domestic refuse Bersu particularly notes. Comparison of phosphate levels between the pits serving as sumps for hollows and other pits with similar sizes and fills might resolve the question.

More livestock buildings will doubtless be recognised as better techniques are applied, and especially if phosphate analysis is used more widely. But despite the evidence from Fengate and Maxey, the suspicion persists that animal houses will not be shown to be a widespread characteristic of Iron Age farming. They may have been used only when environmental factors and the needs of animal husbandry made them essential.

In general animals may simply have been held within the settlement when necessary, explaining why many Iron Age settlement enclosures have substantial areas empty of structures. The relationship between enclosures, fields and settlements throughout later prehistory might usefully be examined in terms of the question of where livestock could be secured. If the settlement itself could not contain livestock, secure fields or enclosures would have been necessary. There is a contrast between open settlements and adjacent enclosures at some Iron Age settlements in Northamptonshire and the enclosed settlements seen in other areas, such as Wessex (Current Archaeology 8, 1984,199). Examples include Pennyland (ibid), where 11 round houses and about twenty storage pits lie outside two small enclosures; and Wakerley, where the Phase 2 enclosure lay to the south of a group of huts (Ambrose and Jackson 1978,122,Fig.4). Macinnes (1982,59) has noted a "major point of contrast" in southeast Scotland, where unenclosed Bronze Age settlements are associated with systems of small fields, while enclosed settlements dating from the early-middle first millenium BC are not.

The situation at Thorpe Thewles, where small enclosures were created as the enclosure ditch was filled in may reflect the continuing need to enclose animals, and perhaps as Heslop suggests the development of new practices in animal care. The development of specialist enclosures for livestock separate from the domestic areas might prove to be a trend in the later Iron Age. A related trend might be an increase in trackways leading into settlements. The development of droveway settlements in the Upper Thames Valley in the late Iron Age, consisting of enclosed rectangular paddocks alongside ditched trackways, is well known (Jones and Miles 1979,319;Hingley and Miles 1984,65). The association of droveways with later Iron Age sub-rectangular enclosures in Hampshire has been noted by Millett and Russell (1984,55). The likely pre-Roman origin for yarded settlements in Northumberland is discussed below. An increase of trackways allowing livestock movements into the settlement and separate enclosures, or defined areas within enclosures, could well represent the daily or frequent movement of livestock into the settlement areas, a practice perhaps becoming important again for the first time since the Bronze Age (see discussion in Chapter 6). This has implications for the possibility of manure collection, as the enclosed livestock could be given litter to allow manure collection, but the distinction between enclosures and yards must be remembered. The limited evidence for housing and yards suitable for efficient manure production suggests the benefits in this respect should not be over-emphasised.

A variety of factors could lie behind these trends. Closer control of the livestock might reflect the need to maintain pasture, or increased use of fodder crops to keep animals in condition through the winter. It could relate to the arable system, with an increasing emphasis on manure production as an aim, or perhaps less use of grazed grass fallows (and hence more frequent cultivation of individual fields) which reduced the possibilities of securely containing grazing livestock in the fields.

5.3.2. Cattle housing from Roman Britain.

In contrast to the later prehistoric period, it is generally considered that livestock buildings from Roman Britain are well known and understood. The Roman agronomists detailed sizes, layout, orientation and location within the farm complex, and it is easy to assume that this information - pertaining to a particular class of agrarian society at a given time in Roman Italy, and perhaps an ideal rather than a norm - provides a description for livestock buildings throughout the Roman Empire over more than four centuries.

The evidence for livestock buildings from Roman Britain is in fact very sparse. A survey by Morris (1979) lists only 29 buildings, from 22 sites, as either cattle sheds or other agricultural buildings containing stalls. Most of these are described as doubtful; as well as being scarce, the evidence is often poor. Morris noted that "most surprisingly" the evidence from stock buildings of the Romano-British period is less clear than that from mediaeval byres. Yet the expected evidence (drains, partitions and hollowed floors) "should survive as well in an excavated Romano-British floor as in a mediaeval one" (1979,3). Morris suggests this may reflect differences in "expectations, scale and date" between Romano-British and mediaeval excavations, with the emphasis on the domestic areas of villas tending to leave outlying agricultural buildings uninvestigated (Morris 1979,3-4,53-4).

Applebaum (1972,142-150) has also examined the evidence for byres and stalls from Roman Britain. His identifications are based almost entirely on the internal dimensions of the buildings. He derived a standard width of 13 to 15 feet (4 to 4.5m) from a variety of archaeological, literary and other sources (ibid, 146-7). A number of villa outbuildings with widths in this range (or twice it) are interpreted as byres on this basis, rarely with any supporting evidence. A problem with this is that there is no indication whether these buildings form a distinct group with widths clustering around this size, or whether Applebaum is in effect simply picking out buildings from a group whose widths are distributed over a much greater range. As Morris' survey is more recent and considered a wider range of evidence, it is preferred as a basis for discussion here.

The following discussion is divided into two parts, the evidence from villas and from other Romano-British rural settlements. It is accepted that there are problems in making this distinction. However models for agricultural productivity which stress the intensive management of livestock and the heavy use of manures have been applied primarily to villas (specifically to Bignor and Gatcombe, discussed in Chapter 2). To evaluate these, it is useful to consider the villa evidence separately. And there does seem to be a distinction in the evidence between the two classes of settlement.

5.3.2.(i). Cattle housing from villas in Roman Britain.

Only four of the ten sites with 'definite' byres or stalls identified by Morris (1979,121-6) are villas. Of these, Otford is published only in interim form (Journal of Roman Studies 45, 1955,143), with little information and no plan; the identification as a byre rests largely on the presence of a number of horn cores, and the presence of a deep gully in the cobbled floor. Colerne (Godwin 1856) is a nineteenth century excavation with little to suggest the building was a byre; at Stroud (Moray-Williams 1909,47-50) the building is located in the villa courtyard, a location Morris (1979,53-4) suggests is more likely to indicate stables than cow sheds.

At the fourth site, Winterton, Morris lists four buildings. Two of these, aisled buildings M and P, are published only as interim notes, without plans (Arch. Ex. 1971,20-1; 1972,11; Britannia 3(1972),22; 4(1973),286). They have evidence for partitions suggesting division into stalls, and possible manger supports; one has drains. The other two buildings, rectangular building A and phase two of aisled building B, are interpreted as incorporating livestock accommodation on the basis of their shared feature; each has a long trench, four feet (1.2m) inside the wall (Stead 1976,24,35,Figs.14,16). The trenches were regarded by Stead as too deep for dung channels, and there is no drainage out from them. He suggests they might have supported feeding troughs, with access to them along by the wall. It has been suggested by several writers that the aisles of aisled buildings are readily usable as cattle stalls, but these trenches seem to be the only evidence cited in support. Stead commented that this interpretation of buildings A and B was "no more than a guess" (1976,90) and it is a measure of the problem that they fall into Morris' 'definite' category.

Morris lists only three other aisled buildings as having evidence suggesting use for livestock; two of these are doubtful as aisled buildings, the third doubtful as a byre. This is despite cataloguing over a hundred such buildings, 28 of which produced evidence of agricultural uses (1979,152,T.4). There was much more evidence for use in cereal processing than livestock related activities (ibid,58), though the easier recognition of features such as corn driers and granaries must be remembered. Hadman (1978,192) refers to an aisled building in Leicester which might have been divided into stalls. Publication of the Winterton buildings M and P may clarify the use of these buildings. The evidence from this site for enclosures, yards, waterholes and trackways, some of which show signs of trampling by livestock, referred to in interim reports (Britannia 12(1981),330-1; 14(1983,296); 15(1984),283; 16(1985),281; 17(1986),387) suggests that Winterton may be very informative on a range of questions relating to livestock management.

An update of Morris' work has not been attempted, but the annual summaries of excavations published in Britannia have been used to assess whether changed emphasis in villa excavations has led to greater recovery of livestock buildings. The results were disappointing, with few references to animal buildings or enclosures indexed (see Table 5.2), and such buildings were rarely mentioned in the reports. There are a few references to livestock accommodation; as the sites are mostly not fully published, they are difficult to evaluate.

Two structures have interior gullies or trenches similar to those at Winterton. At Bancroft (Britannia

Table 5.2

References to Romano-British agricultural buildings in the index to Britannia, 1977-1986.

Villa	166	(86 different sites)
Farmstead	34	(32 different sites)
Barn	9	
Corndrier	59	
Granary	46	(includes military granaries)
Byre	1	
Stable	4	(all military)
Midden	3	
Cattle-corral	1	
Paddock-systems	3	
Stock enclosures	2	

No entries found for: cattle shed, cowshed, farmyard, pen, pigsty, stall, sty, or yard.

16(1985),290,293,Fig.22) this feature lies inside a line of postholes 2m from one wall and 2m apart. These could divide the side of the building into substantial stalls. But the gully, about 1.2m from the wall, as at Winterton, is probably too close in for a dunging channel, unless the cattle were stalled longitudinally. At Tarrant Hinton a walled enclosure (regarded as such because of its poor foundations, but badly plough damaged) has a gully or ditch parallel to one of its long walls (Proceedings of the Dorset Natural History and Archaeological Society 99 (1977),124-5,Fig.43). As at Winterton, neither gully appears to have an outlet for drainage. But before these features could be taken to indicate cattle housing, some stronger evidence, such as raised phosphate levels, is needed.

A different type of byre was identified at Bucknowle (Proceedings of the Dorset Natural History and Archaeological Society 104 (1982),183,Fig.9). A large room (No.25) contains an L-shaped internal wall defining and area approximately 2.5 by 3m, "the right dimensions for a byre, convenient for a yoke of oxen". However, it is difficult to envisage a substantial villa requiring accommodation for only one yoke of oxen, and this must weigh strongly against this interpretation, for which no additional evidence is offered. If it was used for livestock, its location off the courtyard may suggest that stabling for riding horses is more likely.

It is surprising that no consistent and recurring type of cattle byre has been recognised on Roman villas in Britain. On sites where the provision of corndriers and granaries demonstrate the importance of the cereal harvest, provision of accommodation for at least the essential draught animals would surely be expected, both for their protection and ease of handling. The lack contrasts with the attention paid to the care of oxen by the Roman agronomists, although this is against the background of a different set of climatic and environmental problems.

It is likely that excavations of villa surroundings will lead to better understanding of livestock management. The variety of buildings being recognised spread over a wide area around the Bancroft villa (Archaeology in Britain 1986,52-3) indicate the sort of evidence which may be produced. Building 2, with a 2m wide band of fragmentary limestone paving along one wall, is plausible as a byre (Zeepvat 1987,72,77, Fig.20). There was also "a sunken area paved with limestone slabs", perhaps a animal pen (Britannia 16 1985,293). It is interesting to note that at early stages of the work at Bancroft, the absence of agricultural buildings was commented on (Current Archaeology 8, 1984,201)). Even the recent excavations at Barton Court Farm found "no buildings ... whose purpose was specifically to shelter livestock" (Miles 1986,33). It is perhaps the evidence for pens, enclosures and trackways which will prove to be important, suggesting that livestock was usually kept in the open, perhaps with shelters rather than sheds. Columella distinguishes between the need to provide stalls for the working animals and the enclosures, with shelter, needed for the other cattle (I.VI.4;VI.XIII). The emphasis on allowing sufficient space to avoid injury due to crowding seems to imply that the cows were not enclosed in separate stalls. While this cannot be assumed to apply to Britain, it does not seem reasonable to assume the Romans will have introduced to Britain a more intensive standard of cattle housing than they used elsewhere.

The problem may partly be one of recognition; byres and cowsheds may have lacked distinctive structural features, paralleling the probable lack of subdivisions in military stables. Waterbolk (1975,391,Fig.4) describes two eighteenth century methods of cattle housing which did not used individual stalls. Similar arrangements could fit into Romano-British aisled barns. The buildings described were multipurpose, with cattle held along the sides and a threshing floor in the middle. Aisled buildings could have had different seasonal uses, such as crop-processing during the summer months while cattle were kept outside. If stalls were necessary, a building with a substantial timber framework could easily accommodate hanging stall divisions, which were formerly a common alternative to fixed stalls (Harris 1987,51). These could be removed seasonally, would not rot at ground level, and would make removal of manure easier. Hard flooring or paving would prevent signs such as hollowing of the floors.

It may be possible to infer in this way the housing of draught cattle on villas, which would be expected in the light of known Roman practice elsewhere, and for reasons such as ease of handling and the need to maintain fitness for the spring ploughing. But the existence of such housing cannot be said to have been demonstrated.

The clusters of pens and enclosures increasingly being recognised around villas (such as Winterton [Britannia 14 (1983),296; 15 (1984),283; 16 (1985),281; 17 (1986),387] and Gorhambury; [Britannia 13 (1985),269]) suggest livestock may have been enclosed overnight close to the farmyard.

The Gorhambury villa had two yards, the inner holding the main house, "bailiff's house", bath house, and granary, the outer containing a substantial aisled building, with evidence for domestic use, a second bath house and other structures. In the second century, the outer yard was divided into four paddocks, one containing the aisled building, another a pen, and the other two devoid of structures. The outer yard seems to be a farmyard with workers accommodation, and the paddocks presumably were used for livestock.

At Winterton, one of the ditched enclosures contained a rectangular timber building, Q. Little domestic debris was found, and the building might have been used for stock. Building were also seen among the walled closes at Barnsley Park. It is disappointing that despite the recognition of the importance of the closes and the field system at Barnsley Park, there was little excavation of these. The villa and courtyard of buildings lay inside a much larger (c. 130 by 70m) stone walled enclosure, which also contained the walled closes. There were a number of buildings within the closes, and relationships with trackways suggested animals were moved between the closes and pasture lying beyond the lynchet-defined arable field system lying outside the enclosure (Webster et al 1985,73-82).

The walled enclosures and buildings (one interpreted as a byre) at Butcombe (Fowler 1968), about half a mile from the Lye Hole villa, could be a similar example, though there is no evidence it related to the villa. These sites indicate the sort of evidence for livestock housing and management that can be recovered when these aspects receive a higher priority in villa excavations. It is difficult to reach conclusions on the basis of the limited evidence. Buildings such as Q at Winterton, at around 15 by 4m internally, could have held perhaps 25 tightly packed animals, although the building is rather narrow for two rows of cattle, or a single row of stalls for draught oxen, holding about 5 yokes (based on the space allocations given by the Roman writers). This gives some indication of the scale of provision which can be inferred.

Many villas may have been surrounded by clusters of enclosures, in which livestock could be held, overnight, during calving or in the winter months. Buildings within these could have provided accommodation for some animals, but so far the evidence need imply housing of no more than the draught animals. This would allow manure collection on scale sufficient to account for the evidence of Romano-British manuring. But the evidence is not strong enough to infer large-scale winter housing. Models based on a six month period of indoor housing for large numbers of cattle (1000 head in Barker and Webley's (1977) reconstruction of the economy of Gatcombe) are not realistic on the basis of the present evidence for livestock management. They may therefore greatly overestimate the productivity achieved.

5.3.2.(ii) Livestock accommodation on other Romano-British rural settlements.

In contrast to the villas, the 'expected' evidence for byres - partitions, drains, churned up or hollowed floors - does occur on a number of other Romano-British rural settlements. This could result from differences in emphasis in excavation, but it is also possible it may reflect the scale of the enterprise involved. Stalling a yoke of oxen in one part of a building may necessitate drains and partitions while occupation of an entire building by livestock does not. Well paved floors which do not show signs of wear by livestock are less likely in the agricultural buildings of more modest farmsteads. These are factors affecting recognition, but in addition, economic considerations might dictate closer care of what were possibly the farmer's most valuable asset, the draught animals.

This section considers a few sites which have fairly convincing structural evidence for cattle housing. It has two main aims. The first is to see which of the 'expected' evidence does occur, and if its contexts could be informative. The second is to consider the scale of the accommodation provided for livestock, and the allocation of space within the farmstead to the various domestic and agricultural purposes.

The 'longhouses' of late third to fourth century date at Studland replaced second century buildings, one also probably a longhouse, the other with a byre as an annexe. They each had two well defined stalls, their ends visible in the stone wall foundations and clear partitions dividing them (Field 1965, Figs.1,6). Other features noted were the churned dark earth floors and lack of finds in the byre area. The byres were not drained; the drains which were present were apparently to keep the doorways or living quarters dry (ibid,155,165). Each building had stalls for two animals, presumable a yoke of draught oxen. The space given to the livestock is easily equal to the living areas; one building had an additional forge or storeroom.

The fourth century building 'B' at Iwerne apparently has substantially more space allocated for agricultural than domestic activities. The 'long room' has a roughly central stone lined drain over two thirds of its length, and Hawkes identified it as a byre on this basis. The other end, with an in-situ quern and adjacent to a granary, was related to crop processing. There was no evidence for subdivision. There were two small living rooms (Hawkes 1947,58-9,Fig.10B). The byre area was 4.5m wide, possibly too narrow for two rows of stalled cattle at right angles to the walls, although two of the cattle buildings illustrated by Waterbolk (1975) are as narrow. If cattle were stalled or tethered along one wall, six or eight could be housed, with two more in the 'entrance hall'. Assuming the length of the drain defines a byre, the accommodation is assigned, roughly, one third each to domestic uses, cereal processing and storage, and animal housing.

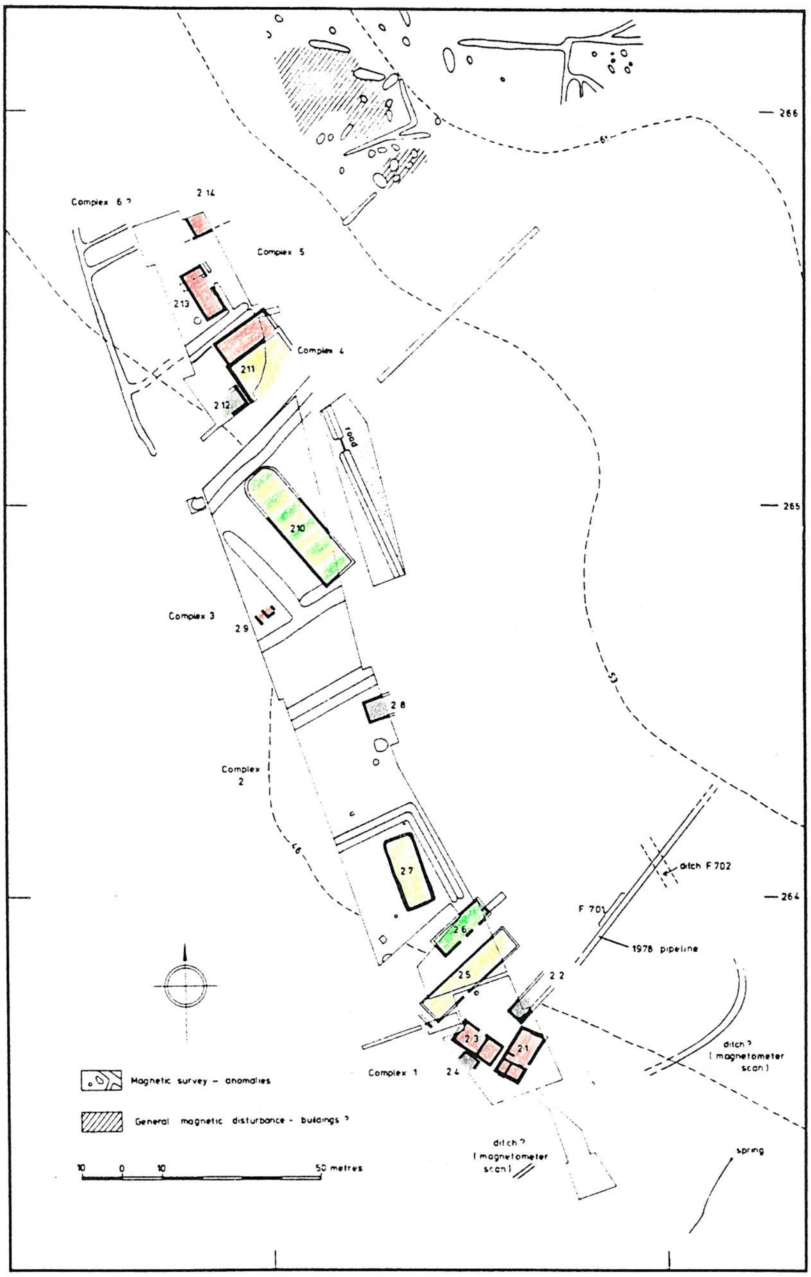
At Bradley Hill the fourth century settlement consisted of two houses and a "general-purpose farm building" (Leech 1981,). In its first phase, the west end of building 3 held vertical stone slabs suggesting stall divisions; in contrast to the rest of the building, this area was probably paved. There may have been a cistern at the end of the drain, which could have supplied water for stalled livestock. Leech infers that three or four animals could have been stalled (ibid,189), but only two stalls are clearly defined, and the area round the possible tank might have been kept clear for access. There is no indication of use for the rest of the building in the period 1, and in period 2 the stalls were not in use.

Leech suggested that, because the two dwellings were accompanied by only one agricultural building, the lack of structures associated with cereal processing and the limited evidence for stalling animals, the settlement might have been a subsidiary of a larger unit. It seems unwise to attach significance to the scarcity of stalling, given its general rarity. The small proportion of agricultural buildings might reflect the economy of the site; the animal bones were predominantly from sheep, their age structure suggesting wool was important. Some were described as waste from skin preparation. The site produced both spindle whorls and loom weights. Potter (1981,130) has suggested weaving was practised on relatively few Romano-British sites, as loom weights are uncommon finds. [There was nothing to suggest building 3 was used for housing sheep.] The economy may have been craft as well as farming based.

Leech has made a similar inference of dependency for the roadside agricultural settlement of Catsgore, principally because of the contrast between the small dwelling house and apparent lack of wealth of the inhabitants and the number and size of the agricultural buildings on some of the complexes. Some complexes lack farm buildings, and the corndriers were concentrated on only two of them (1982,36-9). It is necessary to separate two aspects of this argument. The apparent contrast between the evidence for productive agriculture and the poverty of the inhabitants might well, as Leech suggests, indicate that "the produce itself was redirected outside the settlement" (ibid,36). But this need not imply the five complexes did not form independent units in agricultural terms. The arguments about the provision of barns are not convincing; the complexes lacking agricultural buildings are also those for which excavation is less complete, and the suggestion that the provision on other complexes compensates for a possible lack of storage at the nearby villa does not explain why this arrangement, which would make supervision and control more difficult, should be used. There seems no reason why the crops stored on the complexes should not have been cultivated from them. Similarly, since none of the complexes had corndriers in period 2, their presence on only two in period 3 does not seem to require special explanation.

To examine the division of space between domestic and agricultural use, the functions inferred by Leech (1982,7-26) have been indicated on the plans for periods 2 (c.150/180 to early 4th century AD) and 3 (from early 4th century AD) (Figs. 5.1-2). The picture is incomplete, as some complexes are not fully excavated and some buildings lack evidence for their use. The ratio of dwellings to agricultural buildings is 14:12. Domestic buildings exceed agricultural on complexes 3 and 4 in period 3. These both have dual purpose domestic and shop/workshop buildings on the road frontage. Complex 3 shows a shift in location of the buildings towards the road between periods 2 and 3.

Figure 5.1. Functions of the buildings at Catsgore.
(i). c. 150/180 to the early fourth century AD.



Source: Leech 1982, Fig.4 and pages 7-26.

Key:

uncertain

agricultural,

except:

byre

* corndrier

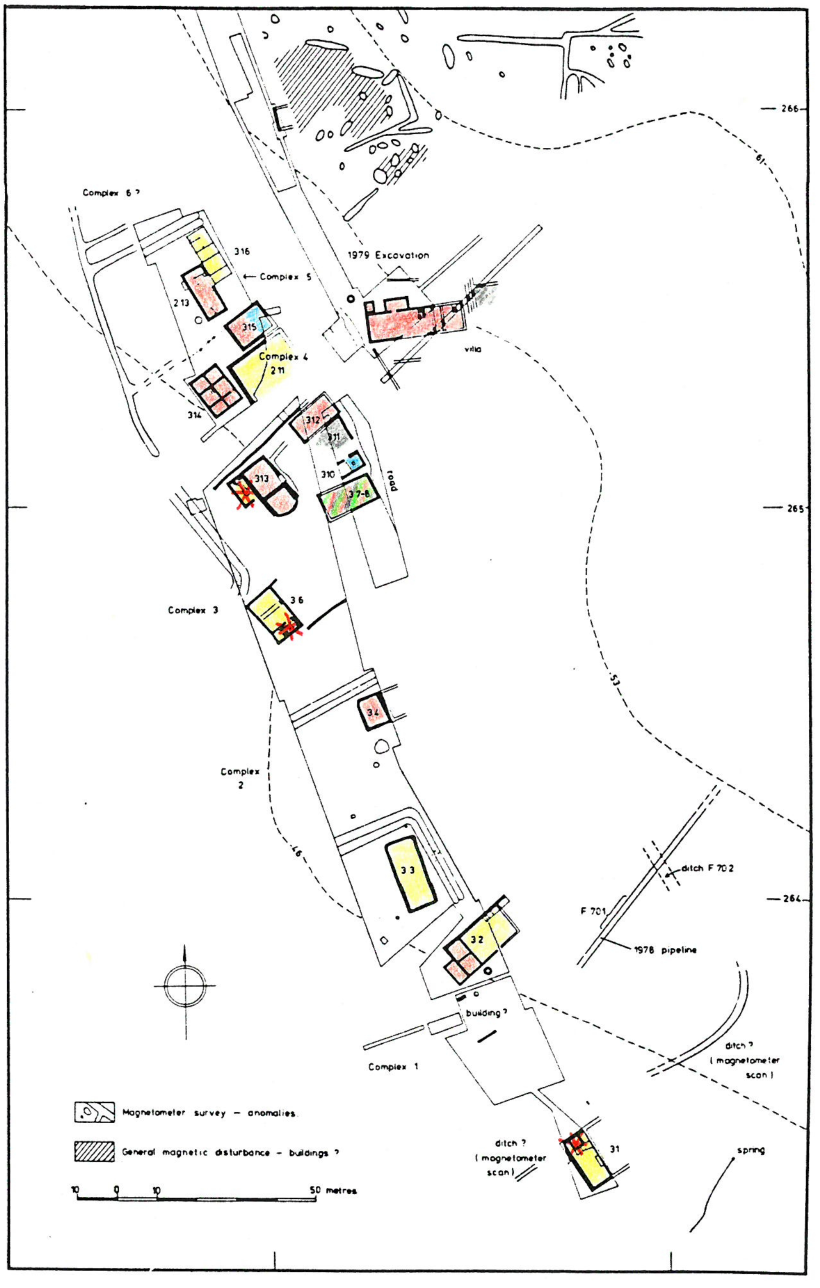
domestic.

shop or workshop.

successive uses or two possible uses.

dual use indicated.

Figure 5.2. Functions of the buildings at Catsgore. (ii). Early fourth century AD onwards.



Source: Leech 1982, Fig.5 and pages 7-26.

Key:
- uncertain
- agricultural, except:
  - byre
  - corndrier
- domestic.
- shop or workshop.
- successive uses or two possible uses.
- dual use indicated.

Table 5.3

Functions of the buildings of the Romano-British roadside agricultural settlement at Catsgore.

Period	Complex	Function A	B	C	D	E	Total	Ratio
2	1	2			3	2	7	2:3
	2					1	1	-
	3	1			1		2	1:1
	4		1			1	2	1:1
	5	2					2	2:0
	All	5	1	0	4	4	14	6:5
3	1		1		2		3	1:3
	2	1					1	1:0
	3	1	1	1	1	2	6	3:2
	4	1		1	1		3	2:1
	5	1			1		2	1:1
	All	4	2	2	5	2	15	8:7
2 and 3	All	9	3	3	9	6	29	14:12

Notes:

1. Functions: A domestic
   B domestic and agricultural
   C domestic and shop/workshop
   D agricultural
   E unknown
2. Ratio is domestic:agricultural buildings; buildings with dual functions are included in each category.
3. * indicates complexes/periods where evidence is particularly incomplete.

Source: Leech 1982, 7-26.

The ratios may reflect the importance of non-agricultural economic functions in these complexes in the fourth century. Complex 3 is perhaps odd in period 3 in having two corndriers and a granary but no barn. Given its shop frontage and the evidence for malting at this site (Hillman 1982) this may again reflect its economic base. On complex 1, agricultural buildings are in the majority in both period, though this may be exaggerated for period 3 by incomplete survival or excavation. It occupies a larger area than the others; in period 2 it had two dwellings and three agricultural buildings, two barns and a byre. It may have formed the nucleus of a substantial farm in both periods, this being reflected in the provision of agricultural buildings,though there is no evidence for the size of the land worked from any of the complexes.

Only period 2 of complex 1 produced strong evidence for cattle stalling. Building 2.6 was identified as a byre because of an elaborate system of drains, and stone-packed slots suggesting division into stalls (storage bins are another possibility). Two postholes could have supported a feeding rack (Leech 1982,10,12,53,Fig.40). Two stalls are inferred by Leech (ibid,Fig.7) with space for two more on the same basis. They were 2m wide; large enough for two animals in comparison with the stalls illustrated by Waterbolk (1975), but perhaps better interpreted as having held one draught animal each. The byre could therefore have held four or eight cattle, or more if the rest of the building was similarly used.

The large barn of period 2 on complex 3 may have had livestock accommodation at one end, and building 3.7/3.8 of period 3 of that complex may have been used as a byre for part of period 3. The evidence for both is simply the presence of drains in the buildings.

The identification of building 2.6 is plausible, although some confirmation such as phosphate analysis would be valuable. Assuming it was a byre, it is probably significant that even on a site where a structurally inferable byre type does exist, two possible further examples can only be tentatively identified, on the basis of a single criterion (drains) only. In addition, it appears that most of the complexes for most of the time lacked livestock housing, or at least, lacked housing of a type which has left recognisable traces.

Another site with a byre which has been excavated sufficiently to allow consideration of the space allocated to different purposes is the round at Trethurgy (Miles and Miles 1973). The site, occupied from the third century AD, consisted of buildings arranged inside and enclosure bank around a central cobbled area. The layout included four or five oval domestic buildings, three smaller storage buildings and and open air grinding area, and a four post structure, here interpreted as a watchtower. Provision for livestock took the form of a byre, about 15 by 7m internally, which could have held perhaps 20 to 30 head of cattle. The basis for identification was the absence of the internal features of the houses, such as drains (ibid,146).

Interpretation of the livestock provision would depend on the nature of the social unit occupying the site. If the settlement held four or five separate families, as Miles and Miles suggest, then the byre could house four to six animals per family. But it is not clear whether settlements like Trethurgy were occupied by several families or a single extended family (Fowler 1976,170) and there are some indications from the layout (presence of large and small houses, single grinding area and byre) that the latter explanation might be better. In this case the accommodation might suggest housing on a larger scale; for comparison, the mediaeval crew-yards at Goltho and Barton Blount probably held 14 cows or 12 draught oxen (Beresford 1975,18). But livestock housing was evidently not considered an essential at Trethurgy; the building went out of use as a byre, becoming a midden. The livestock were subsequently housed in rough open pens built against the inside of the rampart.

Byres and stalls have been recognised on a few other Romano-British rural settlements; the evidence is summarised by Morris (1979,40-9,120-6). The characteristics identifying them are not constant; drains are the most frequently cited, yet it was their absence which suggested interpretation as a byre at Trethurgy and at Studland they served to protect other areas rather than to drain the byre. Provision of byres is not universal; although recognition is clearly a problem, even on some sites where a byre 'type' is seen in one phase, none can be recognised in other phases. Although the possible permutations of animals into buildings is almost endless, the indications are that only small numbers were housed; there is no reason to consider this level of care was extended to other than a few valuable animals, presumably the draught oxen. Trethurgy may have been, for a time, an exception to this.

The proportion of all agricultural buildings to dwellings can be high, and a 1:1 ratio may be common. But the proportion of livestock space is rarely high; levels similar to the Cat's Water site are seen only at Studland and Iwerne, and the numbers of animals involved do not seem to be high. Bradley Hill and Catsgore suggest that variations in these proportions can be related to the economic base of the unit; and where settlement are fully excavated, assessment of these proportions may be informative.

The geographical spread, as with the Iron Age structural evidence, may reflect climatic conditions. But it may also reflect the use of stone in building, a factor which applies to pens and yards as much as buildings. While the pens at Barnsley Park and on the stone built rectilinear settlements of Romano-British Northumberland survive in recognisable form, a possible crew-yard from Werrington (second/third century AD) survives only as a shallow (10 to 20cm) depression about 20 by 25m set in an area of paddocks and enclosures (Mackreth and O'Neill 1980,23,Fig.13). Turf walling was used to enclose the mediaeval clayland crew-yards described by Beresford (1975,13-8); use of thick-cut turves to build cattle walls in Denmark is described by Lerche (1970,151). Pens in clay areas might be expected to have paved or cobbled floors; this is the case on clay soils in Northumberland, at Barnsley Park and in the mediaeval clayland examples cited.

The Northumberland rectilinear settlements form an interesting example, because they provide a highly recognisable and distinctive type. They are characterised by two depressed yards, paved or cobbled on clay soils, occupying the front third to half of the enclosure (Jobey 1960,4-8). The walls of the houses, yards and the enclosure itself are all stone-built. The settlement type, but constructed in timber, may have originated earlier, in the first century BC (Jobey 1978,27;1983,201).

While some evidence for housing livestock does occur, and its recognition may as suggested above relate to the scale of the agricultural unit, it seems clear that byre housing cannot have been general. The scale of provision suggests it was restricted to a few animals, presumably the draught animals or other valuable animals. Again it seems that it is in the evidence for enclosures and paddocks that the management of most of the farm livestock must be seen. Such management would protect land from trampling damage, and allow manure collection, but until pens and crewyards are regularly identified, assuming efficient manure production on the scale envisaged in some discussions seems unrealistic. Droveways, enclosures and subdivision of settlement enclosures (eg at Penrith, Higham and Jones 1983,52,Fig.2) are the basic structures of livestock management. Only a thorough review of the evidence for these, their chronology, development and relationships with the agricultural economy of individual sites could provide a basis for assessing the importance of the management of livestock to the arable economy in more precise terms.

5.4. Livestock management and the arable economy in later prehistoric and Roman Britain.

Buildings for housing livestock are sparse, although for both periods it seems clear that expectations about the form byres 'should' take are likely to be impeding recognition of buildings actually used for livestock. In the Iron Age the examples so far recognised are predominantly in the north and west. The round structures at Maxey and Fengate are exceptions to that, and it may be significant that these are associated with livestock based economies and not cereal cultivation .The needs of livestock husbandry and not a demand for arable inputs is the motivation.

In the later Iron Age, the provision of droveways and separate enclosures or paddocks suggest changes in livestock management. These could relate to either pastoral or arable elements in the agrarian economy, and could reflect more intensive production in both. The daily movement of cattle into enclosures would allow collection of manures. But it still implies that dung was simply collected from the enclosures, perhaps augmented by litter spread in sheltered corners where livestock gather. This is not the intensive manure production achievable in pens or yards and cattle sheds. It is perhaps a reintroduction of the Bronze Age practice of moving animals to byres or pens in the settlements daily (see discussion in Chapter 7).

In Roman Britain there is still surprisingly little evidence for a recurrent byre type. On villas, some livestock was probably housed in aisled and other rectangular buildings, often situated in outer yards or among enclosures around the main buildings, but the scale of this provision seems to imply only draught oxen and other valuable animals, perhaps especially horses, were treated in this way. Use of stalling may have been seasonal, allowing the buildings to be used for cereal processing and similar activities over the summer. Though wider examination of villa surroundings should recover more agricultural buildings and techniques such as phosphate analysis should reveal if there was livestock use, it seems unlikely this basic picture will change. Though there is a tendency for insubstantial and poorly defined structures to be suggested as livestock buildings, in practice livestock buildings must be fairly sturdy to withstand the pressure of the animals. Insubstantial surviving traces need not imply insubstantial buildings; walling materials such as turf earth and cob might have been used. Buildings capable of overwintering large number of cattle must have been sizeable and strong, and some recognition would have been expected.

The recognition on other rural settlements probably reflects their different scale, such as the need for subdivision in shared-use buildings. Unless there is regular failure to recognise byres and cowsheds, they are still clearly not generally provided; Catsgore illustrates this. But the bias due to building in stone may be an important factor influencing the distribution as seen.

The use of enclosures, perhaps with provision of shelter and litter spreading, could have allowed manure collection compatible with the scale of manuring recognised in Roman Britain from the evidence of sherd scatters. However the present evidence does not seem to allow the intensive production of manures by large scale winter housing of livestock, as assumed for instance in the Gatcombe model. But the extensive housing of livestock is not a feature in the Roman documentary sources; and it therefore should not be assumed the Romans were likely to introduce it here. The very emphasis by Columella and Pliny on manure production and collection, and use of a range of other collected materials and refuse to supplement it may reflect an inability to use large scale housing of animals for manure production, or at least to suggest such a practice was uneconomic. The Roman agronomists did evaluate costs of their farming methods, especially in terms of labour inputs and the likely returns (Varro I.LIII; Pliny Natural History XVIII.VI.30). Pliny noted that "Good farming is essential but superlative farming spells ruin" (ibid,XVIII.VII.38). Of course the practice could have developed in Roman (or pre-Roman) Britain - there is no reason why not, especially given White's comments that most of the innovations in agricultural technology of the Roman Empire originated not in Italy but in the northern provinces (1970b,xx). But this would need to be demonstrated, and so far there seems to be no evidence sufficient to do so. This, as noted in Chapter 2, has implications for estimates of agricultural productivity.

Chapter 6.
Fertility maintenance.

6.1 Introduction.

Fertility maintenance practices form a particularly important element in describing agricultural systems and in examining change in them. In addition to the discussion here, it forms an important theme in Chapter 2, discussing estimates of agricultural productivity; Chapter 4.4, discussing small-seeded legumes as crops or weeds and the nutrient levels of Iron Age and Roman fields; and Chapter 5, discussing livestock penning and housing.

Fertility maintenance is a key determinant of the productivity of agriculture. The extent to which the productive potential of land is realised depends on the prevention of damage or degradation and the replacement of removed nutrients and organic material, the two elements of fertility maintenance. Productivity is not a simple outcome of the quality of the land and the crops cultivated. The frequency of cropping and yield levels which can be achieved depend on the quality of the soil being preserved. Fertility maintenance imposes constraints and costs. Preventive measures limit the frequency of cropping, the ploughing season, and the time for which livestock (especially cattle) can be pastured or penned on land which is to be cultivated. The labour and resources put into fertility maintenance can be a major part of the total 'costs' of agriculture.

Change in an agricultural system may have substantial fertility implications. Some developments may not be sustainable without corresponding changes in fertility maintenance practices. An aspect of the Boserup model of agricultural intensification which is often overlooked is the availability of artificial fertilisers which it assumes (1965,112-5).

Where a change places increased demands on the land, the key question is how it was to be sustained. If it is assumed that at least the most immediate detrimental effects of overcultivation and overstocking were recognised, it would seem unlikely that these would be risked without cause. Yet in the longer term more gradual cumulative effects of agriculture might result in serious loss of fertility; Cunliffe, for example, suggests that this, coupled with population growth, was an important factor in social change in the middle and late Iron Age of southern England (1984b,31-2,36). An evaluation of the methods used to safeguard the fertility of the soil and their effectiveness should help to assess this question.

Pressures arising from increasing fertility maintenance needs tend to lead to increasing integration and interdependence of the elements of agricultural systems. The obvious examples are the dependence of cultivation on animal manures, and of livestock on cereal by products. This leads to an increased need for activities to be interleaved both spatially (i.e. in terms of the successive uses of the same piece of land) and temporally (especially in the organisation of seasonal labour intensive activities). The activities are not independent, an important factor in considering the causes and consequences of change. For example, increasing the area used for cereal production may decrease the land available for livestock grazing or fodder; the corresponding drop in availability of manures may depress yields and negate the gains from the increased acreage. This integration of elements may be an important indicator of the adoption of systematic manuring practices, where for instance developments in the management of livestock to facilitate the collection of manures relate to the intensity of arable exploitation. It is by integrating these elements that the functioning of the agricultural system can be understood and the significance of changes in it can be evaluated.

Understanding the relationship between a 'site' (occupation area and its recognisable fields and enclosures) and its surroundings depends on assessing the importance of the transfer and concentration of nutrients and organic matter on to the arable from a wider hinterland. This nutrient transfer is a crucial element in the agricultural system; it is described by Christiansen (1978) and Rasmussen (1979). It is essential unless fertility is maintained solely by fallowing or manuring using livestock whose fodder and litter derives entirely from the arable fields, or where seasonal flooding provides waterborne nutrients. Livestock form the prime means of transfer. Animals may be grazed on pasture and folded or penned overnight for direct fertilisation or manure collection. The use of vegetation collected from outside the cultivated area for livestock fodder or litter, in the production of manures and composts, or for burning on the fields also represents a nutrient transfer.

The need for these transfers imposes constraints on the expansion of the cultivated area (the area acting as a 'fertility reservoir', such as unimproved grassland or woodland, cannot be reduced beyond a certain limit), and on the intensity of arable production, as the quantity of material transferred must be limited to allow regeneration within the 'fertility reservoir'. Further expansion would require "a restructuring of the system", with the introduction of new practices which are likely to result in changes in the spatial layout of land use (Widgren 1983, 82-4). An understanding of fertility needs should therefore be an essential part of interpreting landscapes.

Fertility control may be a major factor in the development of field systems. A number of definitions of fields in terms of their function are possible; one which seems particularly likely to be useful is to define a field system as a framework for regulating fertility by controlling cropping, grazing and fertility maintenance practices. The suggestion that "celtic fields" represent areas on which sheep might be folded has been made by Fowler (1983,170), and field boundaries can also play a direct role in maintaining fertility - for example by reducing soil erosion or controlling water run-off. However the point is more fundamental than that. Fields form a framework for regulating long term processes as well as boundaries for short term needs.

It is suggested that fertility maintenance provides a key to understanding how agriculture was organised to link the various elements of crop and livestock husbandry into a unified productive system. It is an important consideration in assessing the productivity of agriculture, and the causes and effects of change. The ability to sustain levels of productivity relates to the organisation as well as the practice of agriculture, and hence the needs of fertility maintenance have implications for social and economic as well as agricultural change.

The following section reviews some of the evidence for fertility maintenance practices. It stresses the problems with the evidence - in particular, with dating and with assessing the importance of manuring in the agricultural regime.

6.2. Evidence for activities directly relating to fertility maintenance.

This section deals with practices which modify soil characteristics to maintain, restore or enhance soil fertility. Fertility depends on four factors: nutrients, reaction, cleanness and soil structure. A wide range of historical and traditional practices for maintaining or enhancing soil fertility are known.

The surviving Roman texts on agriculture show that their writers considered that manuring was an important part of agricultural practice, although it is clear from Columella's Preface (1-3,12) not only that he felt it was often neglected, but that he was countering an opposing view, that yields declined because the earth was growing old. Columella (II.XIV.6-7,9) recognised the different needs of different soils and crops, including meadow grass. Manuring involved high labour inputs, and obtaining sufficient manure was sometimes difficult. However it was "the mark of a slothful husbandsman to be destitute of fertilizer" - even road sweepings and weeds from waste ground could be utilised in need. More routinely recommended were animal excreta, old oil lees, ashes, and cut lupine plants, ie, a cultivated green manure. The practices of marling and of folding livestock on the arable are also described (Pliny _Natural History_ XVII.VI; Cato _De agri cultura_ XXX), and a range of cautions stress the need to avoid damage by means of adequate drainage, only ploughing when conditions were right, and avoiding trampling by livestock (eg. Columella, II.II.9;II.IV.5-8).

It cannot be assumed that these techniques were known and used in Britain; in any case, many of the details are inappropriate because of differences of soil and climate. But these accounts are of value as descriptions of manuring practice in an agriculture system with a simple technology.

The comments on prevention of damage are interesting; it could be argued this is agriculturally the most important and archaeologically the least accessible aspect of fertility maintenance. While the consequences of failure in this respect may be recognisable, in for example environmental degradation, success will not be demonstrable. A wide range of practices can minimise the effects of cultivation on the soil. These include crop rotations to balance the nutrient demands made on the soil, use of fallow periods, and organising cultivation to minimise the vulnerability of the soil to erosion.

Two important aspects of this are the need to avoid causing structural damage to the soil (by ploughing only when conditions are suitable and preventing heavy trampling by animals) and minimising weed fouling. The limits on the ploughing season are generally accepted and taken into account in reconstructions of agricultural productivity (e.g. Barker and Webley 1977,199). They are more severe for heavy clay soils than for lighter soils (Robinson 1979,119). Other factors receive less attention. In particular, when grazing of fallow land is an element in a model of agricultural productivity, the limits imposed by the need to avoid damage to soil structure due to poaching of the ground by trampling livestock (especially cattle) and the potential value of bare fallow in weed control must be balanced against the benefits deriving from grazing the land [see discussion of estimates derived by Mercer (1981) in Chapter 2 below].

6.2.1. The use of animal manures.

The most frequently recorded indicators of manuring in British prehistory are scatters of pottery and other domestic refuse; the inference that these represent the less destructible elements of a mixture of dung and domestic refuse spread over cultivated fields was first drawn by Rhodes (1950,14) from his work on Berkshire field systems. The analysis of such scatters has the potential to define and date areas of intensive agricultural exploitation. Widgren, working on the Swedish Iron Age

(100BC - AD600), was able to show the coincidence of traces of early cultivation (field walls etc.), scatters of small and abraded potsherds, and above average soil phosphate levels (1983,45-6,70-2), a valuable confirmation of this interpretation of the refuse scatters. Wilkinson (1982) was able to relate the extent of manured land around the site of Siraf (Iran) to surviving field boundaries, and to distinguish a zone of manured agriculture close to the settlement from a wider zone of less intensive exploitation. He compared this to some contemporary systems in Turkey (Hillman 1973,219-220).

Unfortunately the method of using surface scatters of pottery to recognise land use zone seems unlikely to be applicable to later prehistoric Britain, where there are a number of problems in evaluating this type of evidence.

Most prehistoric sherds are rapidly degraded in ploughsoils, and differences in survival between sherds of different periods and fabrics mean comparisons are of dubious validity. Rhodes, for example, noted that if Roman sherds occurred at all in the fields examined, they were usually plentiful (1950,14), and this contrast between finds of prehistoric and Roman pottery is confirmed by recent survey results from the same area (Richards 1978, Tables 4,5,9). But there seems no grounds for relating this to manuring differences - variation in survival would mask any underlying differences. While Roman sites are often recognisable by scatters of pottery and tile, and earlier prehistoric sites can be located from flint scatters, identification of Iron Age sites from surface indications is particularly difficult. Where Iron Age pottery has been recovered, it has often been abraded so as to be almost unidentifiable (eg Bedwin 1978,49). The differential survival of Iron Age and Roman pottery was demonstrated at Maxey, with survival rates of Iron Age material seen to be very poor in the topsoil (Pryor _et al_

1985,46). Experimental work (eg. Swain 1988) is also beginning to provide information about these differences. Where Iron Age sherds have been recognised in field survey, they are likely to derive from recent disturbance of occupation sites by ploughing rather than from prehistoric manuring (Shennan 1981,115).

Material recovered from buried ploughsoils demonstrates that sherds were rapidly degraded during cultivation. In two cases sherds have been recovered from under banks beside ditches apparently cutting through lynchetted fields (in neither has this relationship been confirmed by excavation). At Knoll Down, the buried ploughsoil contained "6 very small sherds", four of which were "indeterminate" and two possibly Beaker (Bowen and Evans 1978,149). At Lycombe, the buried soil contained "many very small fragments of charcoal and pottery, few large enough to recover". The sherds, mostly less than one square centimetre in area, were described as "almost certainly Bronze Age" (Wacher 1978b,36,40-1). It is difficult to place much confidence in these dates; the problems in identifying and dating prehistoric sherds from ploughed soils may be a reason for the wide date range 'post-Beaker but pre-Roman' which often seems to attach to elements of agricultural landscapes. However, at Gwithian, the contrast between the ploughsoils of two fields sealed by wind-blown sand allowed the conclusion that one, but not the other, had been treated with manure containing domestic refuse. The charcoal, bone, shell and pottery were "all finely comminuted and worn", and this was "particularly marked with the pot-sherds" (Megaw et al, 1961,210). Manuring is also attested at Houseledge, where sherd, flints and charcoal were found in the ploughsoils of the rectilinear fields of the second millenium BC settlement at Houseledge (Burgess 1984,151-3).

Only sherds which were rapidly buried or incorporated into a field boundary such as a ditch or lynchet are likely to survive in a state allowing their recovery and firm identification, but there are a number of difficulties in interpreting material recovered from such contexts. In contrast with continental north-west Europe, field systems in Britain have been examined mostly using non-excavational methods. Most excavations of field systems have been limited to a few lynchet sections close to occupation sites. A few projects have attempted to examine a wider landscape, as at Bullock Down (Drewett 1982) and Fyfield and Overton Downs; the latter is however still largely unpublished, and the location of the lynchet sections was biased towards suspected settlements. Because of this, there is no basis for assessing, for example, differences in the artifacts from lynchets in relation to their distance from domestic occupation areas.

Surface examination of lynchets can be misleading. Rhodes (1950,) noted how the accumulation caused by Romano-British cultivation at Streatley Warren (Mills 1949) entirely masked the Iron Age sherds in the lower levels of the lynchet. Differential survival of pottery also affects its likelihood of incorporation within lynchets.

The way in which lynchet deposits are formed also makes their dating particularly complex. For example, at Fyfield Down, a lynchet section produced pottery dating from the Neolithic to the late Roman period, "generally stratified in chronological order". But the origin of the lynchet was clearly dated to no earlier than the early Iron Age (Bowen and Fowler 1962,105). The dating of the lynchet at Bishopstone, which originated in the neolithic, is discussed in Chapter 7.

This problem is caused by the ploughing responsible for the lynchet formation disturbing earlier occupation deposits lying within the cultivated area. Material from these is incorporated into the lynchet, suggesting a falsely early date. This is particularly likely to mislead where the cultivation did not involve use of manures incorporating domestic refuse, with the result that material contemporary with the cultivation is absent from the lynchet. Ploughing will also mix material from different manuring episodes; and there is even the possibility of reuse of earlier occupation deposits as manures, a problem encountered by Wilkinson (1982) in Syria.

Drewett (1982,208-210) concluded that the primary level in lynchets will often contain residual settlement material rather than artifacts deriving from contemporary manuring. This is based on the assumption that manuring will have occurred only when a decline in fertility was noted. But whether manuring was a response to falling yields rather than a regular part of farming practice is surely a question to be investigated rather than an assumption to be made. Drewett also suggests that primary lynchet levels may derive from soils which were fertile as they had not previously or recently been cultivated. This clearly accords with Fowler's model of 'celtic field' layout in terms of initial clearance (1983,Fig.42). However, extensive and regular field systems may represent reorganisation of existing cultivated land. This is seen at Overton Down, where a curving lynchet, following the line of a ditch apparently bounding an earlier settlement, overlay earlier ploughmarks (Fowler 1967,17). "Celtic fields" in the Netherlands have been shown to replace irregular plots and trackways, with pollen analyses suggesting continuity between the two systems (Brongers 1976,56-7). Fertility maintenance considerations may be important in reorganisations of land use, fields providing a framework for regulation of fertility and possibly limiting erosion.

Reliable assessment of the extent of manuring practices will require more that the one or two short lynchet sections usually available. It is necessary to establish the source of material, whether from disturbed earlier occupation, a spread of manure, or direct rubbish dumping onto field or bank. Dating the formation of a lynchet depends on having either a terminus post quem provided by a datable initial boundary layout or a sufficiently large number of datable artifacts to allow statistical treatment. But perhaps the most intractable problem with the identification of manuring from lynchet material is that because artifacts in the accumulated soil are almost always the dating evidence for the lynchet, there is a weakness in the argument which can imply that any dated period of lynchet formation will produce evidence of manuring.

Field ditches can also incorporate domestic refuse derived from manuring. Here the dating problem is that if ditches are cleaned out, only the material most recently incorporated into the fill may remain. Regular cleaning is less detectable than spasmodic recutting, which may leave pockets of older fills. Deciding when a series of ditches was first used is therefore difficult (Hinchliffe and Thomas 1980,65). At North Bersted, only one of the ditches excavated had pottery of the two phases of late Iron Age occupation stratified in chronological order (Bedwin and Pitts 1978,310).

Material in ditch silts can only be taken to derive from manuring when other sources, such as adjacent contemporary or earlier settlement sites, can be excluded. Deliberately dumped material may be recognisable by its occurrence as a distinct layer in the fill, or by the presence of large unabraded sherds (Hinchliffe and Thomas 1980,64; Bedwin and Pitts 1978,310). Bedwin and Pitts suggest that the mixture of pottery of different dates in ditch fills may result from ditches being filled by having the banks levelled into them when the banks had been used for dumping. But repeated clearance and silting of ditches would have a similar effect.

Drainage ditches were probably subject to both rapid infill (due to cultivation) and routine cleaning, while ditches which functioned as simple boundaries or quarries for banks may have been allowed to silt up without interruption. Interpretation and dating of ditch fills must therefore involve explicit consideration of their uses and maintenance. The importance of drainage in soil fertility is discussed later in this chapter.

By their nature, fertilisers break down in the soil to release nutrients, and the things which survive are usually those only incidentally incorporated into the manures. Buried ploughsoils can contain more durable organic materials such as bone, shell, ashes and charcoal which may have been significant components of the original manure. Domestic refuse is likely to have been mixed with animal manures and plant materials, but the refuse scatter cannot indicate what the bulk of the material spread consisted of, or the quality of the manure.

Recognition of manuring depends on these 'markers', but it is not inevitable that they end up on dungheaps. In the mediaeval period, in some places domestic rubbish seems to have been dumped in rubbish heaps and cesspits and not mixed with manures (Fowler et al 1965,67; Austin 1976,81), while some mediaeval pottery scatters do seem to be the result of manuring (Richards 1978,80). Fowler comments that "the sheer quantity" of rubbish dumped into Iron Age pits is surprising if domestic refuse was regularly and intentionally used in manures (1983,169-170).

Where livestock was enclosed overnight within settlements, a single midden for dung and domestic refuse would be expected. But where livestock was kept in separate pens or enclosures, mixing would require a decision to use the domestic rubbish to augment the dung. In that case, a shortage of manures might be implied (cf. Columella II.XIV). The absence of a refuse scatter cannot be taken to imply there was no manuring, and other evidence, such as for livestock housing or dung heaps, must be taken into account. Penning livestock directly onto the arable would also leave no 'markers'.

Evidence that material was removed from settlement sites can also suggest manuring. Burstow and Holleyman (1957,199-200) argued from the number of different vessels recognisable that about 80 per cent of the pottery (by weight) had been removed from the settlement at Itford Hill, and that manuring was the likely explanation for this. Although sherds from one of the incomplete pots found on the settlement site were subsequently found in a nearby barrow (Holden 1972,110) showing that manuring is not the sole reason for the discrepancy, examination of valley sediments in Itford Bottom by Bell supports this interpretation. Bronze Age sherds were found concentrated in the colluvium; this both probably identifies the area of cultivation associated with the Bronze Age settlement, and demonstrates that it preceded the lynchet formation, as the colluvium was partially overlain by the excavated lynchet (Bell 1983,135-140).

Manuring scatters can also contain material unlikely to have originated in the immediate area, suggesting that manure was transported some distance. The best example seems to be of Roman roofing tile, found distant from any known substantial building of the period, as at Frost Hill (Bullock Down). Drewett suggested this indicated transport of manure from the villa at Eastbourne (1982,213). This is plausible, although there are other explanations. Suggestions that "foreign stones" (Drewett 1970,55), found in prehistoric and Roman ploughsoils, indicate transfers of manure are less convincing, because there is no information on 'background level' of occurrence of these stones. Such non-local stones are not uncommon on Downland sites (Fowler 1965,50-1).

Most of the examples discussed are from southern England; it is not clear to what extent this is due to the greater amount of survey work from the south, and to factors such as differences in pottery use and soil types, the latter having a major effect on the survival of pottery. But the Houseledge evidence shows manuring was practised in Northumberland during the Bronze Age. For the later Iron Age and the Romano-British period, there are field boundaries incorporating pot sherds from at least as far north as Yorkshire (Raistrick 1938, Close et al 1975), and Fowler (1983,157) notes Romano-British sherds from field systems in Caernarvonshire.

There seems no reason to doubt that many sherds in buried soils and lynchets are the result of manuring. But, particularly because of lynchet formation processes, in many cases the interpretation will be uncertain. Occupation debris from the buried neolithic ploughsoil at South Street (potsherds were "noticeably sparse") (Ashbee et al 1979,283), and the neolithic material in the dip of the negative lynchet at Bishopstone (Bell 1977; Allen 1982) both represent incorporation of material into ploughsoils contemporary with their use, but in neither case is it possible to be confident this is the result of manuring. Fowler (1983,169) suggests while the first strong evidence derives from Middle Bronze Age sites such as Itford Hill and Gwithian, the occurrence of Beaker sherds in ploughsoils is sufficiently frequent to suggest manuring. The ploughsoil of Beaker date at South Street (Ashbee _et al_ 1979,273,289) produced a number of sherds from only three vessels. The sherds are small, but the report does not suggest they were particularly abraded; the contrast with the comminuted and unrelated sherds from Gwithian (Megaw _et al_ 1961,210) is marked, and may argue against manuring. Fowler concludes that manuring was a "regular operation" from the later second millenium onwards (1983,169). This he sees as part of a "phase of consolidation or ... adjustment to a new situation", following the layout of the axial field systems during the period 2000 to 1400 BC (ibid,207). This interpretation depends heavily on both the early date for the axial field systems and the change from arable farming to stock rearing inferred from the 'linear ditches' or 'ranch boundaries', said to cut through axial field systems during the second half of the second millenium BC (ibid 207,190-2). The dating of the field systems and their relationship with linear ditches are here regarded as doubtful (see Chapter 7).

With careful assessment of its source, material from surface scatters or incorporated into boundaries may allow the practice of manuring to be fairly confidently inferred. But this evidence does not allow the frequency or heaviness of manuring to be inferred. The fact that manuring can be recognised tends to obscure important distinctions, relating to the frequency, heaviness and reasons for manuring. The dumping of any rubbish and dung handy onto the fields when newly cleared or as yields are seen to fall is significantly different from the deliberate collection of manures to spread regularly on the fields as a part of the agricultural routine; and to assume that any evidence for spreading domestic refuse implies "a regular practice" (Fowler 1983,169) overlooks the importance of these differences. Accumulating manures in the quantities (see Chapter 2) needed to boost fertility almost certainly carries implications for livestock management, such as bedding overnight or for the winter on litter to absorb the wastes efficiently. It carries implications for the use and organisation of labour, if manure is to be spread as an additional part of the ploughing season (manure should be ploughed in rapidly once spread to avoid losses). As with the use of scythes, effective manuring is part of a 'package' of practices.

Inferring the intensity of manuring from the kinds of evidence discussed in this section is unlikely to be possible. The composition of manures must be assumed to have been highly variable in its content of domestic refuse; it is likely that the better quality manures had the lowest proportion of domestic refuse in them. The additional factors of soil conditions, subsequent land use and pottery fabric variation add to the difficulties. A straightforward correlation between artifacts recovered and manures spread is an unrealistic expectation. For a small area and limited time span, attempts to define areas of different cultivation intensity might succeed, but since surface scatters are unlikely to be an adequate source of information for any pre-Roman context, collecting the necessary data would require numerous lynchet sections or excavations of preserved ploughsoils. Where occupation of a known settlement persisted throughout the period of land use, the approach could be productive. But the often noted absence of settlements associated with "celtic fields" would make interpretation of any recognised patterns difficult. It is suggested below (Chapter 7) that this may be due to relatively impermanent dwellings shifting around within the field system; this implies that excluding abandoned occupation areas as the source of the refuse would be difficult without substantial excavations. In addition, land use theory implies that shifts in the location of settlement would be reflected in the spatial pattern of intensity of land use.

The suggestion is therefore that while manuring may be inferred, with caution, from the recognition of domestic refuse in buried ploughsoils, ditch fills or lynchets, an assessment of the importance and organisation of manuring will require other evidence.

6.2.2. The accumulation and storage of manures.

The 'package' of practices implied by effective manuring includes its accumulation and storage. Evidence for these activities can both complement the evidence described above, and allow some inferences about the significance of manuring in the agricultural routine. The relationship with livestock management is crucial; good farmyard manure is not simply collected dung. The evidence relating to housing and penning livestock is discussed in Chapter 5 above; and estimates of manuring rates and their implications, especially in respect of livestock management, are critically examined in Chapter 8. This section is concerned with the recognition of dung heaps.

Where manuring is an important component of the functioning of an agricultural system, the collection and storage of manures can be a labour intensive and meticulous process. An example is provided by King's first hand account (1927) of the traditional agriculture of China, Japan and Korea during the first decade of this century. The careful preparation and storage of manures also is described by the Roman agronomists (eg Varro I,XIII; Pliny XVII,VIII; Columella II,XV).

Storage of manures in pits has been suggested on a number of Iron Age sites. At Barley, a number of "shallow irregular pits", a few having a "skin of dark brown material on the floor and sides" were interpreted as manure stores. Unlike the more substantial storage pits, their fills did not include chalk rubble. The pits date from the second century BC to the first century AD. The existence of a midden, from which the pits were filled, was inferred from the distribution of pottery ("it was noticeable that the sherds of one pot often came from more than one pit") and the complete but partially disarticulated skeleton of a dog from one pit (Cra'ster 1961,30-1). This pattern of potsherd location is certainly not universal on late Iron Age sites; at Tollard Royal (early first century AD) attempts to establish the relative dating of pits failed because only one vessel was represented as sherds found in more than one pit (Wainwright 1968,117). Another contrast between these sites is that while at Barley several complete pots could be reconstructed, at Tollard Royal "a large number are represented by only a few sherds". As at Itford Hill, because of "the completeness of the excavation", this was interpreted as the result of manuring with domestic refuse (ibid,120). Wainwright also suggests pits might have been used to store manure, but with no direct evidence for this. Caution is needed in relating middens to manuring - clearly the midden material at Barley was not all spread on the fields. It is not clear why pits should be preferred for manure storage; a heap, perhaps enclosed by turves or hurdles, would be more easily shifted. The Roman agronomists recommend pits, but the problems experienced in Roman Italy differ from those in Britain; while the Roman writers recommend ways to keep the manure from drying out, British farmyard manure, according to McConnell (1883,65), is 50% rainwater.

Dix (1981,24) has suggested that at Odell, ditches were deliberately filled with domestic and farmyard refuse, which was later cleaned out and used as manure.

This is not convincing. Manure would rot more efficiently in heaps where heat can build up than in ditches. The view that because the subsoil is gravel the ditches were not for drainage is doubtful, and the frequency of recutting probably reflects the ditches' importance as drains. Rubbish filled ditch silts might well be spread as fertiliser, but that does not imply they were deliberately allowed to accumulate for this purpose.

A possible dung heap of the second century AD was identified at the Cat's Water site, Fengate (Pryor and Cranstone 1978,25-6). The site consisted of two ditched enclosures with a number of small roughly rectangular "yards" at one end. There was no structural evidence for habitation and few finds, except for a concentration of potsherds (of the second century AD) in a highly organic layer in the ditches of one of the "yards". The site was interpreted as stockyards containing a manure heap to which domestic refuse was transported. Similarly, at Frost Hill, Drewett has suggested that because of the absence of other evidence for habitation, the domestic debris may derive from "temporary manure dumps" in what was simply a farmyard (1982,213). Pryor _et al_ have identified a possible midden site, and evidence for a restricted area of manuring, at Maxey (1985,47,50,53,Fig.30). The ditches of the midden yard, produced smaller pots sherds and a higher proportion of harder fabrics than other gullies; phosphate levels in the yard ditches were variable, and in some cases high.

Insect remains are also potential indicators of manure heaps. Based on work in the Upper Thames Valley, Robinson (1981,279-282) has defined 10 ecological groupings of coleoptera. The two dung beetle groups (dung/pasture and dung/foul organic material) are not entirely distinct; beetles which breed only in field dung are attracted to manure heaps, and the typical manure heap species can also be found in dung. But some species do seem to be largely confined to either field dung or foul and decaying vegetation (Lambrick and Robinson 1979,117-8). Robinson's summary of the evidence from this area shows that beetles characteristic of manure heaps and decaying vegetation, and domestic refuse comprised between 9.0 and 15.4% of the terrestrial beetles from the two Iron Age and three Romano-British sites. However, he did not discuss intra-site variation, and the data indicates a general presence of manure and other rubbish rather than specifically identifying manure heaps.

Phosphate analysis is another technique which could suggest the existence of manure heaps (see comments on Maxey above). Its use in recognising livestock housing is discussed in Chapter 5. It is interesting to note the contrast between the relatively high phosphate levels on the droveway surface at Newark Road, Fengate (part of a group of Bronze Age fields interpreted as pastoral in use) and the result from the deserted mediaeval village of Low Buston where it was suggested that the absence of high phosphate levels in the roadway might reflect "regular scouring to remove manure" (Craddock 1980,214; Alexander and Roberts 1978,113).

In view of the widespread evidence for some level of manuring represented by the refuse scatters discussed above, there is perhaps surprisingly little evidence for manure heaps. But once the manures were removed and spread, dung heaps would leave little or no trace, and would be especially likely to escape recognition if they were outside the main occupation area, in the corner of a field for instance. If domestic refuse was not incorporated, identification would depend on techniques such as phosphate or beetle analysis. Despite the limited evidence at present, it is clear that there is a range of techniques and sources of evidence with the potential to allow the former presence of manure heaps to be inferred, particularly if they can complement each other. It is likely that attempts to identify the accumulation and storage of manures could be more informative on the extent of manuring and its importance in the agricultural regime than sherd scatters and lynchet sections. But this will depend on the problem receiving attention, with odd 'empty' corners of enclosures, areas of disturbed subsoil, and concentrations of domestic refuse in fields and enclosures being examined with this problem in mind.

At present, the evidence from sites such as Cat's Water and Frost Hill, for farmyards with domestic refuse or concentrations of organic material preserved in ditches may suggest that Romano-British livestock management included systematic manure collection; but the interpretation of these sites depended on the apparent separation of domestic occupation from farmyard, and the movement of domestic rubbish. Sites where domestic and livestock activities were not separated would not be open to interpretation on this basis; for the Middle Iron Age house and compound groups at Farmoor, for example, it would be difficult to assert that the evidence for dung and decaying vegetation indicated manure heaps rather than livestock enclosure in close proximity to dwellings. Hence although manure collection can be inferred in this way once the domestic and agricultural activities are to some extent separated, it cannot be taken to be absent in contexts where that type of evidence does not exist.

Some evidence for penning and housing for livestock in Iron Age and Roman Britain is discussed in Chapter 5. As evidence from features such as pens, paddocks and subsidiary buildings begins to receive more attention than has been the case in the past, a clearer indication of the management and use of animal manures may emerge.

6.2.3. Other materials used to enhance fertility.

In addition to farmyard manures and domestic refuse, a variety of organic or mineral substances can be spread onto the land to enhance fertility, by adding nutrients, improving soil structure or modifying reaction. Marling has the rare distinction of being an agricultural technique with documentary evidence for its use in Britain in this period; Pliny, writing in the first century AD states it "brings wealth to the provinces of Gaul and Britain" (Natural History 17.4). He distinguishes a variety of types of marl, used on arable and pasture: "the stone is crushed on the land itself, and .... the fragments make the cornstalks difficult to cut" - a comment which implies the use of scythes. Chalk was used "chiefly in Britain", obtained "usually from pits made 100 feet deep, with a narrower mouth but with the shafts expanding on the interior, as is the practice in mines". The benefit from chalk marling "lasts for 80 years, and there is no case of anyone having scattered it on the same land twice in his lifetime".

Fowler (1983,170) suggests that much of the chalk removed in excavating Iron Age storage pits may have been used in this way, although the fill of pits often include chalk rubble, and removed chalk might equally have been used in constructing banks or mixed into cob and daub for building. Oliver and Applin suggested that some of the irregular shallow pits (dated to the third to first centuries BC) at Ructstalls Hill might be chalk quarries, for building or agricultural use (1978,88). It is difficult to see how these interpretations could be tested.

Stronger evidence for marling is provided by excavations on Bullock Down (site 16). One of a series of depressions visible around the edge of the capping of clay with flints overlying the chalk was found to be a pit. 6m in diameter and 1.25m deep. The primary fill was undated; higher layers include Romano-British pottery of the second and third (and possibly fourth) centuries, apparently deriving from a nearby lynchet. The location of these pits also supports their interpretation as marl pits, dug to obtain chalk to spread on clay fields. Similarly, it is the location of the Owslebury site at the junction of of two soil types which makes the interpretation of chalk quarries immediately outside its ditches as marl pits plausible (Collis 1970,248). None of the examples described above resembles Pliny's deep shafts, which sound more like flint mines. Possibly the use of chalk spoil from around earlier flint mines is implied.

The principle is to modify soils by adding materials with different characteristics; as Pliny describes it, adding sandy or "dry" marls to damp soils, and "greasy" marls to dry soils (Natural History 17.4.48). A variety of practices in addition to chalk marling were used in traditional British agriculture, using material dug from the subsoil or brought from elsewhere. These include adding sea sand with a high shell content to reduce acidity and improve workability of heavy clays (Lucas 1977) and digging clay from beneath Fenland peats to improve the peaty soils (Porter 1977,168-171). I have found no evidence suggesting these practices in the Iron Age and Romano-British period, unless the sea shells from Staple Howe (Brewster 1963,138) derive from the movement of sand. The site is 15 miles inland; some of the shells are water worn and from inedible species (seaweed, discussed below, is another possible explanation).

Silts from rivers and ditches are often high inorganic matter and nutrients, and can be used as fertilisers. There does not seem to be any evidence for their use in Britain, although where field ditches were cleaned out, silts presumably ended up on the field.

Fowler (1983,170) states that Brongers shows that river silts were spread on late prehistoric fields in the Netherlands, where the practice is recorded from the mediaeval period.

A corresponding variety of vegetable materials can also enhance the fertility of arable land, being either directly spread and ploughed in, or modified by composting, use as litter for livestock, or burning to obtain ash. Transfer can only be inferred when a local origin is unlikely. Seaweed is an obvious example, and Fowler (1983,157) suggests that the comminuted shells from the manured field at Gwithian are the result of seaweed manuring. The excavators regarded the shells as food refuse, and the report does not indicate whether they were food species (Megaw et al 1961,210). At Bishopstone, seashells, from small inedible species of the kind usually found attached to weed, were found throughout the lynchet deposit. The nature of the shells strongly supports their interpretation as the result of manuring; as accumulation of the lynchet, from the neolithic to the Roman period, is well dated, an early date for the origin of the practice seems established. In the Iron Age, seaweed may have been stored in pits; one produced bryozoans (sponge-like organisms which live on seaweed) (Bell 1977,70,263-4,287).

Two land plants with restricted soil preferences used in recent times in fertility maintenance are heather and bracken. Bracken spores have been recovered from the buried soils from neolithic barrows and other prehistoric sites on chalk; it has been suggested this represents the use of bracken for bedding and its subsequent use as manure (Dimbleby and Evans 1974,132). However the marked stratification of the bracken spores from the soil underlying the South Street barrow suggested that the bracken had been growing on the site. Bracken grows readily in calcareous woodland, which the environmental evidence indicates was the prevailing condition on the chalk during the neolithic; its modern absence from the chalk is due to land management (Dimbleby 1979,286-8).

Bracken fragments from Middle Iron Age ditches at Farmoor are unlikely to have been growing in the immediate area because of the soil conditions (Lambrick and Robinson 1979,116). Both these and bracken stems from an Iron Age ditch at Fisherwick (Smith 1979, 98) may derive from use as livestock litter. Pollen from the same ditch at Fisherwick included heather; although immediate conditions are unsuitable, Smith notes that heathland could have resulted from soil degradation on the slopes on the edge of the floodplain. Heather charcoal was recognised at the Romano-British farmstead at Elsted, where local conditions are unfavourable to the plant, and this may imply its use as a fuel (Rednap and Millett 1980). But pockets of atypical soils and vegetation occur in many areas, and it is difficult to exclude a local origin for pollen and spores. Hence it is probably only where plant remains are incorporated into occupation deposits that the use of bracken or heather can be inferred.

Bracken's uses are essentially as litter or bedding, while heather, cut as turves, has a wide range of uses, as fuel, building material and litter. The close relationship between these uses is stressed in Fenton's (1981) account of traditional manuring practices. Ashes and turves removed from buildings (often soot enriched) are incorporated into manures. There are a wide range of permutations of paring vegetation from arable or wasteland and using it in manures and composts or burning it on the field, and it seems unnecessary to attempt to describe them. But while positive archaeological identification of any one particular method is unlikely, the possibility of a fertility maintenance implication for such material in its initial or subsequent uses should be considered.

Burnt material is often observed in buried ploughsoils; where it accompanies other domestic refuse, this is probably its likeliest source. Paring and burning of vegetation in situ is apparently only of short-term value on marginal soils, such as occasional cultivation of the outfield in infield-outfield systems, or in bringing heathland or bog into cultivation for the first time (Lucas 1970). Burning material from elsewhere does of course represent a nutrient gain. Dung can also be used as a fuel; Pliny notes that in some parts of Italy farmers preferred to burn it and spread the ashes as fertiliser (Natural History 17.5.49). Vitrified cow-dung ash, possibly the result of using dung as fuel, was identified at an Iron Age site of Hawk's Hill (Evans and Tylecote 1967).

One well documented example of vegetation transfer is the plaggen (Germany) or essen (Netherlands) system which continued in use until the nineteenth century AD. The fertility of arable fields on poor sandy soils was maintained by the transfer of vegetation and soil from uncultivated heathland. Layers of sods were put into byres to absorb animal excreta; this formed high quality manure which improved soil structure and water retention. The area of arable which could be cultivated was closely related to the heathland available for turf paring and the meadows producing animal fodder (Brongers 1976,36) Behre (1976,222) linked the introduction of plaggen cultivation with settlement nucleation and intensive cultivation of autumn sown rye and others cereals, dated to around the tenth century AD. Brongers reviewed a number of available radiocarbon dates for es and plaggen soils, and concluded that the essen began not earlier than 650 AD, earlier dates relating to either pre-essen cultivation or to old charcoal or peat included in the sample dated (1976,71).

Brongers' concluded that the "celtic fields" of the Netherlands, dated to the period c.500 BC to 150 AD, must also have depended on humus replacement, as they were situated on the same poor soils. As they substantially pre-date the essen and there is no evidence for "intentional manuring" (presumably this implies no refuse scatters), he infers fertility depended on fallowing and controlled grazing. But in addition, he argued, "humic material was deliberately added". This can be by comparing the depth of soil eroded from the surface of the fields with the similar material accumulating in the banks; the quantity of material deposited exceeds that eroded. He concluded that the layout of "celtic fields" was more than a "parcelling method"; it represented a "fundamentally new agricultural technique" based on "multiple course rotation and humus transportation to ensure a lasting soil fertility in a more or less limited area" (1976,60-2).

Brongers took this argument further. In one section through a bank and field at Vaassen he identified a layer of washed sand lying over the "pre-celtic field soil" preserved by the bank, and sloping down under the "celtic field soil" onto the subsoil. The layer derives from the action of rain on exposed soil - the humus is washed out leaving clean white sand. From this he concluded "..it is clear that at one moment the arable soil .. was not present in the parcel..", that is, that the "arable soil was removed and replaced" (1976,42,49, Plate 13B, section c-d).

This interpretation is difficult to accept. The washed sand layer, which stretches about 2.5m into the field, clearly occupies a distinct dip in the subsoil, 5 to 10cm deep. In excavations of Iron Age fields and ploughmarks at Store Vildmose, Nielsen noted that "at the sides of some of the boundaries a special hollowing, up to

4cm deep, was observed" (1970,152). This was probably due to intense ploughing along field edges, where ".. a close set of marks lying parallel to the edges forming a belt up to 2m wide" was a characteristic feature (ibid,162). The same parallel ploughing at field edges was also observed in Swedish fields of the same period (Lindquist 1974,24), and may be explained as a response to the encroachment of the developing banks onto the fields, a process noted by Lindquist, Nielsen and Brongers. This intensive ploughing at field margins appears a more plausible explanation for the occurrence of the washed sand than total topsoil stripping of a field.

It was suggested in the introduction to this section that one useful definition of a field system could be a framework to allow the regulation of soil fertility, and Brongers views on the Dutch "celtic fields" give support to this approach. The particular forms of fertility maintenance in both _essen_ and "celtic field" systems were dependent on environmental conditions, poor sandy soil and limited arable accompanied by a larger uncultivated heathland area. Bradley (1978,272) has suggested that differences in soils may explain why cattle byres are found in Northwest Europe but not in England in this period. It seems surprising if manures from housed cattle were not utilised on the Dutch Iron Age fields; possibly they are not recognised because domestic refuse was not mixed with them. However, Brongers explicitly excludes the possibility of continuity between the "celtic field" systems and the _essen_ cultivation; little is known of the agriculture of the chronological gap of c.500 years between them , but there seems to have been a distinct though poorly understood pre-_essen_ phase (1976,70-2).

As with the use of animal manures, vegetation transfer depends on the availability of areas of non-arable land as the source of transferred nutrients. The areas can be large; Slicher van Bath (1963,22,258) notes that animal manuring demands an area of good quality meadow at least 1.5 times that of the arable, more for poorer land. For turf manuring, grassland areas of two to seven times that of the arable are needed. Widgren calculated that arable cultivation in the Swedish Iron Age required areas of meadow and pasture each ten times that of the arable infield (1983,78-9). Use of this land must also be controlled to prevent overgrazing and to allow time for vegetation to regrow. This limits the potential for arable expansion, which both demands higher nutrient inputs and physically encroaches on the area supplying them (Widgren 1983,82-3; Slicher van Bath 1963,124).

6.2.4. Rotations, fallows and grass leys.

These practices are similar in that they depend on the scheduling of cropping to ensure that the fertility of the soil is not depleted and to replace removed nutrients.

Crop rotations may be detectable from carbonised seed remains (Jones 1981,112-3). The presence of small quantities of a second cultivated species may represent self-sowing from the previous season's crop. Jones suggests that the presence of legumes may in itself imply rotations, but there are grounds for doubting this. Beans in particular could have been a garden rather than a field crop, as they were for example in mediaeval Norfolk, although leguminous fodder crops and, in small quantities, peas, were grown as field crops (Campbell 1983,31-3). To suggest crop rotation on the basis of a single pollen grain, possibly from the celtic bean, as Smith does for Fisherwick (1979,101), seems to be stretching the evidence too far. But legumes may have been much more significant than the evidence at first suggests (Chapter 4.4.3), and their presence as contaminants of stored cereal crops, seen as early as the late Bronze Age at Black Patch

(Drewett 1982), makes their use as a field crop and hence in rotations entirely possible.

There is an important distinction between bare fallow and grass leys. In bare fallow, the land is not cropped; weeds are allowed to germinate but are ploughed back into the soil before they can seed. This has considerably value in reducing weed fouling, and it is what nineteenth century agricultural writers usually mean by fallow. Weed fouling can be a major cause of decline in crop yields. Long (1979) has argued this is the chief reason for the low mediaeval yields recorded; mediaeval fallow periods appears to have been grass leys, which do not have the cleaning effects of bare fallow. In grass leys, grass is sown and the field often grazed. When ploughed in, the grass increases the organic content of the soil. Some experimental data on the effects of bare fallowing and grass leys are discussed in Chapter 2.

Examination of some lynchet sections has led to the identification of standstill phases in their accumulation. At Fyfield Down, soil differences and lines of flints were observed. Fowler and Evans (1967,296) interpreted these as the result of intermittent cultivation, but "not just in the sense that allows for fallow years". Stone lines are most likely to represent deliberate clearance of stones brought to the surface by ploughing, and there is no reason to relate them to breaks in cultivation.

Problems in recognising breaks in lynchet formation are discussed in Clarke's (1982) analysis of a lynchet at Heathy Brow. Snail analysis indicated a break, with a phase of stable grassland, and coarse fraction particle size analysis supported this. But analysis of humus content provided no indication of a break, and both the section stratigraphy and fine fraction particle size analysis suggested that accumulation was continuous. The evidence was therefore contradictory; Clarke comments that "any such [standstill] phase must have been fairly extensive, in order to stand any chance of detection" (1982,20).

A section on Portsdown Hill examined by Bradley (1967,55-8) contained a number of overlapping boundaries (lynchets, ditches and a bank), representing several phases of cultivation. Snails recovered from the first four samples were dominated by waster species, a result Bradley found "hard to reconcile with the continued ploughing necessary to produce lynchet formations in places up to 3 feet thick". He suggested that this, with the evidence for discrete cultivation phases, implies that the land was "deliberately disused to restore its fertility before a fresh phase of ploughing". The activity was dated by a scatter of undiagnostic Iron Age pottery.

The evidence from the sites discussed above seems to represent distinct breaks in cultivation, that is changes in the use of a field or its disuse, rather than fallowing. During the lifetime of a field system, periods during which a particular field was not under cultivation would not be surprising, and would not necessarily relate to fertility considerations.

The snail analyses from Portsdown Hill raise several problems. These samples are all in or close to the boundaries, and could reflect scrub cover on the lynchets or banks between fields. The fifth sample, from the most recent ploughsoil, consisted largely of _Helicella itala_, and this suggested that this phase of land use was pasture. But _H. itala_, although today a grassland species, is "recorded from numerous ploughsoils in prehistoric contexts" (Evans 1975,143). Two of the species regarded by Evans (1972) as indicating open country are now found rarely in arable environments, but have been recorded in abundance from some Iron Age contexts suggestive of heavy cultivation (Pupilla muscorum in ploughwash at Pink Hill, ibid 312, Fig.116; H. itala in lynchets at Fyfield and Overton Downs, ibid 320-1, Figs.120-1). While Evans suggests climatic change and increased competition as possible explanations for this apparent change in habitat preference, it may be a change in the habitat itself which is responsible.

Prehistoric arable fields may have been much more weed infested than modern fields from which weeds have been largely eliminated (Reynolds 1980,12; 1981,115-7). Regular use of grass leys could have had a similar effect on the snail fauna. It might account for the contrast between the snails characteristic of of short grazed grassland and the evidence for repeated cultivation (lynchet and ploughmarks) in the negative lynchet at Bishopstone (Thomas 1977,264). Grass fallowing may be represented not by identifiable discontinuities, but by differences in the environment of arable fields between systems based on frequent periods of grazed grass leys and those with a greater intensity of cultivation. [Differences in weed flora and the environmental and nutrient status of prehistoric fields are discussed in relation to the evidence for small-seeded legumes reviewed in Chapter 4.4.1].

However there is a conflict between this evidence for the grassy nature of arable fields and the growth of lynchets and colluvial deposits.

Soil loss resulting in colluviation is known from the neolithic onwards; Bell (1982,138) notes the contrast between the silt loams of earlier colluvium and the later calcareous "hillwash", reflecting the thinning of soil cover in later prehistory (Bell 1882, 138, Fig.3). In understanding the implications of colluviation, it is important to note the distinction drawn by Allen between the formation of valley deposits and lynchet sections. He suggests valley deposits often arise from infrequent but larger scale erosion events rather than the more gradual processes which characterise the lynchet formation (1988,76-8). The formation of valley sediments is not simply a gradual process caused by prolonged periods of cultivation; it results also from a series of distinct episodes, and the quantity of material which can be redeposited in one such episode is considerable (Allen 1988,80). It is therefore not necessary to suppose periods of prolonged cultivation in the same way as for lynchet deposits. Many of the buried settlements or scatters of material interpreted as indicating nearby settlement derived from sections through valley deposits date from the Beaker or Bronze Age periods (ibid, 84-5).

The build up of lynchets suggests that the organic levels in the soil were being depleted, as this is a major factor in erosion. In contemporary contexts, use of grass leys is advised to arrest soil erosion (Hodges and Arden-Clarke 1986,13). Use of bare fallow could be a factor in lynchet formation. Evans noted a decline in _Vallonia costata_ and an increase in _V. excentrica_ occurring "perhaps during the Iron Age" (1972,153-164); as the latter species is much more tolerant of the disturbance caused by cultivation, the change might relate to a factor like a change from ley to bare fallow and greater weed control.

A major factor in modern soil erosion is winter sowing of cereals; because the field has a fine, smooth seed bed and minimum vegetation cover during the worst weather, erosion is high. Fields ploughed in autumn and left bare before spring sowing have a rough furrowed surface, less prone to rain erosion (Hodges and Arden-Clarke 1986,19). Winter sowing has been identified from the weed contaminants of cereals crops from Bronze Age contexts onwards (Jones 1981,109; see Chapter 4 above), and the practice might account for the contrast between the evidence for erosion and for the grassy nature of the fields.

It may be that the nature of fallowing regimes will be discernible from the evidence for the environment of the arable fields, but the sparseness of the evidence and problems such as interactions with other aspects of agricultural practice and the current limited understanding of the environmental needs of the 'open country' snails (Evans 1972,198) make conclusions difficult.

Another approach to the recognition of fallowing is proposed by Reynolds (1980,3), who suggests that the recommencement of cultivation after a period of grass fallow is responsible for the ard marks which survive in the subsoil of some prehistoric fields. His argument, that ard marks were formed by the initial process of breaking grass cover using a 'rip ard', were discussed in Chapter 3. On this basis, multiple sets of ard marks might relate deeper ploughing after fallow episodes. Nielsen (1970,152) noted at Store Vildmose that deeper plough marks did appear to derive from early ploughing of the fields, and that there were a number of other episodes of deeper ploughing during their use. This is compatible with Reynolds' suggestion that the surviving ard marks represent a special process.

However, periodic deeper ploughing need not relate to fallowing or imply a 'rip ard' (the evidence for this tool was discussed in Chapter 3). Given the capability of the bow ard to deal with land after a short grass fallow of one or two years there is no reason to associate the ard marks with short periods of fallow. For better established grass cover, given the present limited evidence for a 'rip ard' (see Chapter 3) and the likely value of turf, use of spades to prepare the land for ploughing seems more likely. Deeper ploughing might relate to other problems, such as a compacted ploughpan layer or the effects of leaching in which nutrients dissolved from upper soil levels are redeposited in the subsoil, as iron pan in podsolic soils or as zones of secondary calcite in calcareous soils (Robinson 1979,126; Briggs 1977,127-8). Podsols were recognised in Dutch Iron Age fields by Brongers (1976,eg. Pl.13b).

It seems that although substantial breaks in cultivation can be detected, routine fallows or grass leys are unlikely to be represented in the archaeological record. It should be noted how frequent such episodes would be; even if a grass ley lasted 5 or 10 years and was followed by a similar period of cultivation, this would imply 5 or 10 periods of grass cover every century. Short fallows (such as one uncultivated year in five) would be expected to leave no real trace, and the effect of bare fallow on lynchet accumulation would differ little from cultivation. The breaks detected were infrequent and presumably long; they might reflect the need to rest soils, but they do not seem to represent part of the agricultural routine, and are probably better interpreted in terms of changes in the allocation of fields to different activities. This might in turn relate to fluctuations in the area cultivated, or shifts in the location of settlement.

6.3. Field Systems and fertility maintenance.

It was suggested earlier that an important function of field systems relates to fertility maintenance. Fields do not only define cultivated areas; they also provide a framework within which fertility can be monitored and regulated. In addition, the boundaries between fields may be significant in limiting erosion and so in maintaining fertility. Soil erosion and the formation of banks and lynchets are dependent on soil conditions, and it seems useful to discuss the evidence for different soil types separately.

There have been a number of investigations of fields systems on light sandy soils in Northwest Europe, where differences in level between the subsoil surfaces preserved under the banks and in the centre of the fields indicate the extent of the erosion. The depth of lost soil ranges from 5 to 10cm (Nielsen 1970,152; Brongers 1976,61-2). Brongers calculated that without the addition of humic material to the field, the figure would have been substantially higher, at least 15 and probably 30cm. The problem on these soils is wind erosion. The banks certainly functioned as barriers to soil loss, but Lindquist (1974,26-7) considered it "extremely unlikely that fields were deliberately planned with soil drift in view". In support of this, he notes that fields on clayey soils in Schleswig are similar in form, although soil drift will not have been a serious problem there. However, in some cases (Brongers 1976,57) the fields were superimposed on earlier settlement and cultivation (Brongers 1976,56-7; Lindquist 1974, 21); there is a strong possibility that their layout was a response to erosion and declining fertility on these soils, even if the intent was to organise fertility restorative activities rather than to limit wind erosion. Presumably also farmers would notice that banks, walls or hedges did provide a barrier. Erosion by wind seems to have been a factor in the British Bronze Age, but not in the Iron Age, perhaps because of a wetter climate (Bell 1982,136)

On clay soils, drainage is likely to have constituted the major problem, rather than erosion. Bell (1982,138) discusses the evidence from alluvial deposits, mostly in the English midlands, which indicates that loss from clay soils became significant later than on the chalk downs. Deposition of alluvial clay in the Upper Thames Valley also appears to have started in the late Iron Age (Robinson and Lambrick 1984,810). Extensive exploitation of clay soils in these areas may therefore have begun in later prehistory. While heavy clay soils are more difficult (labour demanding) to cultivate, they maintain their fertility better than lighter soils, where in the long term acceptable yields are dependent on manuring (Long 1979,473). There may therefore be a level of intensity of cultivation where the extra work of cultivating heavy soils becomes a more attractive proposition than the fertility maintenance work demanded by lighter soils.

River gravels generally lack extensive field systems; this is the case in the Upper Thames Valley (Miles 1978), despite evidence for cultivation such as ploughmarks from late Bronze Age and early Iron Age contexts (Robinson and Lambrick 1984,812). Some ditched fields on gravels are discussed in the section on drainage below. Alluvial deposits on the gravels derive from a wider catchment area, and flat free-draining gravels contribute little to alluviation.

On chalk hillsides, the scale of erosion can be seen in the size of some lynchets: for example, an 8 foot high lynchet of Fyfield Down was formed by 4ft 6in of accumulated soil and 3ft 6in of chalk ploughed away in front of it (Bowen and Fowler 1962,105). Interestingly, Brongers notes that lynchets are not found in the "celtic fields" of the Netherlands, even where they are "fairly steeply sloping" (1976,102). Differences in cultivation practices are presumably implied. Evans (1975,153) discounts the importance of erosion in the exploitation of the chalk downs, noting that a degraded chalk soil can rapidly regain its fertility. However, it is possible for a chalk soil simply to become too shallow to support cereal cultivation (Hodges and Arden-Clarke 1986,25).

Analysis of colluvial dry valley sediments by Bell also demonstrate substantial erosion: estimates based on two deposits on the South Downs were 5 to 12cm and 18cm soil loss over the hillslope. But this is not uniform - excavations in similar locations have failed to produce any colluvial deposits. Bell also notes that the characteristics of the colluvium imply that the prehistoric soils of the slopes may have been significantly different from present types. He "suspects ... some Celtic field banks, such as the stony Itford Bottom lynchet, may be evidence that prehistoric farmers responded to the linked problems of erosion and stoniness by deliberately casting the stones from field clearance onto lynchets" (1977, 147). It seems possible that the "celtic field" systems themselves were a response to erosion. This is suggested by the relationships of the colluvial and lynchet deposits in Bell's Itford Bottom trench B. A worm-sorted soil dated to 1770+/-120bc is overlain by a colluvial deposit accumulated during cultivation, and in turn overlain by a stony lynchet. Bronze Age sherds, associated by Bell with manuring from the Itford Hill settlement discussed above, occurred mostly in the colluvium. Iron Age sherds occurred in the colluvium and lynchet, while Romano-British sherds were restricted to the upper part of the soil profile; the lynchet formation therefore took place mainly in the Iron Age (ibid,132,135,140). The creation of this boundary may have been a response to erosion during the Bronze Age and earlier Iron Age which resulted in the build up of colluvium. The dating and relationship between the colluviation and the lynchet is important in understanding the development of field systems, and will be referred to again in Chapter 7. Bell's work has produced evidence for colluviation from the Neolithic onwards, in marked contrast to the widely held view that it occurred chiefly in later prehistory. He draws attention to the contrast between the silt loams of earlier colluvium and the later calcareous "hillwash", reflecting the thinning of soil cover in later prehistory (Bell 1982,136-8, Fig.3).

Cultivation (attested by ploughmarks) preceded the layout of coaxial fields at Overton Down (Fowler 1967,17), and at Streatley Warren the lynchet contained a layer of stones overlying the buried soil, which Mills (1948) interpreted as the product of stone clearance. Where the initial layout of a boundary consists of stones, earlier cultivation is almost certainly implied; although at Fyfield Down the broken nature of the stones suggested to Bowen and Fowler (1962,105) that they derived from the breaking and removal of large sarsens. An important inference from this evidence for previous cultivation is that it argues strongly against Fowler's model for axial field layout as the initial form of landscape organisation after clearance (1983,105 and Fig.42). Distinct stone "tip lines" in lynchets, as at Fyfield Down (Fowler and Evans 1967,296), probably represent periodic clearances of stone during the use of the fields.

The difference in alignment between the positive lynchet at Bishopstone and the underlying ditch, fence and negative lynchet is another example of reorganisation following a period of cultivation. Bell infers from the snail evidence that a Bronze Age phase of grassland followed the neolithic cultivation attested by the lynchet and the ploughmarks in it. But the evidence is contradictory. The brown soil lying in the negative lynchet was apparently "exposed" during the Bronze Age, and it did not have a clearly defined surface (Bell 1977, 42,257-8). The Bronze Age "hiatus in occupation" may also be illusory; if the Bronze Age pottery, which includes Beaker and middle and late Bronze Age types, is "residual" (and 2% of the sherds from Iron Age assemblages are of Bronze Age fabrics) then it must be residual from something. Their distribution suggests the Bronze Age occupation may have been largely outside the excavated area (ibid,45-8).

The soil preserved in the dip of the lynchet differs from later prehistoric soils on site, and in view of Bell's more recent discussion of prehistoric soil changes due to erosion, it may be a small part of the earlier prehistoric cultivated soils, preserved only because the Iron Age positive lynchet covered the earlier negative lynchet (Bell 1977,7,9,257; 1983,147). The analysis of the finds from this lynchet by Allen (1982) showed that the 'best lines' through the distribution of the neolithic and Bronze Age artifacts followed the surface of the chalk, while the 'best lines' through the Iron Age and Romano-British distributions followed the present surface (ibid, Fig.4). Allen correctly draws attention to the need to explain this difference.

The other key factor derives from the snail analysis (Thomas 1977). The neolithic cultivation, well attested by ploughmarks and negative lynchet, is not detectable from the snail assemblages. Inferring a change of use during the Bronze Age on the basis of the absence of snail evidence for cultivation must therefore be unreliable. The inference drawn here is that cultivation of the lower field (i.e. downhill of this lynchet) continued throughout the neolithic and Bronze Age, but that it was punctuated by periods of grazed grassland sufficiently frequent to keep the soil in a good uneroded condition and to allow the grassland snail fauna to persist. The major change occurs in the early Iron Age; the field boundary is realigned (and at least one of the other rectilinear boundaries illustrated by Bell (1977, Fig.23) also dates to this period, and the changes in snail fauna (ibid,262) and the evidence for erosion indicate more intensive cultivation.

Boundaries can significantly reduce soil loss. In the case of wind erosion, a thick hedge (3m) can give protection out to about 30 times its height. In addition, hedges retain eroded soil, which could be returned to the field. On slopes, hedges slow the rate of flow of surface run-off which lessens water erosion. They are particularly effective where there is a large catchment and a sudden increase in slope. In these situations, grass strips, especially on convexities, can have a major effect in slowing run-off and reducing erosion (Hodges and Arden-Clarke 1986,18; Colbourne and Staines 1985,111). It is important to note that the effect of boundaries is not simply to accumulate eroded material; their presence reduces soil loss.

In the sandy soils in northwest Europe, banks and lynchets encroached significantly on the arable, a marked increase in width being seen at both Vaassen and Store Vildmose (Nielsen 1970,152). Brongers estimates that the banks at Vaassen finally occupied 40% of the arable (1976,71). He suggests the bank material was allowed to regain fertility and then brought back into cultivation, but this is not convincing; the banks are often stony, and he presents is no evidence for this transfer. Lindquist discounted the possibility that the broad banks in the Swedish fields served as access tracks (1974,126). It seems possible that their value as a broad shelter belt (if carrying hedge or scrub) outweighed the loss of potential arable. With both banks and hedges, it seems reasonable to suppose that even if erosion control was not their original aim, their value would soon have been recognised. It is interesting that at Store Vildmose, only some of the boundaries became defined by banks (Nielsen 1970,163).

There is evidence for earlier cultivation in a number of the field systems from northwest Europe; at Vaassen, the "celtic fields" closely succeeded a previous agricultural phase (Brongers 1976,57). Survey and excavation by Nielsen (1984) in eastern Denmark demonstrated a "cultivation phase" from about 1200 BC, in one case probably using "amorphous fields"; the "larger, well organized" field systems appear to have first been laid out on land already cleared and cultivated in the period 500 to 300 BC (Nielsen 1984, 161-2; sites 3,28,107 and 149)

In both Britain and northwest Europe it is plausible to interpret extensive field systems as a response to problems of erosion, stoniness or declining fertility resulting from previous cultivation. The field systems provide a fixed framework within which manuring or other fertility maintenance measures can be organised, and their physical form may itself impede erosion. In addition, their banks and lynchets may reflect the other activities carried out to improve the productivity of the fields, incorporating evidence for stone clearance and manuring.

In some areas, significant landscape change is well documented for the later Iron Age. In the Upper Thames Valley, this took the form of tracks and enclosures, which sometimes overlie middle Iron Age settlement. But although rectilinear enclosures and trackways are common on aerial photographs, relatively few are dated (Hingley and Miles 1984,65). There were also new settlement types, as at Barton Court Farm, with its "innovative agriculture" (Jones 1986,120). A similar change is seen at Odell, in the Great Ouse Valley, where the settlement of the first century AD consisted of an enclosed occupation area and a series of "small stockyards or paddocks" either side of a trackway which frequently included wells situated close to their entrances. The farming practices implied by these changes were "already well established" by the Roman conquest (Dix 1981,22-4, fig.2).

A reorganisation of the layout of fields accompanying the layout of a trackway at Burntwood Farm, Itchen Valley, is described by Fasham (1980,49-51). Two negative lynchets, parallel but spaced in a way implying the existence of "a staggered corner" were part of "a vestigial 'Celtic' field system visible on aerial photographs". A ditch defined track or road cut across the system, and land boundaries "unknown in number or total extent" ran from it. The road was in use for most of the Roman period, but its precise date of origin was not clear (ibid,55). It was "heavily used", hollowed and rutted; yet it was only 700m from and parallel to a major Roman route (ibid,81). Fasham suggests that its layout and the digging of its ditches relate to a short length of Iron Age ditch, possibly a boundary between different land holdings. North of that feature, the road ditch contained mostly Iron Age pottery, although this could have been residual. This road is reasonably interpreted as part of the agricultural landscape rather than a through route; the ditches may have "formalized a casual route" (ibid,81), and have been constructed by the owner or owners of each section of adjoining land. The date is either late Iron Age or early Romano-British. It again suggests the importance of moving materials and/or livestock around the farm.

A ditched trackway and fields at Islip (Northants) also probably dates from the later Iron Age and continued in use throughout the Romano-British period (Jackson 1982).

Trackways occur in the 'celtic' field systems of the chalk downs, although they are often seen as bounding a block (e.g. Fowler 1983,100) or linking settlements rather than as access to fields. Not all settlements have tracks leading to them (Bowen 1961,27), and it would be interesting to know whether there is a chronological distinction involved. Bowen (1961, Fig.4A,B) suggests that access between the fields was generally by means of the "staggered angles", providing a less steep slope than the lynchet faces.

Fowler (1981,26-7) has questioned this explanation of the 'staggered corners', on the basis of the coexistence of staggered corners and apparent entrances in a ditched field system at Lawford. However I am not convinced by his arguments - a number of the entrances are at field corners, and in any case a hillslope field system defined by lynchets presents different access problems to a ditched field system in a flat river valley bottom. The Lawford field system is undated by excavation; the presence of entrances from the fields to the large field or "reserved area" containing a barrow group does not seem a very strong argument for the contemporaneous of fields and barrows. Access ramps are described for some Danish prehistoric field systems by Nielsen (1984,161), and this perhaps lends some support to Bowen's interpretation.

Rhodes suggested that fields at Fognam Down might date from the Roman period because of their regular layout; they are divided into roughly rectangular blocks of twenty to thirty fields by tracks (1950,11, Fig,7). Clearly access is emphasised here in a way it is not in some other groupings. It is interesting that the area of fields on the Berkshire Downs recently dated to the Romano-British period by Ford _et al_ (1988) includes a number of trackways (seen more clearly in Bradley and Richards 1978, Fig.7.2). Other regular 'celtic' field groups with trackways have been noted, e.g. at Aldsworth and Eastleach (RCHM Gloucs. Vol 1, xlix,1-2,52). It is worth noting that to Roman land surveyors, boundaries (limes) were strips of land, not simply boundaries with no widths. These were used as roads or farm tracks, but were nevertheless regarded "primarily as boundaries having a certain width" (Dilke 1971,87-8).

The difference between field groups laid out with integral trackways, and those in which tracks are absent or appear to be later insertions might well have chronological significance. But in view of the current poor dating of the 'celtic' fields, this must be seen as speculative.

Trackways may also appear with increasing frequency in other areas in either the late Iron Age or Roman period. But although a number of examples of trackways from various parts of England can be cited, and some appear to be associated with fields or enclosures, fewer of these are satisfactorily dated, or provide clear evidence for the relationships between the land boundaries, tracks and settlements (a particular difficulty where the evidence derives wholly or in part from aerial photographs). It is a network of trackways through the fields or the grouping of livestock enclosures alongside the trackways which suggests that they represent the reorganisation of the landscape to accommodate new patterns of agricultural activity.

Trackways are of course not by any means a novelty during this period, and attaching agricultural significance to these developments depends on distinguishing routeways between settlements and other foci (e.g. cemeteries) from tracks whose role was as part of the agricultural landscape - and the two are not mutually exclusive. The association of trackways with enclosures, especially those provided with wells or waterholes, is strongly suggestive of this role; but a track, however important, may only have been defined in a way which would be archaeologically detectable where this was necessary. In the Upper Thames Valley, many trackways exist only as short stretches, often flanked by enclosures, and end in what appears to be unenclosed pasture (Hinchliffe and Thomas 1980,69). At Appleford, the trackway 'disappears' when it ceases to pass between enclosures and enters an open area, served by several other trackways.

Despite these problems of dating and interpretation, it is possible that a trackway based settlement pattern emerged in the later Iron Age, and its development in the Romano-British period when there is a greater spread of evidence has considerable significance for understanding fertility maintenance practices. There are two reasons for this assertion. Routine heavy manuring implies the movement of substantial quantities of materials around a farm, including the transport of fodder and litter as well as the dung itself. It also requires the management of livestock to allow the manures to be accumulated. This could take the form of winter housing, but the evidence for this in the British Iron Age, and more surprisingly also in Roman Britain, is very sparse. The daily movement of livestock from pasture to pens or enclosures or to be folded on fallow arable land, seems therefore to be implied where heavy manure occurred.

As a rough calculation, if a 'typical celtic field' of 0.2 ha produced around 0.5 tonnes of grain (Reynolds 1981, 108-9), this would be one cartload, or 10 to 14 person-loads, or rather more to allow for transporting the grain in the ear. The straw would, on nineteenth century figures (McConnell 1883,107-128) be up to twice as heavy. Hence carting in all the straw and grain requires 3 cartloads. But manuring at the standard nineteenth century rate of 40 tonnes/ha would imply 16 loads, to be applied every fourth year. These figures increase roughly sevenfold if a slide car or a small-wheeled cart was the usual means of transport. Effective manuring clearly results in a large increase in the number of loads to be moved around the farm, and the figures above do not include any additional litter collection. [See Appendix at end of this chapter, and discussion in Chapter 2.] The effect of the ground surface on the tractive force required (and hence on the load which can actually be pulled by the draught animals) is considerable (McConnell 1904,50,53). Between a good road and arable land the necessary tractive force quadruples.

The second point related to the collection of manures. Widgren notes that for Sweden it has been shown that cattle paths are a feature which "exists only in areas where the cattle are driven daily to the farmstead" (1983,72). Manuring, he concludes, was either the reason for the layout of stone walled fields and trackways in Ostergotland, Sweden, during the Iron Age, or else "an intimately related product". The evidence for intensive cultivation and manuring (sherd scatters coinciding with high phosphate levels) supported this interpretation.

This change in organisation of the landscape may be valuable, if indirect, evidence for a reorganisation of agriculture and livestock management to allow manure collection on a large scale for first time. The earlier evidence for manuring, and the limited Iron Age evidence for livestock housing [Chapter 5], may derive only from the management of the draught animals, enclosed for convenience, and from occasional penning or tethering of livestock in or near the settlement for reasons of safety, bad weather, lambing or calving etc. The development of trackways in the agricultural landscape would have facilitated the daily movement of livestock between pasture and pens or folds, and especially so where it was necessary to move livestock through arable land without damage. This is an example of the spatial interleaving of cultivation and livestock management referred to in section 6.01 above.

If this trend can be shown to be a consistent feature, the contexts in which it occurs is crucial to its understanding. As Jones notes, the late Iron Age settlement at Barton Court Farm was not only a new type of site, its occupants also practised an "innovative agriculture" and possessed coins (1986,120). [The context of early coin use and its relationship to agricultural production is discussed in Chapter 10 below.] The much overdue attention now being given to the agricultural aspects of villas (such as Winterton, Bancroft etc.; see Chapter 5) is also resulting in the identification of pens, enclosures and trackways - even if the expected large livestock byres remain conspicuous by their absence [see Chapter 5].

The argument that manuring was in general intended to increase yields and hence productivity rather than being in response to declining fertility [see Chapter 2] carries the implication that an increase in its importance and effectiveness reflects change in the socio-economic context of agriculture. Clarifying the timescale, geographic distribution and the types of site with which such changes are associated may therefore be a key factor not only in understanding developments in agricultural techniques and productivity, but in inferring change in the economic context of agriculture and hence evaluating the nature and significance of socio-economic change in later Iron Age and Roman Britain.

6.4. The importance of manuring: implications for the interpretation of Iron Age and Romano-British agricultural systems.

The crucial question is how important and effective the techniques of fertility maintenance were in the agricultural systems of the Iron Age and Romano-British period. The limitations of the evidence must be stressed; the frequency and quantity of manuring cannot be estimated even when the practice can be inferred. The view that regular and effective manuring manuring was an early development, becoming a continuing factor in prehistoric agriculture with a significant impact on yields, seems to be ill-supported. It is potentially misleading, as it obscures important distinctions between manuring regimes. This has two consequences. Because of the assumption of highly productive agricultural systems (based on extensive field systems and effective manuring) as the norm in the Bronze Age, changes in the Iron Age towards more large-scale and intensive agriculture may be misinterpreted as signs of stress in such systems (this was discussed in Chapter 4.4.2). It can also lead to overestimates of the likely productivity of agricultural systems - there is no evidence suggesting manuring at the levels used in either the Butser or Rothamsted experiments was achieved, at least until the end of the Iron Age. [This was discussed in Chapter 2.]

A pattern of development in fertility maintenance practices can be provisionally outlined.

The earliest period for which there is good evidence for manuring is the middle Bronze Age. By that time, cultivation took place within defined plots, resulting in small field groups around the settlements. Where larger scale axial field systems are attested in this period, they appear to relate to the needs of the pastoral rather than the arable side of the agrarian economy. The evidence for manuring is the presence of abraded and comminuted domestic refuse in ploughsoils. Excavators of middle and late Bronze Age sites have sometimes suggested that some round buildings were used as byres (eg. at Itford Hill, Burstow and Holleyman 1957,210; Shearplace Hill, Rahtz 1962,306; Black Patch, Drewett 1982,342). A long building at Down Farm may have been partitioned, with higher phosphate readings suggesting use of one end as a byre (Bradley et al 1981,223). At Houseledge, some of the 'hut circles' lacked the features of houses and were unroofed animal pens (Burgess 1984, 147-9). Ellison has suggested that the settlement 'module' for the Middle Bronze Age typically consisted of a number of structures falling into four classes, one being animal shelters, although relatively few of these have been identified (1981,417-421). A number of the settlements of this period are approached by trackways (see Chapter 7.2.1), which may reflect frequent movement of livestock into the settlement. Drewett suggests that Black Patch enclosures had "a dual function of settlement plus stock enclosure" (1982,348).

The evidence for manuring is thus accompanied by evidence for the management of livestock needed to achieve it. But it is capable of different interpretations. It could represent intensive small scale agriculture, with frequent or even continuous cultivation and fertility maintained at acceptable levels by regular heavy manuring. But equally periods of fallow/ley could have been the main method of fertility control, with manuring using materials accumulated in the farmstead providing an occasional boost to productivity.

It is argued in Chapter 7 below that the early Iron Age seems to have been the time when extensive axial field systems for arable use were first laid out - this can be seen as an extension of the techniques of layout and possibly the organisation of usage earlier applied to regulate the grazing of livestock. Their layout occurred in areas largely already under cultivation, and may have been a response to problems of erosion and declining fertility.

Manuring at this time is suggested by lynchet analyses; but it is interesting to note the scarcity of Iron Age sherds in some investigations of landscape features. The prehistoric sherds from Rhodes' pioneering survey of the Berkshire Downs, for example, were mainly of late (ie middle) Bronze Age date (1950,13). Recent excavation of linear ditches and lynchets in that area confirm this result (Ford 1985; Ford et al 1988: discussed in Chapter 7). Ford's linear ditch sections produced late Bronze Age/Early Iron Age pottery, but none from later in the Iron Age (1985,6, Fig.7). Several of the ditches were dated by Roman sherds confined to their upper levels (see 7.2.3.i below). At Baydon Roman material was confined to upper levels of the positive lynchet alongside the ditch; a single prehistoric sherd lay beneath the lynchet (ibid, microfiche pages 3-4). Ford et al 1988 drew attention to the lack of evidence for middle and late Iron Age pottery in some surveys of the Berkshire chalk. The question is whether this gap reflects lack of use of areas of the Berkshire Downs during the middle and later Iron Age, or whether it reflects the absence of extensive spreading of manures incorporating domestic refuse.

Fowler has drawn attention to the quantity of domestic refuse which was not used in manures during the Iron Age, but was instead dumped into pits (1983,169-170). He suggests this is because domestic refuse was only an accidental or sporadic constituent of manures. Instead, it could reflect decreased importance of manuring during the period. Middens may not have been universal on Iron Age sites. Finds of sherds of the same pot in different pits was taken to indicate the presence of a midden used as the source of pit fills at Barley (Cra'ster 1961,30-1). But at Tollard Royal, attempts to establish relative dating of pits failed because sherds of only one pot were found in more than one pit (Wainwright 1968,117). [Wainwright did however infer manuring at Tollard Royal, because, as at Itford Hill, most of the pots were represented by only a few sherds (ibid,120).]

Supporting evidence for manuring in the from of animal housing or trackways passing through fields into settlements is also noticeably scarce in the Iron Age. The 'staggered corners' which seem to have provided the access to fields (Bowen 1961,24, Fig.4; see also 6.3 above) and the infrequency of trackways through the fields suggest that frequent movements of substantial loads of manure are unlikely.

Evidence for an increase in leguminous weeds species (see Chapter 4.4.2) during the Iron Age suggests that soil nutrient levels declined, perhaps in part because of the reduced frequency of grazing. It is important to recognise that this does not necessarily mean yields declined; at Rothamsted it was initially suggested that the presence of these weeds in fact maintained the grain yields (experiment showed this was not the case). The classical continual cultivation experiments at Rothamsted and Woburn (see Chapter 2 below for discussion) showed that after an initial decline, yields levelled off and remained fairly stable. The main cause of declining yields appeared to be weed fouling, and in one experiment the introduction of a fallow season every fifth year restored yields to near or above their original levels (decade averages).

The evidence for the increase in leguminous weeds implies that manuring was insufficient to raise the nitrogen levels in the soil substantially or over longer periods. Nevertheless, given the absence of evidence to the contrary, there is no reason to assume that such a agricultural system was not productive and stable, though achieving less than its full potential. Use of manuring would increase yields, and it may be that manuring should be seen in this light rather than regarded as a practice sufficient heavy and systematic to replace fallow or ley periods in maintaining soil fertility. Fertility maintenance in the Iron Age may have depended on the regulation of fallow and ley; extensive arable field systems would have provided a framework for organising this.

The changing layout of the landscape in the later Iron Age, with the integration of trackways and enclosures into the farming landscape is interesting. This seems to be the first indication that heavy and frequent manuring could have formed part of the agricultural routine. Evidence for livestock housing remains scarce, and confined mostly to the north and west, but pens and enclosures also provide an opportunity to bed livestock on litter and accumulate dung. It is important to note that Widgren (1983,72) states that in Sweden the layout of trackways occurs only where livestock are driven to and from the settlement on a daily basis. This development could be interpreted as a response to land shortage, population pressure, fertility decline and so forth, but in view of the evidence for change in other areas of the economy of the period, and given the underproduction implicit in unmanured or inadequately manured cultivation, the explanation preferred here is that this was a deliberate attempt to increase productivity, because there was an incentive to do so. (see Chapter 10). This may be paralleled by increasing use of heavier more fertile clay soils, with changes in ploughs and ploughing techniques to cope with them. The suggested absence of regular heavy manuring in earlier Iron Age agriculture implies that there was considerable potential for increasing production if this could be introduced.

In the Romano-British period, the trends seen in the later Iron Age continued. There is again little evidence for livestock housing, except probably on a scale compatible with the care of the draught animals, despite frequent presumptions of its existence in the archaeological literature. What is increasingly being demonstrated is the cluster of trackways, pens, enclosures and outbuilding around some villas (e.g. Bancroft, Winterton). The yards discussed in section 6.2.2 above are another facet of this. The scale of organisation of manuring on some sites of the Romano-British period - in particular on large agricultural estates, which are not yet satisfactorily documented for the Iron Age - may make the movement of manures around the farming unit easier to detect - if the question is directly addressed. The Maddle Farm Project, with its identification of zones of different intensities of manuring around the villa, is an example of this (Gaffney and Tingle 1985).

This section has outlined the broad changes in fertility maintenance practices which I think can be inferred from the evidence available at present. Many of the conclusions must be regarded as tentative, but they provide framework for understanding evidence now available and a basis for assessing and evaluating new evidence as it becomes available. Some of the discussion summarises the work in this and earlier chapters, but much of it also anticipates later sections. The interrelationships between the different areas of investigation in the archaeology of prehistoric agriculture and the inadequacy of discussing them in isolation forms a major theme of this work, and one this chapter illustrates clearly.

It argues, as do other chapters, against static models of 'prehistoric agriculture' (or even 'Iron Age agriculture'). Change in fertility maintenance practices is implied by the evidence currently available, and it is likely this will be increasingly the case as new data are published. These changes are also those of development and experiment; innovations were not introduced in a developed form which persisted unchanging throughout the rest of the prehistoric period. Systematic and large scale manuring, if it can be inferred for the late Iron Age and Romano-British period, was adopted after a long timespan during which the value of manuring and the ways in which it could be achieved were presumably assessed and modified. Similar arguments will be developed for field systems and land drainage. This is entirely consistent with what a consideration of innovation as a process would predict.

6.5. Ditches and drainage.

Drainage is a means of fertility enhancement rather than maintenance, important in realising the potential of both arable and pastoral land. Water-saturated soil lacks oxygen, needed by plant roots, and is slow to warm in spring. Wet pasture results in plant species whose food value is poor, and increases disease rates in livestock. On wet arable land, the period suitable for tillage is limited, and reduced further by rainfall during the ploughing season. If the land must be ridged during ploughing, the labour inputs are increased. Wetness also increases the risk of damage to soil structure.

Poor drainage results from two conditions: ground water impedance (where there are impervious subsoils, or in low lying areas where the water cannot find an outlet) and surface water impedance (due to impervious layers in the soil itself). Open ditches are effective as drains where water poor drainage results from ground water impedance, but water moves easily through the soil itself. They have less effect on soils such as clays where poor drainage is a consequence of surface water impedance (Briggs 1977, 84,93-4).

6.5.1. The development of ditched fields.

Despite the commonness of ditches as excavated features, the quantity of information on ditches which can be related to agricultural activities and to drainage in particular is not great. The emphasis on the excavation of settlements leads to a relative scarcity of excavated field boundary or drainage ditches which are not close to domestic areas, contemporary or otherwise. Field ditches often had a simple boundary function, unrelated to drainage. Because of the effects of soils on aerial photography, ditches are often not visible from the air in precisely those areas where soil conditions (clays and brickearths) suggest drainage will have been a problem.

An example of this is provided by the site at North Bersted (Sussex coastal plain). Short lengths of ditches found in the strips excavated were projected by Bedwin and Pitts (1978, Fig.4) and interpreted as forming the boundaries of a group of irregular subrectangular fields, which could not be detected from aerial photographs. The ditches became wider and deeper down the slope of the land, indicating that they acted as drains.

The ditches were dated on the basis of the pottery in them to the third to first century BC, earlier material being regarded as residual. However there are two difficulties which should be noted. Firstly, if the ditches were subject to regular cleaning, as the excavators suggest, earlier material could have been removed. In addition, the quantity of pottery diminished with distance from the middle-late Iron Age hut circle; if earlier occupation had centred on a different part of the same field system, its pottery might be similarly scarce in the excavated areas. The point is made by the evidence for Roman usage. Only two or three Romano-British sherds were found in this excavation, but observations during building work 200m distant revealed ditches which seemed to be part of the same field system, and in which Romano-British pottery was found above Iron Age sherds (ibid,310-1).

This second point is a more general one. Extensive field systems may often remain in use for longer periods than individual settlements within or associated with them. The occupation site may have moved around in the cultivated area; it is suggested in Chapter 7 that movement of unenclosed settlements within the framework of "celtic" fields may be one reason why settlements associated with them are relatively uncommon. A defined field system is likely to reduce the need to enclose and define the settlement site. Depending on the nature and permanence of the field boundaries involved, change in settlement location may be reflected in modifications made to them (see discussion of Ashville below).

Emphasis on domestic areas in excavation, and the tendency to regard small amounts of earlier material in these contexts as 'residual' (from what?), may hinder understanding the field system itself, and its pattern and period of use. While material thrown or spread onto hillside fields is incorporated into lynchets and hence potentially recoverable, the need to keep drainage ditches open implies material falling into them will have been periodically removed, probably thrown back onto the field. Earlier pottery is therefore likely to be both heavily abraded and mixed with later. Understanding the function and treatment of ditches may be important in establishing their chronology.

In interpreting ditched fields, there are two basic questions - whether the ditches functioned as drains, and what the fields were used for. Size is a widely used criterion for the latter, with enclosed areas frequently being described as either too large (eg Riley 1980,26) or too small to be arable fields. Small fields are often described as enclosures; sometimes other agricultural uses can be inferred, usually related to livestock. Where soils tend to be waterlogged, drainage ditches would improve conditions for penned livestock.

The variety of ditched enclosures of middle Iron Age to Romano-British date in the Upper Thames Valley has been contrasted with the lack of evidence for extensive field systems (Robinson 1981,255). This contrasts with the botanical evidence for cereal cultivation (e.g. Jones 1978), and it has therefore been suggested that arable plots were largely unenclosed (Lambrick 1978,119). However some fields have been excavated, and it seems useful to consider the evidence from this area more closely.

At Ashville, ditches dated to the late Iron Age (late first century BC to early first century AD) defined small, squarish fields, comparable in size to "celtic fields". The recovered plant remains suggest that the effects of improved drainage can be recognised at this period. Cultivation of a wheat species suited to damp ground (club wheat) ceased; and there was a marked decrease in the quantity of _Eleocharis palustris_, a weed of damp ground sensitive to improved drainage. Although other explanations are possible (such as a cessation of cultivation on damper ground), Jones considered it most likely that ".. the rearrangement of the landscape in the late Iron Age was associated with an extensive improvement in land drainage" (1978,109).

Although it is possible that groups of fields like those at Ashville have simply not been recognised, the important point to note is that field drainage need not imply extensive areas of ditched fields. Ditches can function as drains without being boundaries. There are a number of indications that drainage systems may have existed in this area. At Appleford, Romano-British ditches cross area 4, but evidently did not show up as cropmarks outside the excavated area (Hinchliffe and Thomas 1980, Fig.13). Hinchliffe and Thomas also make two points closely relevant to this problem. They suggest that features will have varied in form depending on their importance as barriers, explaining, for example, the existence of short stretches of trackway which end in open land (ibid,69). They also note that the relatively slight gullies of the middle Iron Age trackway and fields enclosures were less likely to survive or to be identified than later and more substantial features (ibid,43). The same is likely to be true of simple drainage ditches of any period. At Farmoor, for example, a number of ditches (some Roman) showed up only in excavated or trenched areas (Lambrick and Robinson 1979, 13,30,33,Fig.3). Drainage ditches may therefore often be detected only where they impinge on excavated settlement areas. Drainage systems may be more important and extensive than has so far been recognised.

At Roxton, in the Great Ouse valley, cultivation appears to have preceded the digging of field ditches during the first century BC (Taylor and Woodward 1983,10-11). The basis for this is the partial infilling of the Bronze Age ring ditches, attributed to ploughing, preceding the late Iron Age activity. As with the environmental evidence from Ashville, drainage seems to have occurred when arable use was already established.

Other areas also show ditched fields as a later development in settlement. Dent noted that enclosed cemeteries alongside trackways may preserve traces of Iron Age unditched fields in some parts of the Yorkshire Wolds (1982,451-2, Fig.11). This is particularly the case where there were enclosed fields during the Romano-British period. The field system at Fisherwick on the Trent gravels dates to the mid-late Iron Age (C3BC to C1AD); earlier occupation was unenclosed and without (surviving) field boundaries (Smith 1979,89-92, Fig.4). Dent (1982,453,456) suggests that similar trends of increasing nucleation and enclosure of settlement characterise lowland Britain during the Iron Age; the development of ditched field systems in the middle and late Iron Age may be an important part of these trends.

Another area with evidence for ditched fields is along Hadrian's Wall - the effect of the wall and its associated forts on the recorded distributions of earlier settlement and agriculture is not dissimilar of that of motorways. A number of examples of ploughmarks on clay from cultivation predating the Hadrianic frontier are known; some of these were discussed in Chapter 3. At Tarraby Lane (Carlisle) a system of ditched fields produced clear evidence for arable use, with ploughmarks and cereal pollen from the buried soil. The ditches are not closely dated, but the environmental evidence suggests the fields had been grassland for some time when the wall was built, and the ditches had been allowed to silt up (Smith 1978,21-3,35-7,55-6,Figs.2,5). The site is on a clay subsoil, and the ability to improve drainage may have been crucial for its exploitation.

As noted earlier, ditching alone is less effective on clay soils where surface water impedance contributes to poor drainage than it is on soils with ground water impedance. It is interesting that it is one of these pre-

Hadrianic contexts on clay, Rudchester, which has produced the only evidence so far for plough-ridged soils in prehistoric Britain. It should be noted that spade ridging is an older technique, dating for example from the late neolithic at North Mains, Strathallan (Halliday et al 1981,55). At Kilellan Farm (Islay) spade-cut furrows separated ard cultivated ridges; these are not securely dated (ibid,56). The relatively rare recovery of evidence for ridging of either type is probably due to the limited conditions under which ridges are preserved.

A ditched field system at Aldermaston Wharf was dated by the excavators (Cowell et al 1978) to the middle Iron Age. The primary ditch silts produced a single middle Iron Age sherd, and the upper fills a mix of sherds from the third century BC to the early first century AD. However Smith (1985, 205-9) has argued that these fields date from the middle Bronze Age, corresponding to the supposedly middle Bronze Age axial field systems on the chalk downland (see Chapter 7 below). In view of the importance of the dating of the development of ditched field systems, it seems useful to consider this example, which illustrates some of the difficulties of dating field ditches.

Smith's argument is that regular ditch cleaning explains the presence of middle Iron Age sherds in the fills of the main axial ditches; he concludes that the late Bronze Age sherds in the minor cross baulk ditches (his terminology) provide a more reliable dating. The late Bronze Age settlement, he infers, was inserted into a derelict agricultural landscape (based on the environmental evidence) in which an earlier (and therefore middle Bronze Age) field system remained visible.

There are several problems with this redating. When the ditches did silt up, they appear to have done so rapidly, and it seems unlikely that they would have remained a significant landscape feature through a period of abandonment. The late Bronze Age sherds essential to Smith's argument were found "in one part of [one ditch] where exposed by the scraper....not excavated by hand" (Cowell et al 1978,3). Since cultivation over an earlier occupation site will lead to incorporation of material from the occupation into ploughsoils and hence ditch fills, an interpretation of the late Bronze Age sherds as residual seems reasonable. The loss of earlier material due to cleaning is a real problem in dating field ditches. But Smith's arguments imply that ditches used in the Middle Bronze Age and subsequently disused were cleaned out along precisely the same lines during the middle and late Iron Age. The dating proposed by Cowell et al remains more convincing.

Ditched fields at Billingborough, Lincolnshire, originally regarded by the excavator as late Bronze Age in date are now known to be Iron Age in date (Chowne 1978; Pryor 1980,182, citing Chowne, pers. comm.).

Although ditched fields dating to the Bronze Age are known, they do not seem to have been arable in use. Fields at Fengate were attributed to the control of pasture (Pryor 1980, 178,180). The middle Bronze Age fields at Mucking (Jones 1985,17; Jones and Bond 1980,471,Fig.1) are large in size (two adjacent rectangular fields are each around 130 by 160m) and therefore probably also pastoral in function. Certainly they are too large to have provided effective drainage for cultivation.

On present evidence, systems of ditched arable fields can be regarded as originating in the middle Iron Age, becoming more important and widespread in the later Iron Age and in the Romano-British period.

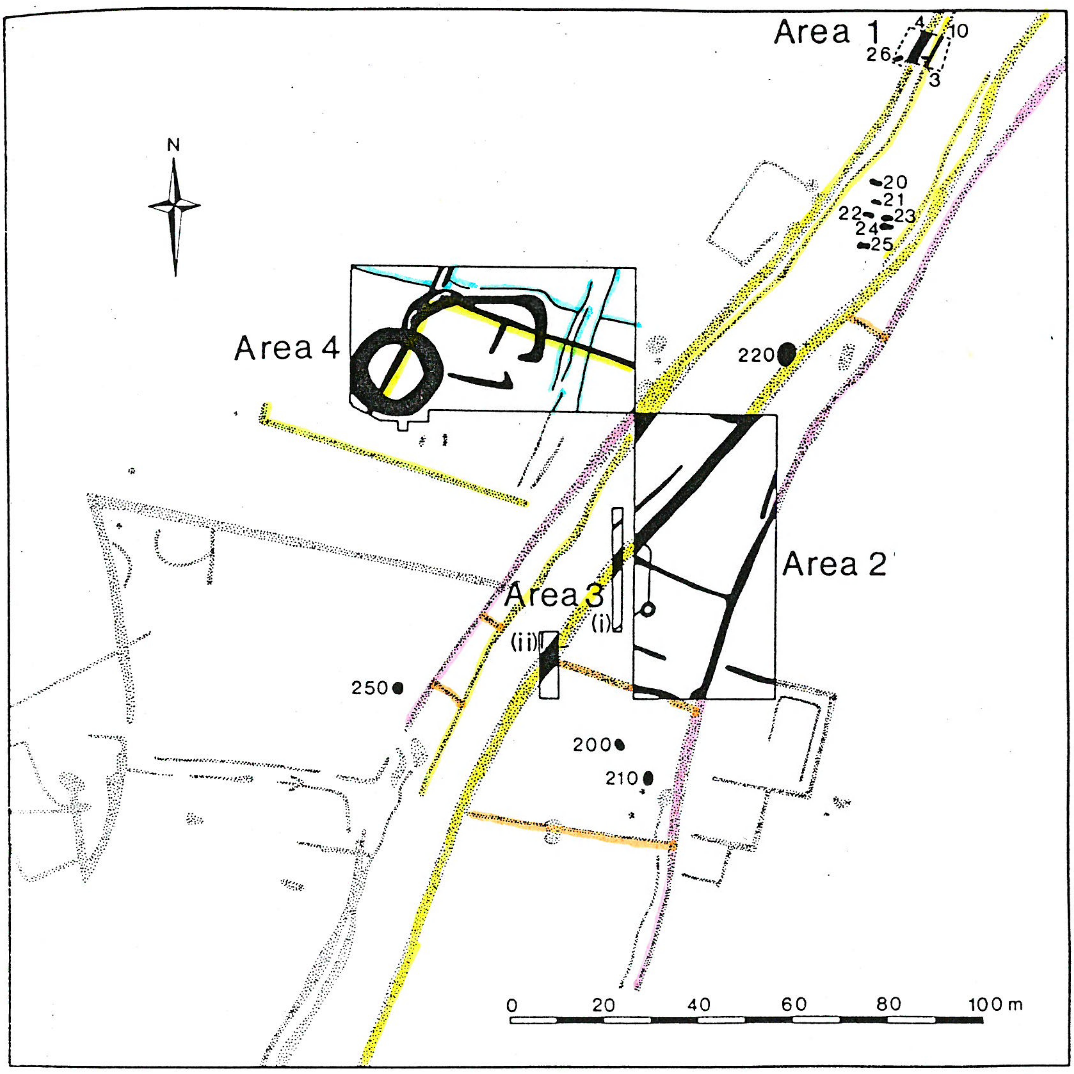
6.5.2. Maintenance and techniques.

The maintenance received by ditches might be expected to reflect their function (see Fig. 6.1). An examination of the ditches from Appleford suggests this can be recognised. The ditches defining the droveway were at least twice allowed to silt up before being recut. The recuts were "in places... so far removed from their predecessors' line as to constitute an almost separate ditch". The ditch forming the eastern boundary of the small enclosures along the east side of the droveway was also recut several times, "though seemingly in a more piecemeal fashion". Its role in defining a boundary is supported by the likelihood there was a ditch alongside it; it was also allowed to finally silt up earlier than the trackway and field ditches (in the second as opposed to the fourth century AD). The ditches subdividing this eastern enclosed area showed no signs of cleaning or recutting. The ditches in area 4, which it was suggested above were field drainage ditches, showed traces of periodic "slight recutting, or cleaning out". One had a pronounced sump in some places (Hinchliffe and Thomas 1980,62-5).

This treatment does seem to reflect function, with the field ditches receiving routine clearance while still well defined, and the trackway ditches receiving periodic recuts after substantial silting. The silting of the ditch bounding the enclosures suggests that in this case the bank (or hedge: ibid,93) may have been the significant feature of this boundary. It would be unwise to make generalisations on the basis of one site, but it is clear that where the evidence is available, distinctions between the functions of ditches and the maintenance they received can be drawn.

Because of the inevitable processes of silting, ditches may be a less fixed form of boundary than, for

Figure 6.1. Romano-British ditches at Appleford.



Key:

limits of main excavated areas

cropmarks

Iron Age ditches

trackway ditches

boundary/barrier ditches

possible field boundaries

enclosure division ditches

Source: Hinchliffe and Thomas 1980, Fig. 13.

instance, banks, walls and lynchets. They may reflect changes in land use more readily. This can be seen at Ashville, where recuts deviate in part from previous lines, and where a gap, presumably allowing access between fields, was closed with a short stretch of added ditch (Parrington 1978,36). Parrington suggests this may be due to ".. differing farming practices or ... change of ownership", but it may simply reflect more mundane changes in the allocation of land to different uses.

The Romans knew a variety of ditching techniques; they are described by Columella (II.II.9-11), Cato (XLIII) and Pliny (XVIII,VII.47). Blind drains, filled with stones or brushwood, were recommended for loose soils. This technique is known from Iron Age Britain; two brushwood drains were excavated at the Cats Water site, Fengate (Pryor and Cranstone 1978, 17 and Plate V; Pryor 1984, 112,114,Fig.88). Both were enclosure ditches rather than field drains.

6.5.3. Settlements trends, agriculture and heavy soils.

The development of ditched fields can be related to the evidence for increasing exploitation of heavier soils during the Iron Age. Analysis of settlement location in the Cotswolds led Marshall (1978) to infer that the third to first centuries BC did see increased utilisation of heavier soils (clays and gravels), a trend which increased during the Roman period. Marshall noted that similar trends are recognisable in several areas which also have a division between light upland and heavy valley soils (ibid, 353-4). Analyses of settlement location in Wiltshire and Sussex by Ellison and Harriss (1972,923-938) identified a trend towards increasing exploitation of high quality arable soils from the mid/late Bronze Age onwards, with increased use of heavy (Valley and Vale) soils from the Iron Age. Interestingly, during the Romano-British period, the proportion of heavy soils was greater for villas, other rural settlement being biased towards downland soils (ibid,927,933). The evidence for the development of drainage is compatible with these identified settlement trends.

Ditched field systems appear to originate in the middle Iron Age, but from the Ashville evidence it was perhaps the late Iron Age before drainage of arable land was fully developed and effective. Use of heavier soils precede the development of these techniques. It can be related to other developments in agricultural practice, as in plough types and techniques, especially in relation to ridging the soil, and also in crop choice, perhaps particularly in the decline in emmer (suited to light dry soils) during the Iron Age in the Upper Thames Valley (Jones 1984,122; see Chapter 4.3.2 above).

Demographic factors (expanding populations) are cited by both Ellison and Harriss (1972,937) and Marshall (1978,353) to explain the increased utilisation of heavier soils. But an important characteristic of these soils is their robust and fertile nature. They are more productive as well as more labour demanding. A desire to increase production may have led to the greater exploitation of these soils, and to the development of the necessary techniques to do so effectively. The development of techniques of draining and ridging the soil may therefore parallel the suggestion in the layout of later Iron Age settlement of an increased use of manuring to increase production. Both involve the intensification of production within already utilised areas. The concentration of villas on the heavier soils in the Romano-British period suggests that they were preferred because of their productivity by that time (Ellison and Harriss 1972,927,933).

Appendix to Chapter 6.
A note on manuring rates.

Manuring rates:

1. Roman documentary sources.

Columella (2.5.1 and 2.15.1) specifies rates of 18 or 24 loads to a iugerum. A load is 80 modii, i.e. about 500kg (Columella 11.2,86). These figures are discussed in Chapter 8. This is a rate of 36 or 48 tonnes per hectare.

2. Recent and historical sources.

(i). Slicher van Bath calculates rates averaging around 10 tonnes per hectare per annum from some eighteenth and early nineteenth century data. Actual application rates ranges from 13 to 38 tonnes per hectare (1963,259-260).
(ii). McConnell (1883,65) recommends an application of 40 tonnes per hectare every fourth year.

3. Experimental rates.

(i). Manuring in the Butser experiments (Reynolds 1981,110, Table 3) is at a rate of 20 tonnes per hectare.
(ii). The classical long term experiments at Rothamsted used rates of 35 tonnes per hectare (Rothamsted Experimental Station 1970,10).

Size of a load.

Columella specifies that a cartload is around 500kg. [The reasons for accepting this figure are discussed in Chapter 2.] However, it is possible that much of the movement of materials around a farm in prehistoric and Roman Britain used simple and smaller vehicles such as slide cars or the small-wheeled carts derived from them. The Kellach cart or rung cart of eighteenth century Scotland could transport around 70kg of dung, or about 125 to 170kg of other loads, for which a lighter framework was used on the cart (Fenton 1973,159-60). I have not found any figures for slidecars; while they were much less efficient that carts on roads, they had an advantage on grassy slopes, and were perhaps similar in loading to the Kellach carts derived from them.

These can be compared with the loads carried by people; harvest workers in twentieth century Czechoslovakia carried loads of 40-50kg (men) or 35-40kg (women) (Baran 1973,57,59,63,70). An early nineteenth century agricultural worker in Britain was expected to carry loads of 50-60kg (Loudon 1825,450).

Loads of manure.

rate of application	loads needed (per hectare). at 500 kg a load	at 70kg a load
18 *vehes*/*iugerum*	72	514
24 *vehes*/*iugerum*	96	686
10 tonnes/hectare	20	143
20 tonnes/hectare	40	286
40 tonnes/hectare	80	571

Loads per field.

The typical size of squarish "celtic fields" is between 0.1 and 0.2 hectare (Bowen 1961,22); Reynolds (1979,52) suggests 0.13 is the average size for Iron Age fields.

A typical "celtic field" would therefore need about one seventh to one fifth of the loads per hectare given above.

Chapter 7.
Organisation of land use; field systems and land boundaries.

7.1. Introduction.

In this work, an agricultural system is taken to be defined as much by its organisation as its practices, and the organisation of land use potentially reflects two key areas of the organisation of agricultural production. The first relates to agricultural practice; it is the way in which systems of land division can act as the framework for coordinating fertility maintenance activities. The second is the way in which the spatial context of agricultural practice may also represent elements of its wider social and economic context. This, and the problems it poses, is discussed later (Chapter 9).

The way in which fertility is maintained in an agricultural system is regarded as one of its crucial components. It can be argued that one of the main functions of field systems is to allow the regulation of the fertility of the soil, by providing a framework within which overuse can be prevented and restorative measures organised. It was suggested from the evidence assembled in Chapter 6 above that fertility maintenance practices probably changed significantly during the last two millennia BC. There is therefore a potential conflict with the generally accepted view that a characteristic type of arable field system was established in southern England in the early or middle Bronze Age, and continued essentially unchanged until the end of the Roman period (eg Bowen 1978,117; Fowler 1983,95). This fits with the largely static view of later prehistoric agriculture which is generally accepted; despite recognition of "an increasing technological, material and social progress" during the first millennium BC (Fowler 1983,204-5), the major developments of land allocation and manuring are attributed to the previous millennium, or even earlier, and there is little recognition of significant change in the methods used. Mercer's estimates of agricultural productivity (1981; discussed in Chapter 2 below) and his conclusions about the populations supported (ibid, especially 236) are perhaps the clearest statement of the implications of such an approach.

An additional implication of this static view is that where change in landscape organisation has been identified, such as in the river valleys of the Thames and Great Ouse in the later Iron Age (Robinson 1981,254-5,272; Dix 1979; 1981), it has to be set against a background of agricultural practice and land use seen as an unchanging tradition which had already persisted for nearly two millennia. If the static view is incorrect, and this is the position argued here, and later prehistoric agriculture was instead characterised by development and modification, then there are surely important implications for the interpretation of the changes identified in later Iron Age and Roman Britain.

The static view also implies that agricultural organisation is likely to be of limited value as a source of socio-economic information. For if the basic organisation of the agricultural landscape remained unchanged, and if the main agricultural practices such as ploughing technology and fertility maintenance methods were similarly uniform, during two millennia when social and economic change are otherwise well documented, it would clearly be unlikely that they could be used as major sources of socio-economic inference. The chronological and geographical spread seen in Fleming's review of the coaxial field systems (1987, Fig 1, Table 1) reinforces this point.

The literature on field systems concentrates heavily on the coaxial/celtic fields of southern England, despite the widespread existence of field systems of various types throughout Britain (eg. Bowen and Fowler 1978). The interpretation of these systems has had an important influence on the discussion of field systems in general, and it is for this reason they are discussed in detail here. Theoretical discussions of prehistoric fields has also concentrated on the extensive coaxial systems, especially as a result of Fleming's work on the Dartmoor reaves, and his social interpretation of them. This has for example been used by Ford in his discussion of the linear ditches of Berkshire (1985,17).

This chapter covers two main areas. It examines the dating for the classic 'celtic' field systems, reviewing both the strength of the accepted dating and the significance of more recently published work. It concludes that the evidence does not support the early date for their origin, and hence argues against the static view of later prehistoric agriculture this implies. At the level of both agricultural practice and social inference, it is suggested that more attention must be given to the dating and use of fields and their relationship with other landscape features. It can then be argued that the field systems do have considerable potential as indicators of social and economic organisation, but that this potential will be realised only if relationships between components and the way they functioned as parts of an agricultural system are specifically considered.

The second theme is a consideration of the results of more recent work, on field systems and especially on the linear ditches; while these clearly show the weakness of applying simplistic or unitary explanations, it is possible to make some suggestions as to how these features relate to the organisation of arable production, to suggest that some trends through time are emerging, and to suggest the sort of questions about these features and their place in the organisation of space which are key to their understanding.

An important point to stress at the outset is that this chapter is concerned almost exclusively with fields whose form and layout appear to be determined by the needs of arable production, as their long term arable use is documented by the accumulation and erosion of lynchets. The earliest coaxial field systems which are adequately dated all appear to have been laid out for pastoral use. This is the case with Fengate, where the enclosures were used "to parcel up flood-free winter grazing" (Pryor 1980,178), and with the Dartmoor reaves, where cultivation appears to have been "confined to small enclosed areas near the houses" (Fleming 1988,105). The extensive and regular Behy/Glenulra fields (Co. Mayo, Ireland) are also interpreted as "designed for animal husbandry rather than tillage" (Caulfield 1978,138), and the much smaller Belderg Beg fields (also Co. Mayo), which produced "direct and indirect evidence of tillage", in contrast "form a very irregular pattern" (ibid,140). This distinction between the layout of the two field groups which are close in date (around 3000 BC) reinforces the point. It does not have to be assumed that arable and pastoral uses were exclusive; parts of pastoral fields may at times have been cultivated, just as fallow arable plots will often have been grazed. The difference lies in the principal reasons governing their layout.

This point is important in itself in considering the farming economies of prehistoric Britain, as it suggests that communal or centralised control of pasture may have significantly preceded that of arable land. The techniques of large scale land division appear to have existed before their need was felt in the management of arable land.

7.2. The dating of the 'Celtic' fields.

The consensus view of the 'celtic' fields is of a distinctive system, established "at least in the Middle Bronze Age" (Bowen 1978,117); at times some such systems are said to have superseded by pastoral land divisions and land use, and in the Romano-British period the individual fields were often elongated, but even so the field systems are considered to have continued essentially unchanged for over two millennia.

Fowler (1983,95) summarises:
"Such field systems were in use from at least the early second millennium BC to the fifth century AD and, at least arguably, a little later. The systems themselves are characterized visually by their extent, often covering many hundreds and sometimes, when fully developed, thousands of hectares; by their organised structural nature in plan, notably in their use of axial lines; by their relationships, often expressed physically by ditches, banks, and trackways, to later prehistoric land boundaries, settlements, and cemeteries; by their shape,edges and content, especially their component fields or plots; and by their date."

He relates the 'celtic fields' to "the first real husbandry, as distinct from earlier essentially 'exploitation' farming" , this being "one of the several innovations following the 'Beaker' phase of British prehistory".

Bradley has distinguished the regular axially planned systems (which he calls "cohesive") from "aggregate" systems. "in which the fields were clearly added one to another on a piecemeal basis" (1978,268). He suggested that "they may represent two stages in the expansion of settlement"; where aggregate systems have been recognised on the edges of cohesive systems, Bradley and Richards (1978) suggest this implies they were later additions.

Definition remains a problem; Fleming, who replaces the term cohesive with coaxial, suggests it should be applied to rectilinear systems with a single "prevailing axis of orientation", and only to extensive systems (larger than 100ha). But the "coaxial <u>principle</u>" may be seen in smaller groups, occurring "in a kind of 'coaxial countryside'" (1987,188-9).

In summary, the accepted view is that coaxial or cohesive systems originated early, and formed the primary landscape organisation (see Fowler 1983, Fig.42). They however continued to be laid out over a long time span (Fleming 1987 Table 1), and Fowler (1983,94) suggests that most surviving examples date from the period 500 BC to AD 500.

This chapter examines in some detail the evidence on which the early dating is based, and the arguments used to reach it. Although the main scope of the present work is the Iron Age and Romano-British period, examining the origins of these systems seemed important because of the essentially static picture of continuity in the organisation of land use over two millennia which the accepted chronology presents as a background to the later period. In considering agricultural change in Iron Age and Roman Britain, it seems important to know whether it took place against a backcloth of continuing development and change, or in the context of an agricultural system whose spatial framework had been essentially unchanged for more than a millennium.

The reconsideration of the evidence, especially for dating, led to the conclusion that the origins and context of these systems was more directly an issue for the Iron

Age and Romano-British period than the conventional view suggested. The recent paper by Ford et al (1988) reinforces that view. This chapter was written before its publication, although its results have since been added in to the discussion.

Three papers are taken to represent the definitive view of the dating of 'celtic fields'. Fowler (1971) states the case for an early date; Bowen (1978) discusses fields and their relationship with ranch boundaries; and Fowler (1983) reviews the evidence for prehistoric fields in Britain.

It is interesting that Fowler's later review almost ignores the question of dating. Elsewhere (1967,295) he noted that "while on the continent ancient fields have been dated and their original boundaries examined by excavation for more than a generation, British studies have relied very heavily on non-excavational field-work". This has clearly had a major effect, not least because of the lack of full publication of the primary results of the work in many cases. In some cases this has made assessing claims based on the work impossible.

Fowler (1971) categorises the dating evidence, and it is intended, for convenience, to follow his divisions in this discussion of it.

7.2.1. Fields and middle Bronze Age settlements.

The first aspect described by Fowler is "their association with settlements like Itford Hill" which "with the back-dating of the Deverel- Rimbury culture ... have now been pushed even further back into the latter part of the second millennium BC" (1971,166). Itford Hill has a radiocarbon date of 1000+/-35 bc (Renfrew 1974,229), and in the South-east coast area the Deverel-Rimbury pottery tradition is now considered by Barrett (1980,314) to have started after c. 1400 BC and to have ended by c. 1000 BC. The dating may have differed in other areas, especially Wessex (see below).

The important question is the nature of those field which can be firmly associated with these middle Bronze Age settlements in Sussex.

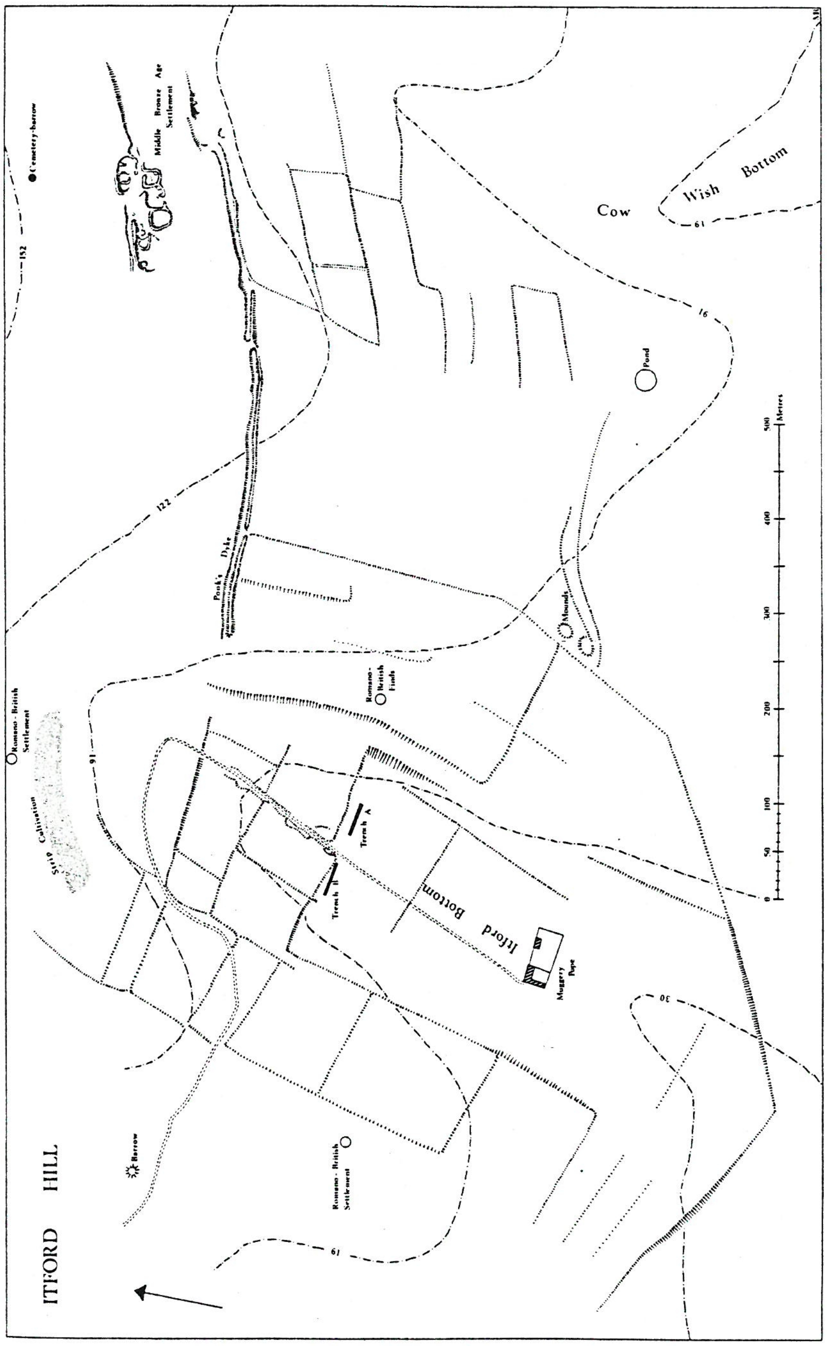
At Itford Hill, a lynchet about 100m long running northeast from the settlement was described as "probably all that remains of the original field system". There was a larger group of lynchets to the south, separated from the settlement by a cross-ridge dyke. This group was "well-defined and regular", but considered to be "almost certainly of Roman date as Romano-British sherds are plentiful over the whole of its area" (Burstow and Holleyman 1957,168-9). As Rhodes (1950,15) had already noted, surface finds on fields and lynchets are not adequate dating of their origin, as earlier objects are masked by subsequent cultivation. Hence the regular field group cannot be associated with the settlement, and only a single lynchet remains to suggest it was once accompanied by a field group of some form.

Work by Bell in nearby Itford Bottom has shown clearance and cultivation in the early/middle Bronze Age; diagnostic sherds from the colluvium show similarities to material from the Itford Hill settlement, and Bell (1983,143) suggests they confirm the manuring hypothesis proposed by Burstow and Holleyman (see Chapter 6 above). But the trench also cut a lynchet of the small field system (Bell 1983, Fig.9), and this is firmly dated to the Iron Age (ibid,140), reinforcing the point that the Itford Hill settlement cannot be assumed to relate to the visible field remains in its vicinity.

Figure 7.1.

Settlement and fields at Itford Hill.

Source: Bell 1983, Fig.9.



At Plumpton Plain, two settlement areas were excavated, and it was emphasised that they were distinct in date. Three different lynchet groups were described. Site A (the middle Bronze Age occupation) has a few lynchets to the south and east of it, considered integral with it. A small group of fields, with curved but parallel sides lie to the west of site B, which was originally described by Holleyman and Curwen as early Iron Age, but assigned by Barrett (1980,311) to his plain ware tradition of the late Bronze Age. There is no evidence for the relationship between these fields and site B; they were said to predate the fields of site A because of their relationship with an oblique lynchet linking the two, but this is unconvincing. There was no evidence to relate either settlement to the larger and more regular group of lynchets to the south of site B (Holleyman and Curwen 1935,18,Fig.1).

At New Barn Down, Curwen used two factors to associate the field system with the settlement site. The lynchets conform to the track, which leads only to the settlement, and except for "a few stray sherds of ubiquitous Romano-British pottery" there was no trace of Iron Age or later activity (1934,169). The general non-survival of prehistoric pottery on field surfaces and the absence of excavation of any of the lynchets undermines the latter point. The fact that the lynchets are parallel to the track does not demonstrate that they are contemporary with it. The lynchets south of the settlement are bounded to the east by a "field way" and to the west by a series of long lynchets running along the slope. The primary east-west axis of the group do not cross the field way; if the fields south of the settlement are contemporary with it, they do not seem to be part of a substantial coaxial group. The trackway leading to the settlement is described by Drewett (1978,68) as a hollow way; this is interesting as Bowen (1961,32) notes that

Figure 7.2.
Fields and settlements at Plumpton Plain.

Source: Holleyman and Curwen 1935, Fig.1

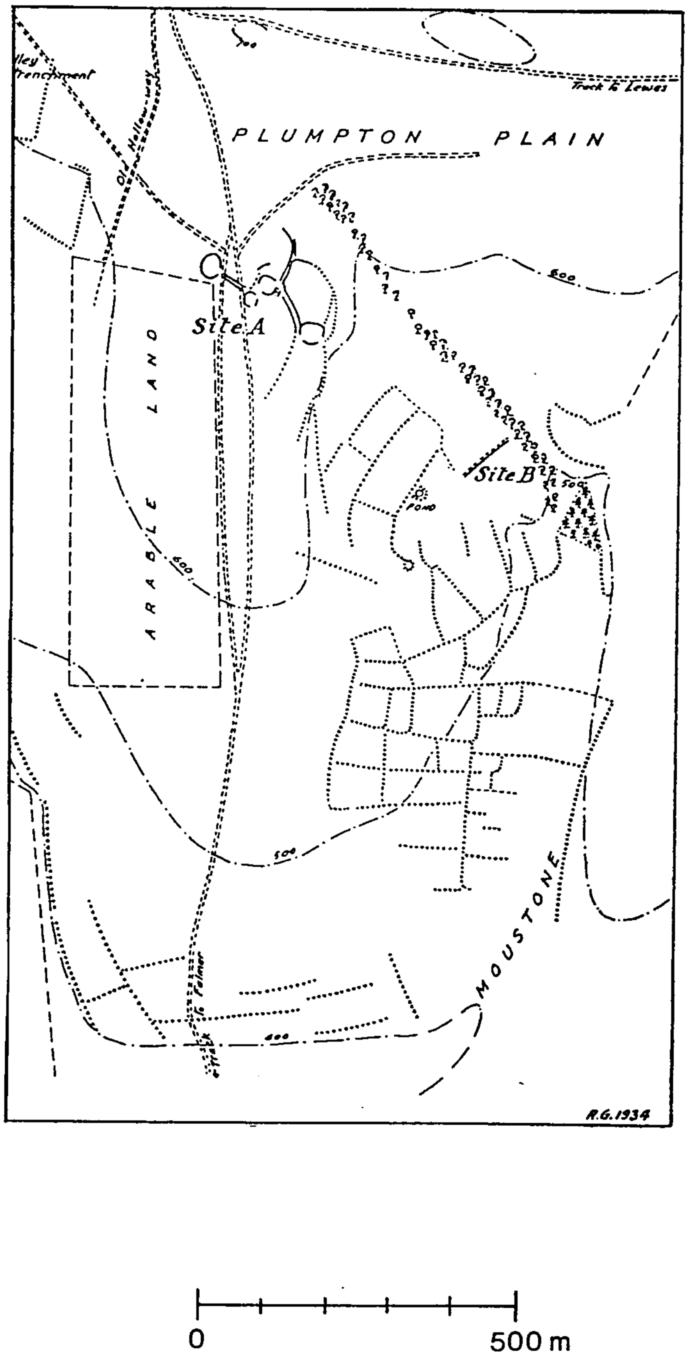
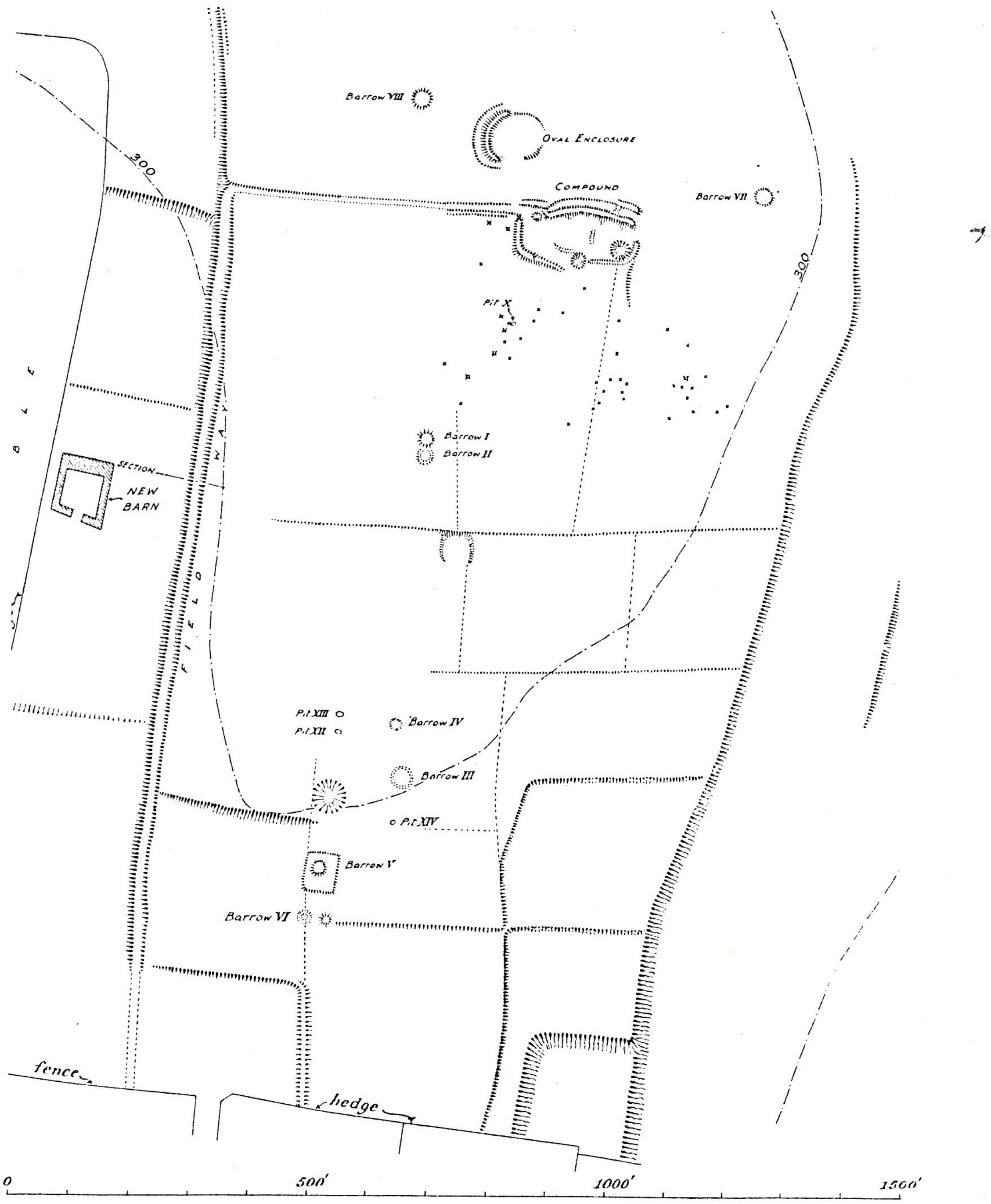


Figure 7.3.
Fields and settlement at New Barn Down.

Source; Curwen 1934.



hollow ways associated with "celtic fields" are rare. The landscape elements may be more complex and of more periods than is suggested, and without excavation of the various elements, their relationships are uncertain.

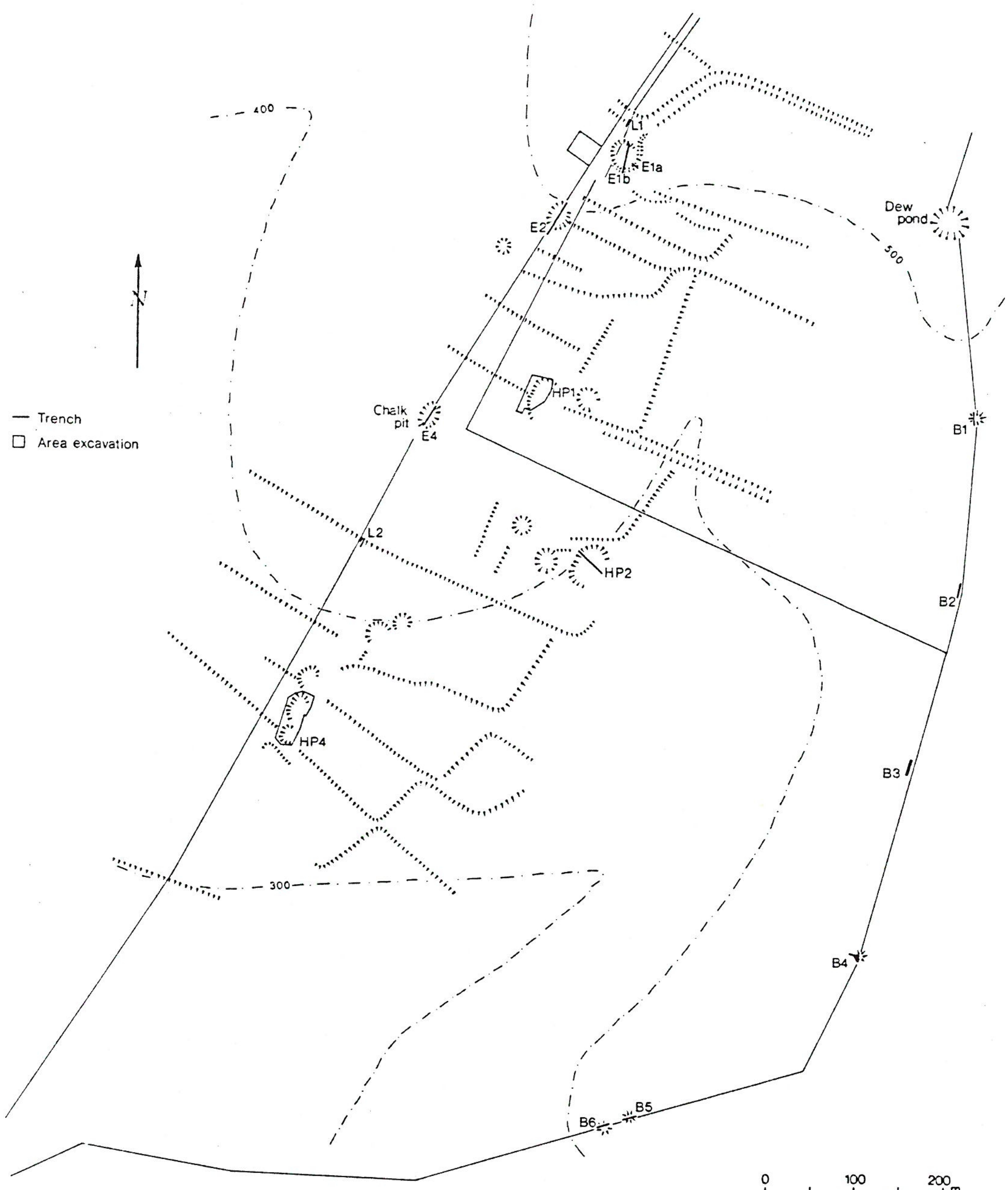
Curwen did however excavate two of the eight round barrows in the fields; he noted that some of these barrows appeared to post-date the fields. One produced an inhumation with an iron knife of seventh or eighth century AD type, and the other was probably of similar date (1934,157-9). This reinforces the point that the use of this area was not confined to a single period; the point that round barrows within 'celtic fields' cannot be assumed to be Bronze Age is also important.

The lynchets at Black Patch are however firmly dated to the middle Bronze Age; of the two sections excavated, one produced two middle Bronze Age sherds, and Iron Age and Romano-British sherds were entirely absent from both (Drewett 1982,352). The lynchets, mostly running parallel across a spur, do not conform to the axially based block pattern of the larger coaxial or cohesive groups. The area of these fields contains a number of hut platforms and enclosures, the latter also containing postholes and occupation debris. Radiocarbon dates for the two excavated hut platforms suggested date ranges of 1060 to 940 bc and 1000 to 900 bc respectively.

Hut platform 1 was shown to have been "constructed in the corner of a pre-existing field", and Drewett concluded that the focus of occupation moved around within the area of the fields (ibid,342-3). This has several implications. Firstly, if fields were the more long-lived component of the agricultural settlement, and occupation moved around within them, the expectation that fields will be organised around settlement sites (as land use models predict) will be unfounded. Intensity of use may have followed the

Figure 7.4.
Fields and settlement at Black Patch.

Source; Drewett 1982, Fig.3.



expected distance-minimising pattern, but within a fixed spatial framework of fields. It may also relate to the apparent lack of contemporary occupation sites in some field systems, if settlements moved and their sites subsequently reused for cultivation. Imposition of a domestic site on a field may imply not that the system was disused (as inferred by Fowler 1967,28,30), but that its use was continuing.

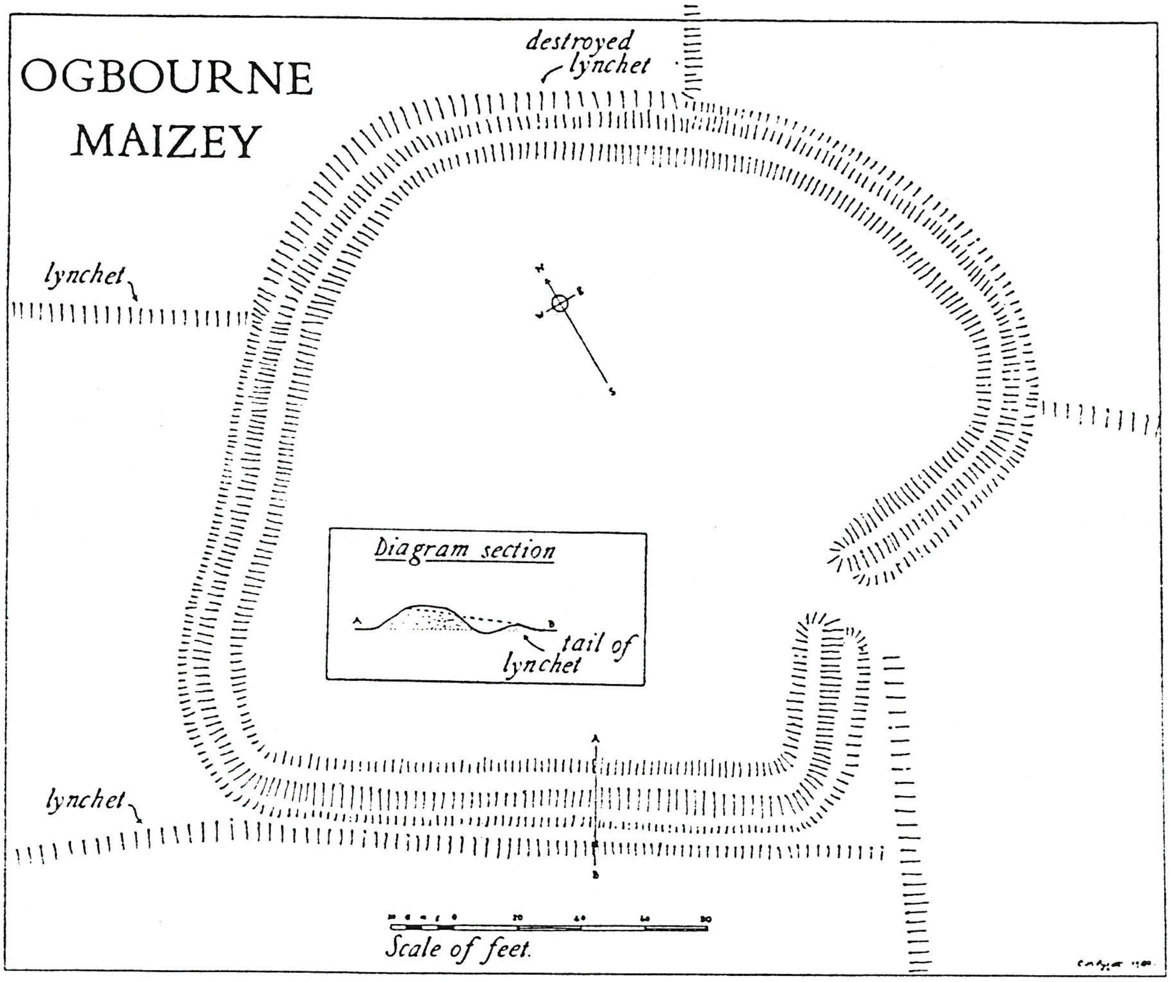
For some of these Sussex middle Bronze Age settlements, association with contemporary lynchetted fields is demonstrated, and long-term cultivation of the same fields can reasonably be inferred. In the examples discussed, the hut groups are well-defined, and some are approached by trackways (as at Itford Hill, Black Patch and New Barn Down and Plumpton Plain, and also some contemporary sites elsewhere, e.g. Shearplace Hill (Rahtz 1962,293), although not all the tracks described there need be contemporary with the settlement). The use of a dominant axis in the field layout is clear at Black Patch. What is lacking is evidence linking these settlements with the larger systems of the cohesive/axial/coaxial type; the distinction between these field and settlement systems and the classic 'celtic field systems' is important in understanding both.

Fowler treats the occurrence of probable middle Bronze Age settlement enclosures overlying the "well developed lynchets" of field systems as a separate class of evidence (Fowler 1971,173), but it seems better to combine it with the other settlement evidence. The only example he cites is the enclosure on Ogbourne Maizey Down.

This enclosure was examined by Piggott (1942,52); there was no excavation but a small number of Bronze Age sherds were found in rabbit scrapes. Piggott considered that the shape of the enclosure was largely determined by

Figure 7.5.
Enclosure at Ogbourne Maizey.

Source: Piggott 1942, Fig.3.

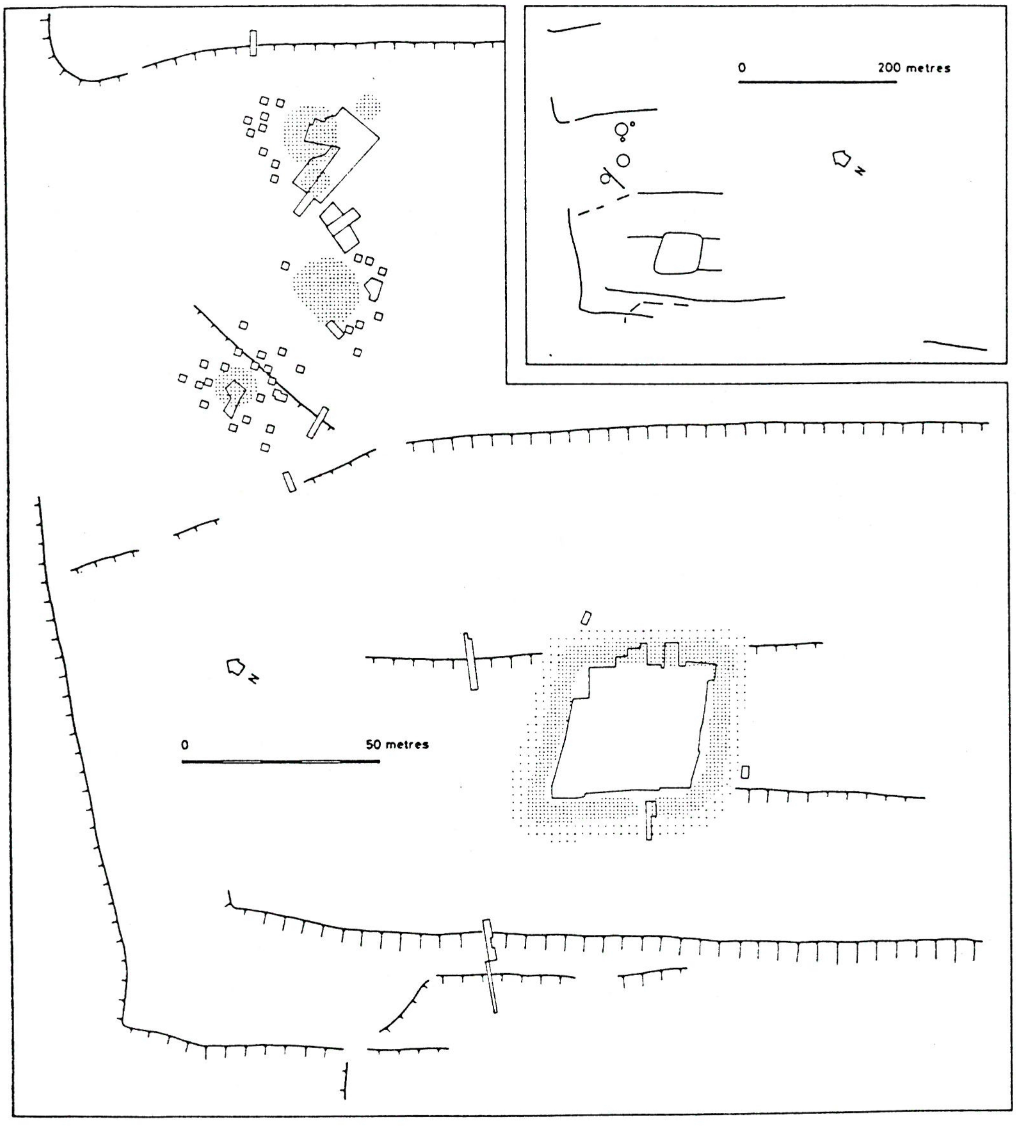


pre-existing fields, which it could be seen to post-date without excavation. Fowler (1971,Pl.8) publishes an aerial photograph, unfortunately not well reproduced, which does not make the nature of the field system clear. Certainly the lynchets seen in Piggott's plan (1942,Fig.3) are not entirely convincing as parts of an axial system. If there was a "destroyed lynchet" on the northeast side of the enclosure, where did it run to? The lynchet on the southeast appears to bend along the side of the enclosure. In the absence of an excavated section, the profile across the enclosure bank and lynchet is as easily interpreted in terms of the development of a negative lynchet, caused by ploughing nearly up to the lip of the enclosure ditch, as by the ditch cutting into an earlier lynchet. The lynchet terminates at another running southwest from the entrance, to which it seems to owe its location; it certainly is not in the same line as the other stretch of lynchet running northeast from the enclosure. Neither the chronological priority nor the axial nature of the field system are convincing on the basis of the evidence as published. The reality could be complex, with the development of the enclosure within a field complex and subsequent lynchet formation caused by later cultivation of the surrounding area. This site does not give real support to a middle Bronze Age date for extensive axial field systems.

However, there is good evidence for a middle Bronze Age enclosed settlement overlying a field system at South Lodge, where the enclosure ditch was shown to have cut through a lynchet (Toms 1925,98). Recent excavation has shown that the settlement originated as an open settlement within one field of the system, and was enclosed later (Barrett _et al_ 1981,220). The published plans (ibid, Fig.10; Barrett _et al_ 1983, Fig.1) show the fields cannot be regarded as an extensive coaxial system, although most of the lynchets share a similar alignment. The field system also developed around a group of barrows; only one

Figure 7.6.
Enclosure and field system at South Lodge.

Source: Barrett et al 1983, Fig.1.



of these postdated the lynchets. Interestingly, this is an "outlier", which produced no Deverel-Rimbury deposits (ibid, 233; see discussion of fields and barrows in section 7.2.4 below).

Barrett et al suggest that the rectangular outline of other middle Bronze Age enclosures in Wessex may result from similar development within a field system (ibid, 226; also Barrett and Bradley 1980,191).

However, the argument for this in the case of the Angle Ditch (ibid 220, based also on Toms 1925,91-4) is not entirely convincing. The chronological priority of the "drain" over the Angle Ditch was not established by excavation; it is presumed to predate it only because it "drained across it" (Pitt-Rivers 1898,60). The "drain" was filled with Romano-British and Bronze Age pottery. There is no suggestion that any stratigraphic distinction was recognised, unlike in the Angle Ditch itself (ibid, 60 and Plate 262). There is not, in the plans published by Barrett and Bradley (1980, Fig.3) or Toms (1925,90), any indication that the recognised lynchets form part of an extensive coaxial system. The single field or enclosure they define is large, being approximately 75 to 90m by at least 65m.

Barrett and Bradley (1980,191) comment that it may be "a recurring pattern for Deverel-Rimbury nucleated settlements to be integrated with their arable land, but at the same time a number of these sites appear to overlie parts of their field systems". It would therefore be "necessary to envisage an earlier, more dispersed settlement pattern with houses, scattered among the fields". However, Barrett et al (1981,226) suggest that rather than nucleation, the enclosure of settlements may reflect "growing pretensions" or "concern with the storage and protection of agricultural produce".

Another example of a settlement constructed within a pre-existing field group is provided by Hog Hill Cliff. three houses were constructed in the lee of a field bank, which Ellison and Rahtz (1987,259) suggest belong to an "extensive celtic field system". However the surviving traces of lynchets are insufficient to show they formed part of an extensive coaxial system, and the interpretative plan (ibid, Fig.23) is not entirely convincing; earlier descriptions were not accompanied by survey (ibid, Fig.1c,223).

The lynchets were not directly dated. Their relationship with the late Bronze Age/earliest Iron Age enclosure and its early Iron Age successor could not be established (ibid,227). The dating derives from the early ploughsoil, which contained middle and late Bronze Age pottery. But the middle Bronze Age pottery derived from " a small series of particular vessels", probably funerary in nature. Some unabraded neolithic and two Beaker sherds also occurred in this ploughsoil. This suggested to Ellison and Rahtz that the middle Bronze Age material derived from a ploughed out early Bronze Age barrow and Middle Bronze Age cremation cemetery located in or around it, and from an earlier material preserved in the old ground surface beneath it (ibid,259,261). This explanation is convincing, and for that reason there is no reason to infer that the fields are earlier than the late Bronze Age. The late Bronze Age structures cut through the ploughsoil (ibid,241), but they need not be much later. A feature which predates a Late Bronze Age feature is not necessarily middle Bronze Age. The early date suggested for the field system (described on Ellison and Rahtz's Fig. 23 as ?EBA/MBA) seems to reflect the conventional early dating of the 'celtic' field systems, rather than the direct evidence.

The important factor appears to be that these middle Bronze Age settlements are integrated with their field groups, and these fields have so far nowhere been shown to form part of extensive coaxial systems. Instead they seem to be small groups associated with particular settlements, contrasting with the often noted scarcity of settlements associated with the extensive 'celtic' field systems (eg. Rhodes 1950,21; Bonney 1978,51). Some do show parallel lynchets perhaps corresponding to Fleming's rather loosely defined "coaxial principle" (1987,188-9), but on current evidence, topography and the demands of ploughing seem sufficient to account for this.

7.2.2. Fields and ard marks.

Fowler's second class of evidence is criss-cross ard marks; he notes that the evidence from fields is similar to that from buried soils under barrows, which occurs as early as the mid fourth millennium BC (at the South Street long barrow). From this he concludes:

"... so far there is no tangible evidence of actual fields being laid out at such an early date even though, by implication, there not only could have been but should have been as the most obvious reason the explain the regularity, the incidence, of criss-cross ard marks." (1971,167).

As the practice of cross-ploughing is frequently regarded as the explanation of the squarish shape and a determinant of the size of 'celtic fields', the danger of circularity in this argument is apparent. If the technique was necessary to prepare a seed bed, it was presumably as necessary in a short-term plot as in a permanent field. To extend evidence for cross-ploughing to imply the existence of field systems (especially noting Fowler's later (1983,95) precise definition of the five characteristics of the systems he discusses) is surely not acceptable.

In fact evidence suggesting a laid out field of neolithic date has come from Bishopstone, where a substantial positive lynchet overlay and preserved a ditch cut by a negative lynchet. Bell dated the ditch to the earlier neolithic, and interpreted it as a field boundary, noting that the negative lynchet followed the line of the ditch (the later positive lynchet was on a different line). The negative lynchet was also dated to the neolithic on the basis of the artifacts in the dark soil in it, although this also contained a little Bronze Age material (Bell 1977,258). Dating lynchets is problematic, but statistical analysis of the artifacts from the Bishopstone lynchet by Allen (1982; discussed in Chapter 6 above) supports Bell's interpretation, in so far as it showed a clear distinction between the distributions of the neolithic and Bronze Age material. But since the negative lynchet truncated the ditch, it is clearly possible, and perhaps likely, that the earlier neolithic material in the lynchet derived from the ditch fill and not from contemporary settlement. Accepting the negative lynchet as earlier neolithic is therefore open to doubt; the ditch, and possible fence, may well represent a field boundary of this period, although it should be noted that only a short length was excavated.

A single ditch, fence or lynchet obviously provides little information on field shape or size. The evidence suggests a defined field, cultivated sufficiently often to create a negative lynchet during the period between the infilling of the earlier neolithic ditch and the main period of Bronze Age use. This is important information about agriculture during this time, but it is not evidence for extensive axially organised field systems.

7.2.3. Fields and linear ditches.

Interest in the linear ditches of the chalklands of Hampshire, Dorset and Wiltshire focusses on two aspects.

The first is their interpretation in terms of a coherent "linear ditch system" (Bowen 1978,122,Fig.2) which was laid out in an "apparent major land re-allotment"; because "in most cases of intersection with 'Celtic' fields" they "ignored, and, for a time at least, put an end to the arable cultivation of these fields" (ibid,120) the linear ditches are clearly important in understanding the arable exploitation of central southern Britain during their supposed period of construction and use. Fowler (1983,190) notes that "there can be no doubt that, in general" this use dates to the second millennium BC, with their development dating "at latest" to the middle of the millennium, and their origins "perhaps even earlier". The interpretation that an early system of cultivation in axial fields systems was discontinued in the way Bowen suggests has important implications for later prehistoric agriculture. If the system 'failed' because either fertility levels or the necessary organisation and coordination of land use could not be sustained, this raises questions as to how these problems were resolved during later use of extensive axial systems.

The second aspect is the relationship between linear ditches and the 'celtic' field systems. Both Bowen (1978,120) and Fowler (1983,190-1) consider that the characteristic relationship is for the ditches to "cross" the fields, putting them out of use. Surprisingly, given the early dating he accepts for the ditches, Fowler maintains this view despite his recognition that most surviving field systems date to the period c.500 BC to AD 500 (Fowler 1983,94). This relationship and the dating of the linear ditches are then key elements in Fowler's dating of the axial field systems. He summarises:

"Their nature and probable function was long ago demonstrated by Hawkes and a middle Bronze Age date for many of them is generally accepted. In many cases, celtic fields are directly associated with them so this would seem to take some of the systems back to that date too. But an earlier date is indicated in a number of cases where the linear ditches actually cut across pre-existing field systems" (1971,169).

There are thus three issues: the evidence for the dating of the linear ditches; whether they can be regarded as constituting a coherent 'system'; and whether the linear ditches exhibit a consistent relationship with the axial field systems. The implications of these questions have wider significance than chronology alone; interpreting the evidence for linear ditches and field systems and the relationships between them is the subject of section 7.4.

7.2.3.i. Linear ditches: dating and interpretation.

Hawkes' (1940,142) original dating of the earliest of these ditches to the middle Bronze Age (then described as late Bronze Age) was based on excavation at two sites, Martin Down and Boscombe Down. He also noted ditches "as late as the Early Iron Age" at Fyfield Bavant and Swallowcliffe Down. His assessment followed excavations at the hillfort on Quarley Hill, where ditches converging on the hilltop preceded the hillfort, one being associated with the earlier palisaded enclosure. The ditches were not all contemporary. Excavations by Arnold (1972) produced no additional dating evidence for the linear ditches.

Pitt-Rivers excavated a 300 foot length of the linear ditch and its rampart at Martin Down (1898,29,109,215, and Plate 307). The rampart contained only pottery of his British No. 1,2,and 4 Qualities, except for a coin of the fourth century AD, a casual find by workmen levelling the bank, which he regards as intrusive or wrongly located. The ditch contained only sherds of No.1 Quality in its lower fill, and notably few of them; the upper fills contained No. 1 and 2 Qualities, and Romano-British pottery and other objects. Neither bank nor ditch contained pottery of Pitt-Rivers No. 3 Quality (ie. Beaker).

Bowen's assessment (1961,35,note 28) of these excavations is interesting. He notes that "such evidence taken alone surely dates the fields it cuts through rather than the ditch itself", a reasonable interpretation which seems since to have been disregarded. One problem is the nature of the fields the ditch cut through. Bowen (ibid,Fig.3A) illustrates the earthworks on Martin Down, in a plan derived from aerial photographs; the fields have since been "virtually destroyed" (ibid,24). [The linear ditch, interestingly, appears to respect the corner of one of a group of long fields (in south east of plan) regarded by Bowen (ibid,24) as probably Romano-British.] If the excavated section was where Bowen indicates (Pitt-Rivers does not give sufficient information to locate it precisely), then it did not include the stretch where the ditch and the field group illustrated by Bowen intersect. As Pitt-Rivers does not note any relationship with other features, there is no evidence as to the source of the material incorporated into the bank and found on the old ground surface below it (the two contexts are not distinguished). It could derive from a scatter of occupation material from the Martin Down enclosure or another unrecognised settlement rather than from fields.

The other problem here, and more generally in the region, is the dating of the pottery. Reassessments of the chronology of the Bronze Age during the 1950's pushed Deverel-Rimbury pottery, referred to in earlier reports as late Bronze Age, into the middle Bronze Age, post c.1400BC, and led to the backdating of several of the sites discussed in this chapter. However the end of this pottery phase is less clear. Barrett (1980) considers that in most of the Thames Valley and south-east coastal

Britain Deverel-Rimbury traditions ended by c.1000BC, to be succeeded by a plainware tradition itself replaced by a tradition using a wider range of decorative techniques by the eighth century BC. In Wessex, there is little to indicate a plainware tradition, and dating evidence for Deverel-Rimbury pottery takes it "at least into the tenth century BC". But he considers it unlikely to have continued beyond the end of the century, and notes that the decorated assemblages cannot be dated that early. He suggests this relates to "a hiatus in the settlement record" (Barrett 1980,310-311).

Gingell (1978,215,219-220) has noted that at Burderop Down (Marlborough Downs) Deverel-Rimbury sherds and plainwares occur in contexts in which they cannot be separated stratigraphically. They are also in association with metalwork of the Ewart Park phase, dated "not before the eighth century BC". All the pottery, except for a few sherds described as "presumably imported" are in the "characteristic heavily flint-gritted ware of the Deverel-Rimbury material"; change to a harder sandy fabric did not occur in the area until the decorated wares. On this basis, Gingell suggests that the Deverel-Rimbury tradition may continue further into the early first millennium BC.

Barrett <u>et al</u> (1981,232) quote six consistent dates from the Handley barrow, falling into the range 950 to 720 +/- bc. Although "there <u>is</u> a gap and it still needs to be filled", they note the closeness of these dates to the earliest Iron Age dates; at two standard deviations, the latest of these (720 +/- 45 bc) overlaps the earliest from Gussage All Saints (510 +/- 80 bc).

The sherds excavated by Pitt-Rivers from the bank of the Martin Down ditch may therefore be as late as the tenth century BC, or even, if Gingell is correct, the eighth.

At Boscombe Down, Stone (1937) excavated a three-sided enclosure, dated by Deverel-Rimbury pottery, which was cut by a linear ditch. He suggests that the linear ditch was dug shortly after the enclosure to close the fourth side, although he notes that the "incomplete" enclosure can be paralleled elsewhere. A small and rapidly refilled length of the enclosure ditch is cited in support of this, but there are some points which cast doubt on this interpretation. The refilled feature, in contrast with the rest of the enclosure ditch, was "a mere scooped out hole". There is also a marked difference between the fills of the enclosure ditch and the linear ditch. The former contained a "profusion" of pottery and other finds, while the latter (except where it cut the enclosure ditch) contained only two similar sherds in its primary fill. Where the ditches intersected, finds were few in both. The fills of the two ditches were "unlike .... in both texture and colour"; Stone suggests this may be the result of the wider ditch silting more slowly and becoming turf-covered (ibid, 469,473-4). The evidence for a short time interval is not strong.

The Boscombe Down ditch did not cut through fields. Stone noted a difference in land use between the faces of the ridge, with "chequer-board fields" on the south-facing slopes contrasting with a series of linear ditches on the north (ibid,488). Contemporaneity was not demonstrated.

Neither a middle Bronze Age date nor a relationship with extensive axially orientated field systems is securely demonstrated for either of these sites; they appear a shaky foundation for building a chronology for either feature type.

More recent excavations of linear ditches do not so far support a date in the middle Bronze Age. Ford (1982) excavated several sections of the Berkshire Grims Ditch, located where adjacent settlements provided the opportunity of obtaining dating evidence. This ditch, partly aligned on round and long barrows, is incorporated into one group of 'celtic fields' and possibly respects another. At Churn, primary ditch fills included pottery of Barrett's decorated ware phase of the late Bronze Age (eighth to fifth centuries BC). The stratigraphic relation between the adjacent occupation layers and the ditch had been destroyed by ploughing, but the ditch must either postdate or only shortly predate the occupation. At East Ginge Down, the pottery from the primary silts was not diagnostic, but suggested a date no earlier than the late Bronze Age for the construction of the ditch. The third section produced only one undiagnostic sherd from the primary silt. Ford therefore dates the ditch to the late Bronze Age or early Iron Age, eighth to fifth centuries BC.

Further work by Ford (1985) provides confirmation of the dating of these features. Fieldwalking and a series of narrow excavations were used to investigate several linear ditches in West Berkshire, with emphasis on both their dating and their environmental context. The dating results were uneven in quality, with a good date of c.50 BC to AD 300 for the Aldworth-Streatley Grims Ditch, and a _terminus ante quem_ of c.500 BC for East Ditch. Scarcity of pottery from the ditch fill at Russley Down Middle 2 suggested that the ditch was dug after the adjacent late Bronze Age site went out of use (ibid, microfiche pages 2-3). However the absence of Roman pottery from primary levels and its presence in higher levels forms the main indicator of date for several of the other ditches excavated.

Ford considers the late Bronze Age and early Iron Age the likeliest date for the ditches, noting that the later Aldworth-Streatley Grims Ditch is morphologically distinct from the rest (ibid,15-16,Fig.7). There seems no strong reason to exclude dates later in the Iron Age or early in the Roman period; for example at Coppington Down, the lynchet appears to have accumulated alongside the ditch during the Roman period, and it is unclear why this makes a pre-Roman date "likely" (ibid, microfiche pages 4-5). While the absence of Roman sherds in the primary silts is noticeable, the rapidity (perhaps one to five years) with which these deposits form (ibid,15) suggests that if the digging of the ditch and the commencement of cultivation together constituted the earliest Roman activity in the immediate vicinity, it need not be surprising. If the Roman material derived from manuring, it would have been 'trapped' by the positive lynchet, reducing its likelihood of reaching the ditch.

This series of excavations is clearly the best evidence for the dating of linear ditches at present available, and the very range of dates found (ibid, Fig.7) is important both in terms of the interpretation of the "linear ditch system" and their use in dating field systems. It also illustrates the difficulties of dating these features - the dates derive essentially from either proximity to late Bronze Age settlement or to scatters of Roman sherds. Differences in manuring practices (see Chapter 6) may be significant; it is also worth noting Richards' suggestion that "the most ill-represented period" in the archaeology of this area is "when the use of flint has declined and is unaccompanied by an improvement in pottery manufacture" (1978,41). This is as significant in interpreting the dating evidence for landscape features as it is for the detection of sites by survey.

Dates in the late Bronze Age for two other linear ditches in Berkshire are reported by Richards (1984). At Streatley Warren, Richards' excavations confirmed a late Bronze Age/early Iron Age date for the origin of the field system. This overlay a substantial earlier ditch, which had been backfilled (ibid,67). At Beedon Manor Farm, the ditch was also apparently deliberately backfilled (ibid,56). At both these sites, Richards suggests the ditches may have played a role in defining the extent of settlement; although if the ditch was refilled before the late Bronze Age/earliest Iron Age occupation at Beedon, as is suggested, it is unclear why this should be so. The grounds for the view that the backfilling preceded settlement are not specified, and the "occupation layer" did not extend (or at least, did not survive) over the ditch itself (ibid,56,Fig.36).

Two sections of linear ditch aligned on a round barrow (Bishops Cannings 81) were excavated by Robertson-Mackay (1980,159-160,Fig.2). The barrow contained a primary Beaker burial, but there were no datable finds from the linear ditches. On the basis of the snail shells from the lower fills, Evans (ibid,174) suggests that the linear ditch is distinctly later than the barrow ditch. These ditches are part of Bowen's 'Wessex linear ditch system', as is the "spinal linear ditch" at Knoll Down. Bowen et al (1978) made two one metre square excavations in the bank of this ditch, where it traverses a group of axial 'celtic fields' (Bowen 1975b, Plate 3A). The aim was to retrieve environmental evidence, to see if the bank was topped by a hedge to contain animals [Ford (1982) noted that his excavations on the Berkshire Grims Ditch produced no support for the 'ranch boundary' interpretation]. Dating was apparently not considered an issue, but one trench produced, from the ploughsoil under the bank, "six very small sherds", of which four were "indeterminate" and two were interpreted as possibly Beaker. The state of the sherds presumably indicates they had been in the ploughsoil for some time, and they cannot be considered to date the linear ditch. However subsequent excavations (Evans and Vaughan 1985,23; see below) have demonstrated that this section of the Knoll Down earthwork overlies a lynchet containing material from the later pre-Roman Iron Age.

The results of these excavations emphasize that only a project designed to section banks and ditches where adjacent settlement sites or other features give the possibility of establishing stratigraphic relationships or of finding occupation derived material incorporated into banks or ditch fills is likely to provide reasonably conclusive dating evidence. In other contexts, the sparsity and poor condition of the material usually found (especially sherds from ploughsoils) implies it is unlikely to provide an indication of its date sufficiently clear to challenge existing assumptions about the dating of these features, as in the case of Knoll Down discussed above. This is in marked contrast with the results Ford et al (1988,402) found in the Lambourn Down field systems, where all the lynchets examined produced Romano-British pottery.

Another problem arises from the difficulty in distinguishing linear ditches from other features such as trackways. Ford's examination of the Berkshire Grims Ditch included a trench through what was thought to be an offshoot ditch; this revealed instead a broad, shallow hollow way whose date and relation to the ditch remained unclear (1982,25-6). In another case he used an auger to distinguish ditch from hollow way (Ford 1985). Bowen (1975,108-9) noted that a linear feature near Knoll Down, abutted by 'celtic fields' was recognised from aerial photographs, and "its position in the local pattern suggests that it might be an element of the 'ranch boundary' system". But excavation showed the feature to be only about 15cm deep into the chalk, and it is probably a hollow way; surface finds were mostly Romano-British.

This raises the question of the relationship between linear ditches and trackways. Cross-ridge dykes (see below) have been regarded as trackways for the movement of animals (eg. Clay 1927; Stone 1934), but Bradley considers they did not function as routes, at least in their original use. He noted that despite the relation of the line of some dykes to tracks on lower ground, the intervening scarp implies they could not have formed a continuous route. He suggests that trackways developed along boundary lines on the lower ground (1971,9-10,13-14).

Robertson-Mackay's excavation of linear ditches at Hemp Knoll showed they terminated before the barrows they were aligned on, and this implies they did not form a continuous routeway (1980,159-60). Although some linear ditches are relatively shallow with broad flat bases, others have deep V profiles, and even slots in the base. The ditches excavated by Evans and Vaughan (1985) include examples of each.

However, in some cases linear ditches were later used as trackways, as at Overton Down (Fowler 1975, Fig.8a), and in some cases trackways run up to ditches, as at Churn (Ford 1982,25). One of the most interesting aspects of Ford's work in Berkshire is the relationship of linear ditches to other linear features; at Baydon the ditch seems to follow "a gap between a positive lynchet and its negative element"; a small ditch at Folly Clump was to be overlain by a hollow way, which apparently followed a pre-existing lynchet-defined gap; the Roman ditch at Aldworth-Streatley may have replaced a hollow way (1985, microfiche pages 3-13). The two lynchets at East Ginge Down (Ford 1982,Fig.4) suggest this section of the Grims Ditch could have been replaced by a double lynchet boundary or track after it had silted up.

Cross-ridge dykes are a similar linear landscape feature, and while they are regarded by Bowen (1978) as distinct from linear system ditches, Bradley (1971,11) has argued that "their distributions are adjacent and almost mutually exclusive" and "the differences are ones simply of terrain". Some of these dykes have been dated by excavation. At Swallowcliffe Down (Wiltshire) the ditch was dated to the early Iron Age by a sherd on its trodden flint bed. The west side of this ditch had been modified by later cultivation and lynchet formation (Clay 1927,63). Curwen and Curwen (1918,65) considered a Bronze Age date probable for a cross-ridge dyke on Glatting Down (Sussex). However this dating derives from fragments of a single cinerary urn, some of which also occurred stratified above Romano-British pottery and tile. It seems safer to regard them as deriving from a disturbed earlier context rather than reflecting activity contemporary with the ditch (ibid,57-8,62-4). O'Connor (1976) dated a cross-ridge dyke at Alfriston (Sussex) to the early Iron Age on the basis of the lowest sherds from the secondary fill, and Bedwin (1979) "tentatively" dated a dyke from Upper Beeding (Sussex) to the same period. Interestingly there were no sherds in the primary fill layers of any of these three Sussex dykes, supporting the view that sherds in the primary fills are likely to reflect earlier rather than contemporary activity (cf Ford's discussion (1985, microfiche pages 7-8) of the East Ditch, Green Down).

Fowler (1983,192) apparently regards the outwork cross-ridge ditches at Hambledon Hill as similar in character to these cross-ridge dykes, allowing the type an origin in the early third millennium BC. But the Hambledon ditches are described by Mercer as extensions of the concentric ditch enclosure concept, their cross-ridge form resulting from the location of the site at the junction of three spurs (1980,40). The outworks of this site extend over a sizeable area, and some are clearly defensive (ibid,46,48). There seems to be no reason to relate these to the later cross-ridge dykes discussed above.

The relationship between hillforts and linear ditches is another indication of their date range. The ditches frequently converge on hilltops occupied by hillforts; Fowler (1983,190) regards it as a characteristic feature of linear ditches that they underlie the hillforts, as at Quarley Hill (see above). However, ditches do not always predate the hillfort; at Sidbury, Cunliffe noted that "one of the boundaries converging on the fort appears to join the earthworks of the fort entrance in its most evolved state and must therefore be late" (1971,62). Bradley, following Bowen, comments that this ditch is "of the developed, more massive type and belongs to a mature phase of the local layout" (1975,202). Bradley notes "an increase in scale from simple ditched boundaries to substantial linear obstacles" (ibid,199).

It is a problem of the discussion of these features that this sort of model of development has at times been accepted without excavated evidence to support it; it can then be used to account for examples which do not otherwise conform to expectations, for instance because of their date, while the underlying assumptions which should be reassessed remain essentially unchallenged.

However, in one instance a progression of this kind has been confirmed by excavation (Evans and Vaughan 1985). Bowen interpreted a thin line visible on an aerial photograph cutting across an arc of the linear earthwork on Knoll Down as a slight ditch, belonging to "an early phase of the linear boundary system" (1975,106.108,Fig.7). Evans and Vaughan (1985,Fig.7) showed that the main linear earthwork 'A' overlies a lynchet which contains pottery of the later pre-Roman Iron Age. The other ditch 'B' had been deliberately backfilled; this fill and a possible ploughsoil overlying it also contained small later Iron Age sherds. This ditch is not otherwise dated, though Evans and Vaughan suggest it may be early Iron Age (ibid,27-8,35,Fig.10). A length of ditch 'E' on the same line resembled 'B', and also had been partially deliberately backfilled. The infilling of the one ditch apparently prior to the construction of the other (ibid,34-5, but there is not direct evidence for this) again points to the difficulties in regarding them as a 'system'. The implications of these results for the dating and interpretation of these features was recognised by Evans and Vaughan (ibid,37); they suggest that "the system is of complex origin, beginning perhaps in the Middle Bronze Age and continuing to be modified and added to into the Iron Age and even later times".

But the term 'system' seems to be misleading in itself, either building in unwarranted assumptions or being used so loosely as to have little meaning. The concept of a 'linear ditch system', as used by Bowen (1978) carries assumptions such as uniformity in function and relationships with other landscape features. Despite differences in form, and additions and enlargements over "a long period, still to be determined", the "linear system ditches" are defined by their "demonstrable relationship to a whole web". Bowen (1978,122) describes the 'linear ditch system' as "looking as if a new and careless power were being imposed". The evidence from excavation suggests a 'system' including trackways, ditches and other land divisions, of differing dates of origin, different function (see below), and not all in use contemporaneously.

Bowen's discussion has obviously been very influential, for example in Palmer's account of the Danebury area (1984). Palmer distinguishes between "Wessex" and "local" linears ditches; the "Wessex" ditches are those "which formed part of the first major system of land allocation in Wessex"; their construction he suggests "may reasonably be assumed to to lie in the middle bronze age" (ibid,10,109). The "local" ditches are "those which do not form part of a major system", and often relate to Iron Age enclosures. Palmer also observes that the "Wessex" linear ditches sometimes converge "at points which were of significance later in prehistory" (ibid,65); that is, they also sometimes relate to Iron Age settlement. The significance of the distinction must be called into question by the results of recent excavations on linear ditches; the clearest difference seems to be one of length (ibid,10,Fig.24).

The distinctness of these features from other landscape features may also be unduly stressed by characterising them in this way. The relationship of linear ditches to other linear features in several of Ford's excavations and elsewhere between tracks and ditches suggests that the ditches should not be viewed in isolation - this is particularly so where the ditches appear to be fitted into a pre-existing gap between field groups. Palmer includes ditch defined trackways in his "local" linear ditch category (1984,10). The discontinuous nature of the ditches (eg. Bowen 1978,Fig.2; Ford 1985,Fig.2) also invites the interpretation that the 'gaps' may have been defined in other ways, perhaps simply by local topography (Ford 1985,17). Bradley's comments on continuity of line between cross ridge dykes and low-lying tracks were referred to above. The examples of axial field groups aligned on the linear ditches also suggests the two should at least in some cases be considered together rather than as separate systems.

The relationships between fields and linear ditches are discussed below. In terms of dating, the essential point is that the demonstration of the wide date range for these features and the difficulty in distinguishing them from other linear landscape features itself removes their value for dating field groups they relate to, unless the particular ditch is itself securely dated. And evidence for a middle Bronze Age date for even the earliest of these features seems poor.

7.2.3.ii. Linear ditches and field systems.

The second important issue is the relationship between "celtic fields" and the linear ditches, which is a key point in both understanding the agrarian implications of the ditches and their use in dating the field systems. This section concentrates on chronological relationships; economic relationships are discussed in section 7.4 below.

The insistence, quoted above, that the usual relationship is for ditches to cut across pre-existing fields, has had considerable influence. This expectation is clearly likely to have influenced the interpretation of aerial photographs and fieldwork. It is interesting to compare two statements: "ditches regularly cut elements of the cohesive systems" (Bradley and Richards 1978,55) and "[this] now cannot be taken as an accurate generalisation" (Richards 1978,40-1). Richards cites examples of other relationships, field groups aligned on ditches and ditches following earlier boundaries. But it is significant that he does not question "the priority of the celtic field system as a whole over the ranch boundary system". This presumably means the earliest fields predating the earliest boundaries; yet while the relationship between these features remains a key element in the argument dating the fields, there is a danger of circular argument in asserting this relationship.

Ford's examination of the linear ditches of West Berkshire (see above) also casts doubt on this relationship. Here evidence that they cut through and end the use of field systems is "neither common nor convincing" (1985,16). He identified five cases where field blocks and linear ditches are associated, and in only one of these could the ditch have cut across the fields. The only evidence is an "indistinct aerial photograph", and as Ford points out, "field systems on an oblique alignment to linear earthworks do not necessarily predate them". In the other four cases the fields are aligned on the linear boundaries; Ford notes there is "less evidence" for linear ditches respecting 'celtic fields', citing some possible examples (ibid,4). The Grims Ditch appears to respect a pre-existing boundary in some places, although the nature of the boundaries and whether they defined a field system is unknown (Ford 1982,35). At least one field system is aligned on it. Interestingly, Ford notes that some linear ditches do cut "lynchets which are poorly integrated with the field blocks" (1985,4).

In the Danebury area, Palmer (1984,65-9) notes that "local" linear ditches "tend to conform to the pattern of ancient fields" and in many cases air photographs suggest that they "follow pre-existing lynchets". Of the two examples he gives which do cut field groups, one is a double ditched feature interpreted as a lane, and the other may relate to Romano-British settlements. Palmer suggests that the "Wessex" linear ditches are more likely to cut through pre-existing cohesive field systems, citing examples at Bulford Down and Cholderton (ibid,65,111,Fig.29). He suggests that the fields and linear ditches at Cholderton "ought to form one of the primary research tasks" following on from his survey (based on aerial photography), and resolving the dating and relationships of these features would clearly be important.

In another Hampshire example, Woolbury, the fields also seem to be aligned on a linear ditch, which in this case separates arable from pasture (Cunliffe 1971,62,Fig.16). The contrast between the strip of fields alongside it and the more obviously coaxial group immediately to their west is interesting, and establishing the relationship between them might prove very informative in understanding landscape developments.

The key point is that a range of relationships exist; and in Berkshire at least, the commonest relationship seems to be for fields to be aligned on the ditches (Ford 1982,4).

Some more general points can be made. One is the need to examine critically the basis for assertions of the relationships between landscape features, where the ability to determine relationships correctly in that way has not been evaluated by excavation. Another is the need for clear description and definition of features if they are to be categorised in the search for generally applicable relationships. In particular, distinguishing what is implied by the terms used is essential. It is necessary to be able to group landscape features to make progress in understanding the organisation of the landscape and its agricultural exploitation - the alternative is merely to accumulate a file of unrelated results. But without clear definitions of the types of features involved, and the ability to distinguish them, models or syntheses are likely to be unsatisfactory.

7.2.4. Field systems and barrows.

Fowler's fourth class of evidence is the relationship between fields and barrows:

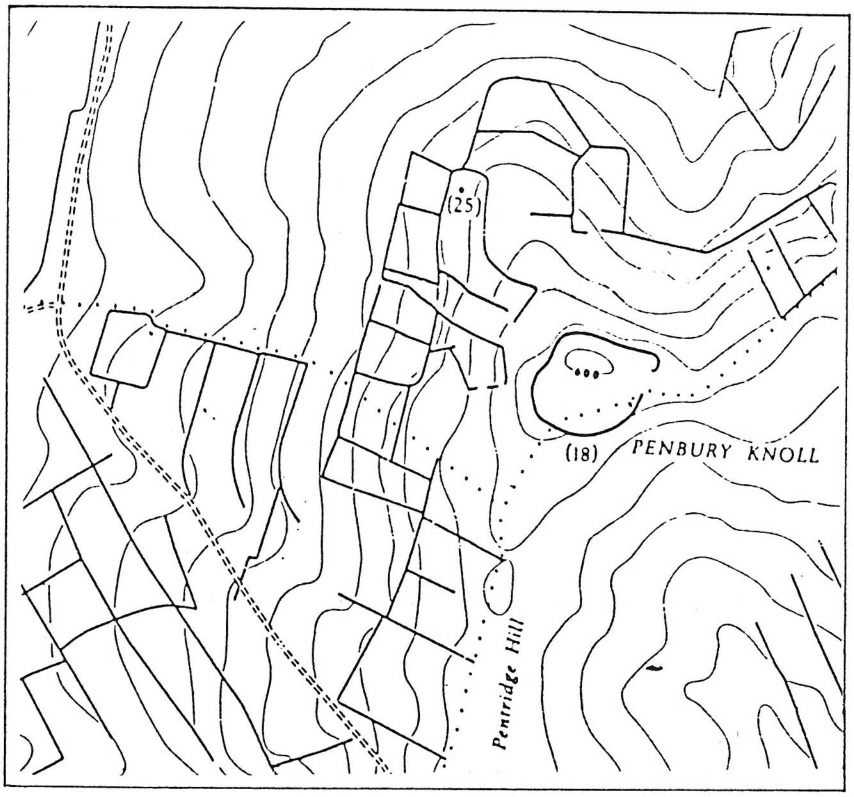
"Usually .... fields are later than barrows. In a few cases, however, with varying degrees of probability, it appears that round barrows are on top of Celtic fields and, therefore, could well push the origins of a regular, rectangular field layout back into or even before the Early Bronze Age" (1971,171).

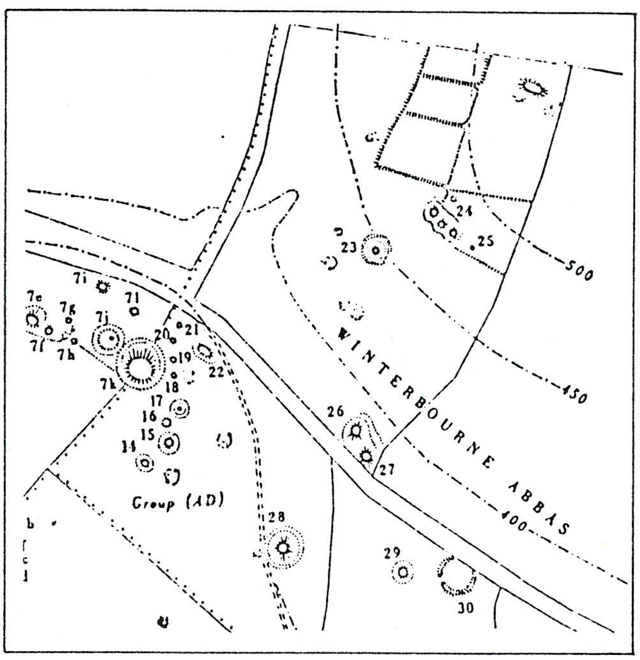
He emphasises two examples, for neither of which is there direct dating evidence. Winterbourne Abbas 24 is a 'triple barrow', a type regarded as belonging to the mid second millennium BC. To the north of this lie three rectangular and axially aligned fields (only a small area of earthworks survived to be surveyed). A lynchet running south-west from these appears to pass under the western mound - its alignment is not precisely that of the fields. The barrow, which has no ditch, appears to lie on the corner of a field defined by this lynchet and two running east-west and northwest-southeast respectively. Ploughing has destroyed the relationship of the barrow with the latter lynchet. It is not clear that the field whose lynchet the barrow overlies forms part of a regular axial field group, and the difference in alignments between its sides and the three fields immediately to the north suggests that it may not be (Fowler 1971,171 and Fig.35A; RCHM Dorset 2(3) 1970,260-3).

The round barrow on Pentridge Hill (Pentridge 25) lies in a field bounded by a two metre high lynchet. Fowler (1971,171,Fig.35B) comments that it is difficult to see how the lynchet could have formed with the barrow in existence, although there is a clear ten metres between barrow and lynchet. Examples of barrows damaged by prehistoric ploughing are known, occurring as early as the Beaker period at the South Street long barrow (Ashbee et al 1979,298). Referring to the RCHM plan (1976, Dorset 5, end pocket), it is noticeable that the field in which this barrow stands is irregularly shaped, in marked contrast to several more regular axially laid out field groups in the vicinity. The RCHM (ibid,57) notes that the field evidence as to which is the earlier is not clear. The breaks and

Figure 7.7.
Fields and barrows at Pentridge Hill and Winterbourne Abbas.

Source: RCHM Dorset Vols. 2(3) and 5.





curves in the lynchet to the north suggests its line could have been influenced by the presence of the barrow.

Fowler continues:

"The point here is that regular field systems of the Celtic field type themselves actually pre-date the barrows. By implication, this might well be a widespread phenomenon since it would now seem reasonable to think that the known instances where a cultivated soil has occurred under a barrow possibly indicate the former existence of proper field systems and not just sporadic and unorganised cultivation" (1971,173).

Here it is important to recall that what Fowler is referring to is a clearly defined type of field system whose five characteristics include "their organised structural nature" (1983,95,n.4). Unambiguous evidence for Bronze Age barrows post-dating this type of field seems to be lacking. Fowler appears to be assuming a 'celtic fields or chaos' dichotomy. But the evidence of excavated lynchets of early date, as at the middle Bronze Age sites referred to in section 7.2.1. above, suggests the existence of field systems on a smaller scale. The case for the definition and repeated cultivation of an area of arable land is not identical to a case for an extensive axially laid out field system. The latter is only a reasonable inference if there is also evidence that the earliest fields to exist were of the extensive axial type; there is no evidence for this, and it seems intrinsically unlikely, implying a transition directly from shifting cultivation to large scale landscape organisation. Bradley (1975,195) notes that in Wessex "individual lynchets are certainly overlain by dated barrows ..... but so far these are not associated with really major systems".

The relationships between barrows and later fields has been discussed by Bradley and Richards. Bradley notes that "the very respect" shown to barrows may mean the time interval was not long - although, as he notes elsewhere, they also feature as fixed points in boundaries much later in date (1975,195; 1978,268). Richards notes that on the Berkshire Downs, groups of barrows tended to be treated with respect, but isolated examples seem to have been treated differently, by incorporation into field boundaries (1978,39). It is perhaps worth noting that cultivators wishing to use land containing barrows have a limited range of options. Incorporation into a boundary may be the most economical way of using the land, and an area holding a number of barrows may be defined and ignored because it cannot be used for cultivation without the substantial labour input needed to level the mounds.

Some barrows may have been ploughed out at an early date; this is the explanation offered by Ellison and Rahtz (1987) for the mixture of unabraded neolithic sherds and early and middle Bronze Age pottery suggestive of funerary use in the ploughsoil at Hog Hill Cliff (Dorset). They suggest an early Bronze Age barrow forming a focus for middle Bronze Age burials was used as the corner of the field system, and levelled during the use of the system. An early/middle Bronze Age date for the fields was inferred by Ellison and Rahtz (ibid,259-261), but it was suggested above (section 7.2.1.) that a late Bronze Age is likely.

There are of course many barrows of post-Bronze Age date, and it is interesting that a number of the excavated barrows from field systems have proved to be Iron Age or later. These include the Saxon barrows from New Barn Down (Curwen 1934), discussed above. Bowen (1961,31) refers to the excavation of a mound overlying a lynchet by Crawford; it apparently contained no burial but overlay Romano-British sherds in the old turf line. Smith and Simpson (1964) excavated three Roman mounds on Overton Down, and noted the earlier investigation of three mounds of possibly similar date in north Wiltshire. White (1970) excavated a late Iron Age round barrow in a square ditch near Handley (Dorset); it lay in a corner formed by a trackway and a group of irregular enclosures. Other possible Iron Age barrows include three in square ditched enclosures at Winterbourne Steepleton, which lie within lynchetted fields (RCHM Dorset 2.3, 1970,472, Fig. facing page 624). White also notes that the excavated Iron Age cemeteries at Owslebury and Verulamium "occur in areas marked off by rectangular enclosures which are tacked onto boundary ditches". He suggests that an association with long enclosure ditches may indicate barrows of Iron Age date.

Dent's (1982) analysis of cemetery location in the Iron Age of the Yorkshire Wolds emphasises the close relationship between barrows, singly or in groups, and linear earthworks and trackways. In some parts, the barrows typically occur in areas enclosed during the Romano-British period. Dent suggests these areas may have been cultivated using an "unditched field system" during the Iron Age also; a difference in land use could explain the contrast between dense packing of some cemeteries and the wider separation of barrows in others. It is interesting that the more scattered cemetery cited by Dent follows "the line of a track which is only defined by ditches to the north where it passes among field enclosures". The arable land use appears to restrict the area occupied by barrows, emphasising the relationship with boundaries and trackways (ibid,450-2).

The relationship between Roman cemeteries and roads is well known, and Romano-British burials also occur alongside trackways (eg at Stanton Harcourt, Oxfordshire; McGavin 1980) and land boundaries (eg. at Burntwood Farm, Hampshire, where a single line of burials lay parallel and close to a boundary ditch; Fasham 1980).

Because of this association between Iron Age and Romano-British barrows and trackways or boundaries, and the fact that a number of investigated barrows which do post date fields system have proved to be post Bronze Age in date, it should perhaps be suspected that barrows which appear to post date field boundaries may also prove to be atypical in date. Even in the securely dated field group at South Lodge, which developed around the Barrow Pleck cemetery, the single barrow which post dates the fields is an "outlier" which produced no Deverel-Rimbury material (Barrett _et al_ 1981,226,233). An undated barrow apparently overlying a lynchet cannot safely be used to infer an early date for the field.

The relationship of fields to barrows is also relevant in considering Fowler's suggestion that "the axial framework of a field system reflects a controlled clearance process", that is, the primary clearance of an entire area for cultivation, possibly in long surveyed swathes (1983,105,Fig.42). However, the fact that barrows frequently precede field systems indicates earlier use of the area, and on the chalk downland Bradley (1978,114) notes that most "well-published" barrows were built in areas which were already cleared of tree cover. Fowler (1971,171) refers to the "numerous cases" of round barrows used as corners of fields. If as Bradley (1978,116) infers, this involved the use of the barrows as "sighting points", it is difficult to see how this could be achieved in a wooded landscape, unless a single barrow was simply selected as a starting point.

Bradley (1975,195) takes a similar view, suggesting that the extensive axial systems could have been laid out only "in a landscape with few fixed boundaries or lasting settlements". The lack of substantial excavation of field systems in Britain makes assessment of this view difficult. Fowler (1967,17-24) found ploughmarks and an Iron Age round house underlying a lynchet of the field system on Overton Down. There are a number of other settlements or enclosures known or appearing to pre-date field systems. These include the linear ditches underlying fields at Overton Down and Streatley Warren (Fowler 1975, Pl.8A; Richards 1984,67), the middle Bronze Age enclosure underlying a coaxial field system at Preshute Down (Piggott 1942, 50-1, Pl.VII) and the middle Bronze Age cultivation deposits under the Iron Age lynchet at Itford Bottom (Bell 1983,132,135,140). Some of the larger scale excavations of field systems from northwest Europe have also produced evidence for earlier settlement or field boundaries. Excavations on Gotland, Sweden, discovered settlements which were, on the basis of both stratigraphic and radiocarbon dating, earlier than the large continuous field system laid out in the late Bronze Age/pre-Roman Iron Age. The earlier settlement evidently did not prevent substantial landscape reorganisation here (Lindquist 1974,18-9,21). Brongers similarly identified "pre-Celtic field" land divisions/use in the Netherlands (1976).

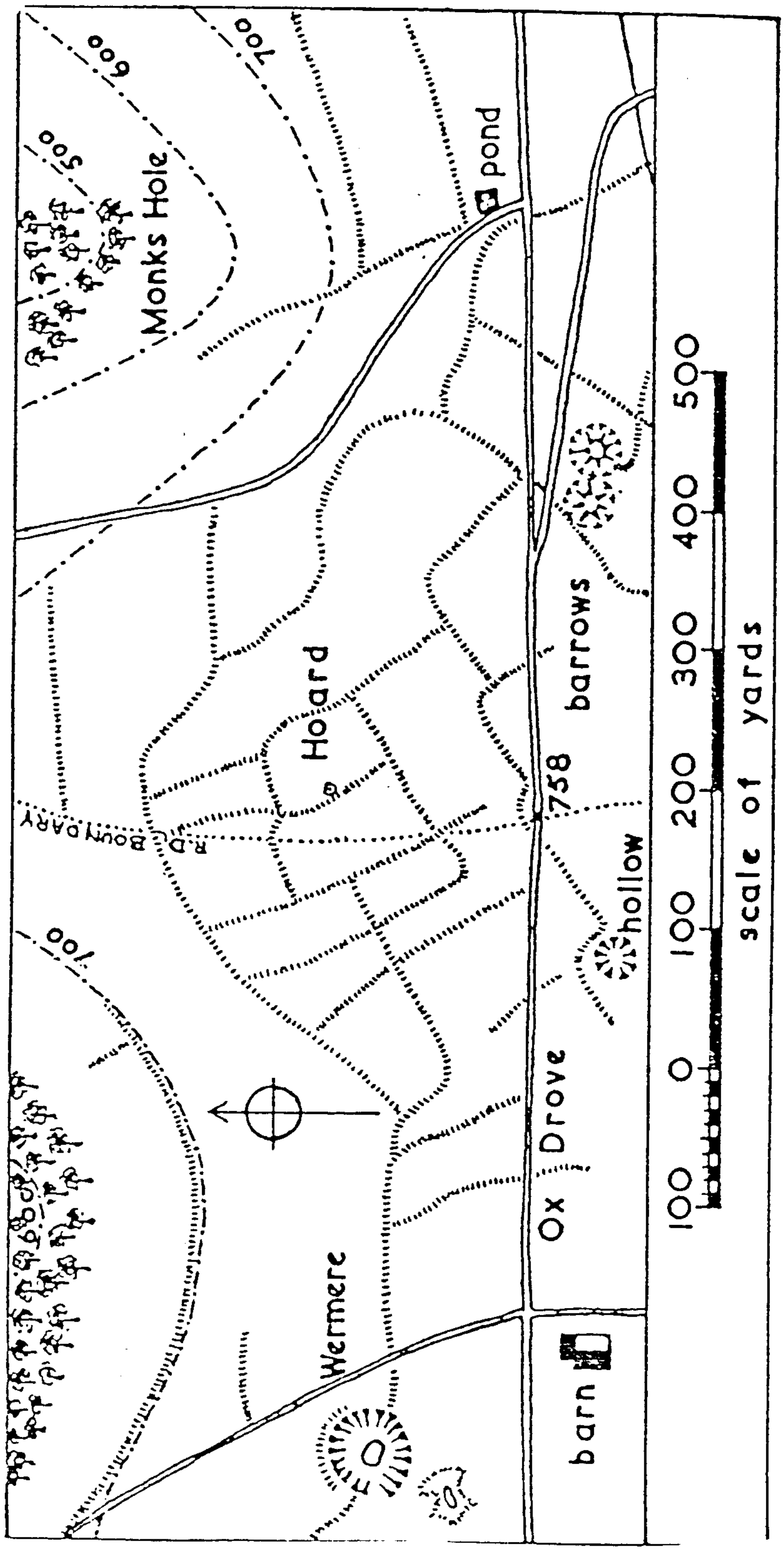
7.2.5. Field systems and hoards.

The final category is finds of Bronze Age metal work, especially hoards, within 'celtic fields'. However, there does not appear to be a hoard which has clearly been buried in the lynchet of an axial field system. Fowler cites four possible examples (1971,170).

The Ebbesbourne Wake hoard was found during removal of bushes which had been uprooted by tractor. It was not in a lynchet. It was not deeply buried, lying on top of a flinty layer which overlay the chalk. Shortt (1949) inferred it must have been deposited after the field was last cultivated, but since hoards are still found in the

Figure 7.8.
Fields at Ebbesbourne Wake.

Source: Shortt 1949.



ploughsoils of cultivated fields today, this cannot be assumed. Of the field in which the hoard was found, Barrett and Bradley (1980,191) comment: "this particular plot does not conform well to the overall system and may be a ploughed-down enclosure."

The bronze socketed axe from Lulworth was found within a dry valley where a large area of lynchetted fields survive, but in a "very disturbed" condition (RCHM Dorset 2(3),628-9 1970). Haphazard flint digging led to the find in 1903 - its location was described by Drew (1935) as "somewhere in this disturbed area". Apart from the fact that flint quarrying often dug into lynchets or piles of flints at filed edges, there is no evidence to suggest the axe was actually in a lynchet.

In a similar way, the middle Bronze Age palstave from Horridge, Devon, was found after a track had been bulldozed across the field system, and not demonstrably within a wall or lynchet. Fox and Britton (1969,223) described this site as a defined field group of 7.6 acres, centred on a nucleus of 4 hut circles. Fleming describes it as "a classic neighbourhood group" within the Rippon Tor parallel reave system (1988, Fig.13). The reaves, as noted earlier, relate to pastoral land use organisation, with cultivation "confined to small enclosed areas near the houses" (ibid,105). This cannot be taken as dating evidence for the arable coaxial systems now under discussion.

The gold hoard from Towednack (Cornwall) was clearly within the bank interpreted by Hawkes (1932,177-9) as a field boundary. The rest of the possible system consists of a second length of bank, a lynchet and includes a possible hut circle. There is nothing to suggest a large scale axial layout here.

Several excavations, discussed below, have produced evidence for occupation or agriculture preceding the layout of axial field systems, and therefore there is nothing to suggest that casual finds within the area of such systems need be contemporary with or postdate them. This is particularly the case where irregularities in layout of the fields are noted, as at Ebbesbourne Wake; it can be compared with the result of excavation on an anomalous curving lynchet on Overton Down Site OD XI (see below). In the cases of Towednack and Horridge Common, the field systems involved are of a different nature to the extensive arable coaxial systems, and it would be unwise to assume evidence for the dating can be referred to them. Better definitions of field systems, including evidence for use as well as layout, should preclude the use of evidence relating to field groups which are clearly different in character.

7.3. The dating of field systems; evidence from excavations.

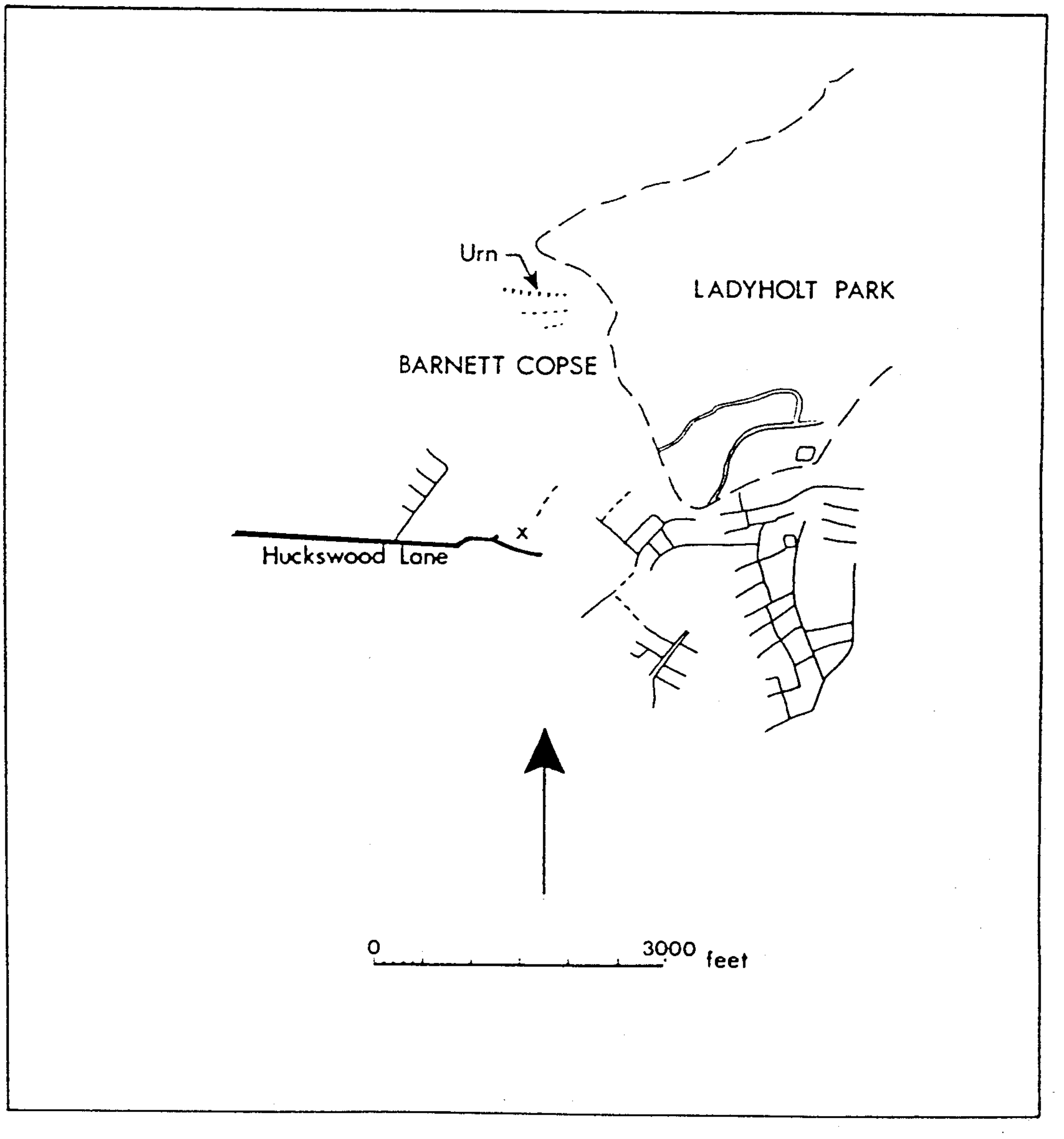
It is interesting that Fowler's assessment (1971) of the evidence for field system dating fails to mention direct excavation-derived dating evidence for 'celtic' fields of axial or cohesive type. In his major discussion (1983,94-119) of these systems, date is the one of his five defining characteristics which he does not examine. The lack of emphasis on excavation in the investigation of landscape features has been an established feature of work in this area in Britain (Fowler 1967,295) and there are still relatively few published excavations of fields of this type. Many excavations of field boundaries are simply minor elements in the excavation of settlements, rather than deliberate investigations of their use of the landscape.

A number of excavated field groups or lynchets from the middle Bronze Age, or, as at Bishopstone, perhaps even earlier, have already been discussed. The point has been made that these do not relate to extensive coaxial arable systems, but to a different form of landscape organisation. One further example of an early lynchet can be added. A lynchet at Barnett Copse, Chalton, was dated by a Wessex culture cremation urn inserted in a pit which had been dug into the lynchet. Despite bulldozer disturbance (leading to the discovery), there was "no doubt at all" about this relationship (Perry 1967,38,Fig.11). The lynchet is one of "perhaps three" surviving lynchets in an area damaged by modern agriculture; it is clear from Perry's plan (ibid,Fig.10) that there is no evidence to show they formed part of a coaxial group.

Fields at Streatley Warren, Berkshire, were excavated by Mills (1948) and further discussed by Rhodes (1950,14-15). The axial nature of the fields shows clearly in the aerial photograph (Mills 1948,Pl.A). The brown soil layer below the lynchet, immediately above the chalk, contained pottery described by Mills as Iron Age 'A'. The stony layer above this was interpreted by Mills as the result of clearing the fields of stone and by Rhodes as a possible original boundary. The upper levels of the lynchet contained Romano-British material. Mills sectioned the upper and lower lynchets of a field approximately 35m wide. Interestingly, differences in the sections led her to suggest that the upper lynchet might have ceased to be a field boundary and have been ploughed over during the Romano-British period. Creation of longer fields at that time is more often referred to than demonstrated. Richards (1984,67) has confirmed the dating of the Streatley Warren field system, and shown that the fields overlie a linear ditch of possible late Bronze Age date.

Figure 7.9.
Lynchets at Barnett Copse.

Source: Perry 1967, Fig.10.



These excavations led Rhodes to draw attention to the masking of earlier artifacts by subsequent cultivation, implying that surface collections of artifacts will tend to represent only the latest period of use.

The important programme of excavations on Fyfield and Overton Downs are as yet published only as a series of interim reports. Bowen and Fowler (1962,105) record a lynchet section from Fyfield Down, which illustrates another of the problems of field boundary dating. Despite a range of sherds from neolithic to late Roman in date in the lynchet soil, the origin of the field boundary was shown to be early Iron Age. The lynchet had formed around a small drystone wall, and three early Iron Age sherds were recovered from the buried soil beneath the wall.

Fowler (1967,17-24) records excavations in the "extensive field system largely covering Overton Down". At sites OD X and XI, the lynchets overlay an early Iron Age settlement, represented by the postholes of a circular roundhouse and a length of enclosing ditch, and ploughmarks from pre-lynchet cultivation. Further ploughmarks, parallel and perpendicular to the adjacent lynchet and not continuing under it, were probably from the cultivation of the field, which was dated to the pre-Roman or Romano-British period.

Close to this site, visible traces of structures survived in the corners of fields at site OD XII. Excavation of two of these revealed two buildings dated to the fourth century AD. Fowler concluded that this:

"demonstrated, over a ⅓ mile on the same stretch of downland within superficially the same 'Celtic' field system, the beginnings of at least part of that system where it overlies an Iron Age 'A' settlement and the end of at least part of that system where it is overlain by a fourth century settlement" (1967,30).

It also posed the problem of "identifying the fields which were being cultivated when those on which the settlement lay had gone out of use" (ibid,28).

It is an interesting point that all the settlement evidence described pre- or post-dates the use of the particular fields involved. The lack of settlements associated with 'celtic' fields is often noted, as in Bonney's review of the evidence from Wessex (1978,51), and in discussions of the Berkshire systems by Rhodes (1950,21) and Richards (1978,38). The simplest answer to Fowler's question seems to be that some of the remaining fields in the same system were being cultivated. If it was usual to site the houses within the fields, and for the settlement to shift and the fields be returned to cultivation, this could explain why settlements pre- or post-dating the period of use are more readily recognised. Settlement sites existing at the time the fields were being established would affect their layout (a curving lynchet at OD XI led to its selection for excavation), and the settlements of the last phase of the system's use would not be obliterated by later cultivation.

At another location on Overton Down, a ditch, whose original function was probably as a land boundary, post-dated a scatter of Beaker pottery. Fowler dates its origin to the second millennium BC, though the evidence for this is not stated. The ditch had been ploughed over and 'celtic' fields laid out over it, a neat reversal of the expected relationship. It is "also overlain by a possible later prehistoric settlement" (Fowler 1975,Pl.8A).

The ten years work on Fyfield and Overton Downs by Bowen and Fowler has produced and reported on some important results. But because of the scattered and often interim form in which it is at present available, it is at times difficult to evaluate. As an example, a plan of a field system at Totterdown is given by Bowen and Fowler (1966,Fig.9); Fowler (1967) refers to cutting sections through lynchets there, and Fowler and Evans (1967,Fig.3) publish the sections. Fowler (1983) provides an aerial photograph (ibid,Fig.IVb) and details of the form of the boundary; he describes how "narrow oblong fields of early Roman date and on a slightly different axis have flattened all but a few fragments of the prehistoric systems" (ibid,111). As this work has been used in their papers synthesising the evidence for early agriculture and land division, the lack of definitive publication makes assessing their conclusions difficult.

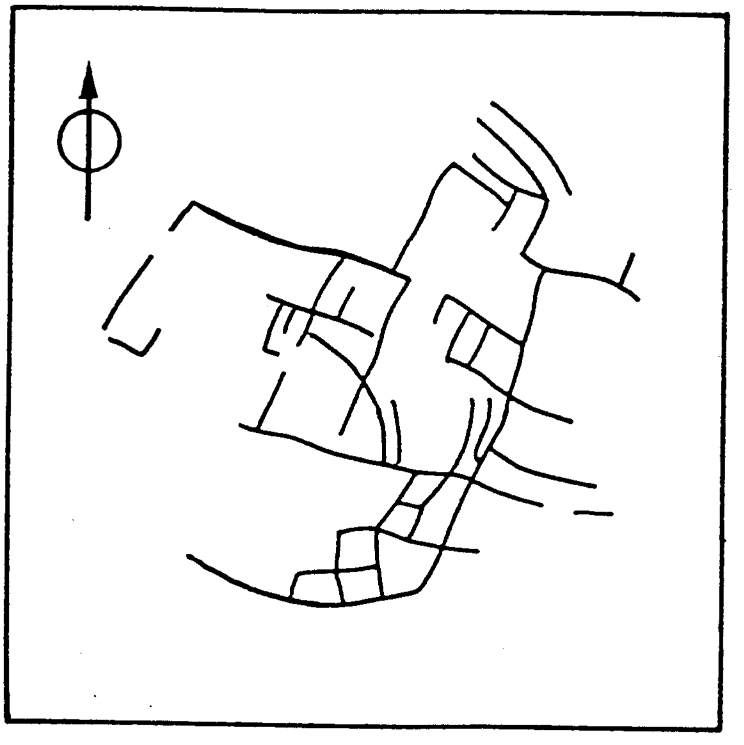
Some important results are clear. An axial system laid out in the Iron Age overlay earlier cultivation, and elsewhere a system of elongated fields of early Romano-British date overlay earlier fields. A linear ditch was also superseded by a 'celtic' field system. This argues against viewing extensive axial field systems as the primary form of landscape organisation, and points to processes of change and development in field systems in the later prehistoric and Romano-British period.

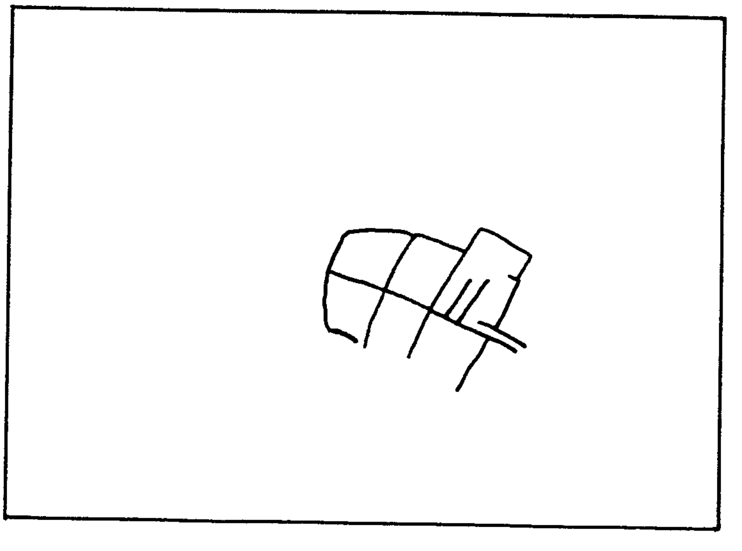
Survey and sherd collection by Rhodes (1950) on Berkshire field systems also raised some interesting general points, and indicated some possible patterns of change. Fields surveyed which produced Romano-British pottery usually produced it in quantity, and fields where it was not recovered "may be suspected to be prehistoric fields which were no longer in use in Roman times". Two of his field groups, Knollend Down and Eastmanton Down, produced only prehistoric sherds,of mid/late Bronze Age type. Four groups produced no sherds, and one produced both Romano-British and prehistoric sherds. These seven groups are smaller than those producing only Romano-British material, ranging from 15 to 100 acres (average around 50 acres) compared with 150 to 1945 acres (average

Figure 7.10.

Field groups at Knollend Down and Eastmanton Down.

Source: Rhodes 1950, Figs. 5 and 8.





6 inches to 1 mile

around 700 acres). The two groups which produced only prehistoric sherds have obvious similarities in their plans although they differ in size. Both have the appearance of being units in themselves, each for example having a partly curved outer perimeter despite rectilinear internal divisions. Despite the use of parallel elements in their layouts, neither could be regarded as an extensive axial group.

Bell's excavation at Itford Bottom (trench B) has already been discussed (Chapter 6). Here a lynchet overlay a colluvial layer, interpreted as the result of cultivation, containing Bronze Age and Iron Age sherds. The lynchet itself contained similar material, with Romano-British sherds in its upper levels only, and its formation appears to have taken place mainly in the Iron Age (Bell 1983,132,135,140). The field system (ibid,Fig.9) is laid out on rectilinear axes, some running across the dry valley. In terms of size, it is not comparable to the large extensive systems, being around 20 to 25 hectares. Some of the individual fields are very large in comparison to the usual size ranges for squarish 'celtic' fields given by Bowen (1961,20,22).

Recently published work by Ford _et al_ (1988) on the Berkshire Downs field systems has demonstrated that many of these were laid out in the Romano-British period. Of thirteen field elements sectioned, nine produced Romano-British sherds, mostly of the first to third centuries, in their primary levels. Eight areas of fields were examined, and only one of these "could be regarded as showing Roman use of a pre-existing field system" (ibid,404). At that site, "surface indications suggest two periods of use, with earlier, squarer fields being replaced by elongated ones", and snail evidence from one of the two trenches involved suggested two periods of build up for the lynchet. Both trenches produced "some evidence" for prehistoric material stratified below Roman.

Reassessing the evidence for other field systems in the area, Ford et al suggest that the dating for the axial system at Streatley Warren, discussed above, is inconclusive as the Iron Age sherds under the lynchet provide only a terminus post quem. While this is true, the absence of Romano-British material from the lower levels of the lynchet is suggestive, given their own comments on its ubiquity, presumably as the result of manuring, in the lynchets they examined. The evidence for modification of the Streatley Warren field to create a longer plot is similar to the evidence referred to above for the earliest of Ford's sites. The key question, precise dating apart, is whether the extensive axial layout of the Streatley Warren fields was established by the earlier lynchets, or was the outcome of Romano-British modification.

These dates for the Berkshire field system raise a number of important questions. Ford et al (ibid,404) suggest they reflect discontinuity in the use of the downland, with extensive layout of arable being a feature of the early Romano-British period, perhaps "linked to the wider economic climate at the time". An obvious question is whether, if this is the case, the same is true of the other chalk downland areas of southern England. This chapter was written to make the point that change and development can be seen in the prehistoric field systems of Britain, and to argue against an early/middle Bronze Age origin for the extensive axial arable systems. Ford's paper reinforces the view taken here, that a picture of an agricultural system whose spatial use of land remained largely static over two millennia is inadequate. But it also shifts the question, the strength of the case for the Iron Age origins for field systems of this type now must be examined.

Clearly, because of the point that sherds buried beneath a lynchet or in its primary levels provide only a terminus post quem, many of the lynchet dates are open to doubt on these grounds. Yet the evidence for widespread occurrence in quantity of Romano-British pottery where Roman use of the land (noted by Rhodes (1950) and confirmed by the more recent work) suggests that its absence can also be given some weight. But this does clearly involve the explicit assumption that all Romano-British agriculture used routine heavy manuring. In Chapter 6 it was argued that this was not the case in the Iron Age, at least until late; this is another factor complicating the dating evidence. The interrelationship between manuring and the ability to date field boundaries, and the risks of circular arguments, were also discussed. Again, as many of the excavated lynchets were investigated in the context of settlement excavations, in few cases are they clearly related to a larger field system.

However, the evidence does seem to support an early Iron Age date for the origin of the extensive axial systems, with the dated lynchets from Overton Down, Knoll Down and Streatley Warren (despite the comments of Ford et al quoted above) appearing convincing both in terms of the dates inferred for their origins and their relationships with extensive systems. The Itford Hill lynchet belongs to a small group showing use of axial lines, though hardly convincing as a coaxial system (Bell 1983,Fig.9); the Iron Age lynchets at Bishopstone appear to relate to a reorganisation on axial/rectilinear lines during the early Iron Age, although little of the system survives (Bell 1977,251-8,Fig.2).

What is clear is that far from prehistoric field systems on the chalkland being a well understood and long-lived element in the organisation of agricultural, the pattern increases in complexity as it is examined. This increases the potential of the surviving evidence for agriculture as a source of information about later prehistoric and Romano-British societies; agricultural organisation is not a largely static backcloth, but an essential part of their socio-economic organisation. The point of greatest concern is that the increasing destruction and loss of the evidence for early land use will greatly increase the difficulty in answering the questions as they arise. This is particularly the case where the answer demands the confident linking of excavational evidence into an overall structure of the agricultural landscape derived from aerial photography and survey.

7.4. Field systems and the functions of linear ditches.

Recent excavations discussed in section 7.2.3 above have greatly increased the information available about linear ditches, and the reassessment of their dating showed the evidence for an early origin for these features was shown to be weak. Fowler's assertion that "there can be no doubt that, in general" their use dates to the second millennium BC no longer seems acceptable, with Ford's results (1982,1985) and others suggesting that many may have originated in the late Bronze Age and early Iron Age. Ford's work (1982,4) also showed, at least for Berkshire, that the relationships between linear ditches and field systems is not characterised by the ditches cutting across the fields, as had been accepted (eg. Fowler 1983,190). Palmer's survey of the Danebury area in Hampshire produced a similar conclusion, in the case of the "local" linear ditches (1984,67).

The function of the linear ditches remains, as Fowler (1983,190) notes, "a vexed question". Although the evidence is still limited, it seems reasonable to assess it here. Hawkes' original assertion of their pastoral function was based on two observations: ditches dividing fields from "untouched downland", and ditches dug "ruthlessly" across fields so that their "only conceivable purpose" is "a boundary to a tract of pastoral land" (1940,144-5). Their function was discussed by Bowen (1978), in an influential paper which outlined his "linear ditch system" concept. He reaffirmed their economic role in the management of pasture, but because of the evidence for "major land re-allotment", suggests that "the term 'ranch boundary' reduces the significance of the system" (ibid,120). They are the sign of the imposition of "a new and careless power", and major ditches such as the Bokerley Dyke define the territorial extent of that power (ibid,122).

Bradley, while noting that their chronological and geographic spread implies that a single explanation is unlikely, relates the linear ditches to the need for communities to secure access to a range of land resources, in the context of "pressure" and competition , while accepting they may have had "both a territorial and an economic role" (1978,47-8). A territorial role is preferred by Jones, who comments that "prehistoric boundaries may have more to do with rights over land than with what went on within them" (1986,84).

Ford (1982,1981/2) has reconsidered the evidence for the function of the linear ditches in the light of his fieldwork and excavations on the Berkshire Downs. For the Grims Ditch, he finds evidence for a pastoral role "unconvincing" (1982,35), as it has few offshoot ditches and does not appear to define tracts of land. He suggests it forms "a major socio/political boundary" (1981-2,1), possibly corresponding to the divide between Barrett's North Wessex and Thames Valley style zones (1982,36). The Berkshire evidence, Ford suggests, can be interpreted as indicating territorial divisions at three levels, with the

Grims Ditch as "a major boundary between communities", the long linear earthworks from his west Berkshire survey defining smaller territories, and the smaller ditches could define "more local communities" (1981-2,17).

But it seems still to be generally accepted that some of the linear ditches had a role in controlling pasture. Even the Berkshire Grims Ditch also forms a divide between vale and downland soils for around two thirds of its length, and Ford notes "it remains possible that [it] simply defined an area of commonly used upland pasture" (1982,36-7).

Yet Ford notes that the most common relationship in his work was for field systems to be aligned on the linear ditches (1982,4). Ford notes "some linear ditches certainly were being used to divide arable from pasture, but this does not occur in every case and this relationship may change within the course of a single earthwork" (1981-2,16). Similarly, Palmer records that "local linear ditches tend to conform to the pattern of ancient fields" (1984,67).

The relationship between fields and linear boundaries is a crucial one, and a key question is the nature of the relationship between the linear ditches and those axial field groups aligned on them. Do the field groups simply make use of a pre-existing boundary, or do fields and boundaries form parts of the same system of land allocation and use? This appears to be a major question, which has been obscured by inferred datings and relationships on which recent excavations and detailed fieldwork now cast doubt.

Two classes of information can be considered to try to approach this question; each has problems. The first is the evidence from excavation about the relationship between the ditches and the remains of cultivation, especially lynchets. Here the problem relates to dating, and the links between dating and past agricultural practice, notably manuring. The second is the use of environmental evidence, in this case snails, to establish land use. The difficulties arise in the interpretation of the snail fauna in ecological terms; again this relates to past agricultural practices, as these will have greatly affected the environment of the arable fields.

Relationships with arable land use were established in some of Ford's excavations. For the Grims Ditch, no pre-existing lynchets were found, although there were some indications of cultivation at two sites (1982,23,36). In the west Berkshire examples, two sections of the Russley Down ditch had lynchets on one side only, as did Coppington Down. Ditches at Baydon and possibly East Ditch (Ewe Hill) lay between positive and negative lynchets, the Baydon ditch apparently having been inserted into a pre-existing gap. At East Garston Down 1, a small positive lynchet 6m downhill from the ditch may, because of its position, represent pre-ditch cultivation. Some sections produced no indications of earlier or later lynchets (East Garston Down/Washmore Hill and East Ditch/Green Down 1 and 2) (Ford 1985, microfiche pages 1-14).

The lynchets or ploughsoils demonstrably later than the ditches produced Romano-British material, but the lack of earlier material could reflect differences in manuring practices or sherd survival. This receives some support from the positive lynchet at Baydon, where a single prehistoric sherd was found beneath it and Roman sherds were confined to the upper levels. Many of the ditch sections are themselves dated only by Romano-British sherds in their upper fills, even though Ford regards the late Bronze Age/early Iron Age as the likeliest date for them (1985,16). However, Ford's work on the linear ditches led him to conclude that "arable land use ... seems to be a Roman feature on these sites" (ibid,17). Similarly, Ford _et al_ (1988) use the contrast between the quantities of Roman pottery found in survey work and the absence of middle and late Iron Age pottery to infer that there may have been discontinuity "at least in terms of the organisation of arable cultivation" in the use of the Berkshire Downs between the Iron Age and Romano-British periods.

The gap in the dating evidence is interesting. Ford's linear ditches are dated by reference to their relationship with either settlement derived material of the period c.800-500 BC or to Roman pottery, often presumed to be derived from manuring (Ford 1985, especially Fig.7). The integration of middle Bronze Age settlements among their fields was described in section 7.2.i. above, and in Chapter 6 it was noted that evidence for systematic heavy manuring of land is essentially lacking, certainly before the later Iron Age. If a change in the spatial relationship between fields and settlements was a feature of the Iron Age, this may have ended the Bronze Age practice of disposing of rubbish onto adjacent fields. Without the introduction of systematic manuring which the later (ie. Romano-British) sherd scatters, as at Maddle Farm (Gaffney and Tingle 1985), seem to imply, the absence of Iron Age material in the field systems is explicable. The lack of Iron Age material in the lynchet and ditch sections may be a result of prehistoric agricultural practices, and this must be considered in assessing the relationship between linear ditches and arable land use.

Snail remains form another source of information on this question, but there are significant variations between workers in this area. Different interpretations are, for example, placed on _Pupilla_ species and on

Helicella itala by Pritchard (in Ford 1981-2,15,14) and Evans and Vaughan (1985,20,25). Possibly the problems will only be resolved when clear independent evidence for land use can be related to the snail profiles; the results from Knoll Down A, for example, could be related to the stratigraphic evidence for land use. The following paragraphs accept the individual writers' own summaries of their analyses.

Work on the Grims Ditch showed an open landscape during the time the ditch was silting. Although there was no direct evidence for either ploughing or intensive grazing, the scarcity of one common downland species intolerant of excessively dry and disturbed habitats and the small number of snails recovered suggest the possibility of "an intensive agricultural origin" (Bowden in Ford 1982,34-5).

For the west Berkshire ditches, Ford concluded that there was "no sign of a consistent change in land use" following their construction (1985,16). Unfortunately there are only two sites for which pre- and post- ditch evidence can be compared, and one of these produced a very small snail sample. Comparing Pritchard's summary of the analyses with the evidence for lynchets (outlined above) is interesting. The two sites for which she infers arable land use after the ditch was constructed produced evidence for ploughslip and lynchet formation in the Romano-British period, and two of the sites for which she infers pasture or light arable lacked such evidence for post-ditch cultivation. The third pasture/unintensive cultivation site, Baydon, is the ditch which occupied a pre-existing gap between positive and negative lynchets. The positive lynchet contained Roman sherds only in its upper fills. The molluscan evidence for slight cultivation and the lack of pre-Roman sherds in the lower lynchet levels (there was a single prehistoric sherd under the lynchet) together may indicate pre-Roman arable usage of a less intensive nature.

Evans and Vaughan's results reflected the differences seen in the field evidence; cultivation was inferred where the earlier lynchets were seen at Knoll Down, and there was little to suggest cultivation at Blagdon Plantation, where there were no signs of fields (1985,36). At both sites the environment seems to have remained largely unchanged after the construction of the ditches (ibid,22,35).

The recent evidence allows some conclusions about relationship between the linear ditches and arable cultivation - but it must be remembered that these are derived from a limited area, and need not be universal even within central southern England. The infrequent evidence for ditches either cutting or respecting fields is noticeable; Baydon and Folly Clump are interesting cases, where the ditches seem to slot into a an existing land use organisation. The extensive field systems are usually aligned on the ditches, and the question is therefore whether they are a later feature (as combining Ford's preferred dates for the ditches with the field system dates of Ford et al (1988) seems to suggest) or whether ditches and field systems functioned together. Pritchard (in Ford 1985,15) does suggest a time interval between ditch construction and intensive arable land use, but in view of her earlier comments on the speed with which primary silts form, there seems no reason to assume this was a significant interval.

Another difficulty, on the basis of the information as published, is determining whether the evidence for cultivation alongside the linear ditches relates to extensive axial systems or to other field types. Ford's comments on the relationships between field systems and ditches are dependent on aerial photography (1985,4), and this point is not clarified either there or in the later paper (Ford et al 1988) on the coaxial systems, which is an interim statement of the results.

Another problem arises from the lack of Iron Age material which is characteristic of these excavations. There is a strong possibility that Iron Age agricultural practice is distorting the dating evidence. The possibility that linear ditches and field systems were together integral parts of the organisation of arable land use should not be excluded too readily.

While recent work has provided much new information about the linear ditches, it has also meant that simple models of their construction, use and spatial and temporal relationships have become untenable. This is increasingly being recognised, for instance in Ford's comments that inferring a single function for linear ditches is unacceptable (1982,35) and Richards' view that they can no longer be the "subject of generalised statements" (1978,41). The two roles of pastoral and territorial boundary, as in Bowen's paper (1978), remain the accepted alternatives. But even taken together, they do not seem adequate to account for the surviving pattern of linear ditches and their relationships, and as argued above, the emerging relationships between ditches and arable land suggest they may offer only an incomplete explanation.

The problems perhaps arise from making an artificial separation between socio-political and economic functions. If it is assumed that later prehistoric societies were essentially agrarian in their organisation as well as their economy, then the 'territories' of different groups and communities can be seen as the land units within which agricultural production was regulated.

The ditches - or more realistically, the boundaries which are visible where they are defined by ditches - can be regarded as defining areas of different control of agricultural land or of different use of agricultural land at a variety of scales. They may be physically expressed only where they are needed, or expressed in a variety of forms depending on their immediate surroundings, physical or social. They may separate land with different uses, such as arable from pastoral; this may also imply different control, as for example in the case of some southern African peoples where control and allocation of arable and pastoral land were vested in different individuals (Sansom 1979a,145). They may separate areas under different types of control, for instance individually 'owned' land from communally 'owned' land.

An interesting example of the latter is provided by the greens of the Suffolk claylands (Warner 1987,9-19). These are frequently defined by ditches, and a typical topographic arrangement is of arable on the gravel slopes of the river valleys, wood on the upper clay slopes, and common or moorland (the greens) on the clay plateau (Warner 1987, Fig.2b). In the period following the Norman Conquest these ditches separated the common pastures from the individually held arable. What is particularly interesting is that Warner is able to suggest that this distinction between individual and communal land is much older, and can be traced through its relationships with Romano-British settlement in the area to the early Romano-British period, if not before. He suggests the green ditches originally formed the boundaries of Roman estates, with their settlements "at the epicentres of the curvilinear green boundaries, well away from the greens themselves" (ibid,11). The distinction between individual and communal land appears to persist despite a marked discontinuity in the pattern of settlement; the late Anglo-Saxon pattern is of settlement along the sides of the greens themselves, as exploitation of the clay soils became more attractive. While it would obviously strengthen this argument greatly if excavations confirmed the dating Warner infers, his interpretation is an interesting example of the relationship between social ('ownership') and economic (land quality) aspects of the organisation of agricultural land use.

More straightforward distinctions in ownership, or perhaps more usefully control, of land may explain the ditches and double lynchet 'trackways' dividing field blocks, and the ditches running through what appears to have been open pasture. Divisions of pasture land need not be explained purely in that way however; they may have allowed the regulation of grazing, limiting rights of access at times to ensure grazing throughout the year. Land use has an essential temporal as well as spatial component, even if the former is intrinsically much less readily detected or inferred.

The territorial inferences drawn by Ford are, as he notes, similar to Fleming's reconstruction of four levels of organisation in the society responsible for the construction of the Dartmoor reaves. But there are some important differences between the Dartmoor reaves and the landscape monuments discussed in this chapter. The reaves were constructed within a relatively short period (c.1300bc), and in their various forms divide up an entire landscape. Some are incomplete, but in general where they exist they form a continuous system of boundaries. Their layout appears to have been determined by the need to organise the use of pasture; direct signs of cultivation are lacking, and while carbonised cereals and beans and quern stones have been recovered from the settlements, it seems that cultivation was "not a major feature" (Jones 1986,80).

In contrast the linear ditches of the chalk of central southern England do not fit into a close chronological slot, and while they may form "a whole web" (Bowen 1978,120) it is one in which the physical links between them are often lacking. Although their pastoral role has been stressed, the recent results of excavation and field work are beginning to suggest a relationship with arable land use also. Their origin and development may be closely tied to developments in arable field systems during the late Bronze Age and Iron Age.

Boundaries do not simply divide - they can also integrate. It is only the presence of a barrier which allows cattle to graze a few yards from growing corn.In social terms, this point can be compared to the realisation that some hillforts, rather than being central places, can act to define a boundary. In this interpretation, they allow and regulate interactions between groups as well as defining their separation. Ford's suggestion (Ford 1985,17-18,Fig.8) that the line of the Berkshire Grims Ditch continues as a line of hillforts reinforces the comparison. And the form of definition a boundary receives may depend on socio-political as well as topographical or agricultural circumstances. Indeed, the existence of "very short but massive double ditch systems" (Ford 1985,16) seems difficult to explain other than as the result of a need to display power and status at a particular point on a boundary otherwise unmarked (or, of course, defined in a way which has not left traces so far archaeologically recognised). The point where a major route crosses into the territory of a different community would be one example. Such short stretches may be making a similar statement to the hillfort defences elaborated beyond the needs of defence (Cunliffe 1984b,30; see also Bowden and McOmish 1987,76-80). The recent dating evidence for the linear ditches suggests that the origins of some of the linear ditches and hillforts occupy a similar period. Factors such as the occurrence of linear ditches converging on some hilltops occupied by hillforts and the relationship between hillfort defences and linear ditches at Sidbury (Cunliffe 1971,62) also suggest some developments may have run in parallel. Again, as with the relationships between the linear ditches and fields, better dating evidence is needed before any confidence can be placed on these conclusions.

Accepting a wide range of specific functions for individual stretches of linear ditch has the potential to explain the variations in form, location, dating, efficiency as barrier, and perhaps use as routeways which are encountered. There need be no attempt to impose a "generalised statements" (Richards 1978,41). But if the linear ditches are considered in a context which is not 'agricultural' and not 'socio-political' but is that of an agrarian society whose socio-political organisation relates closely to the control of the productivity of the land, this then provides a context for further investigation, which offers greater potential both for understanding these features and for using them as a source of social and economic information.

7.5. Conclusions.

This chapter has reviewed the case for the early dating of extensive axial field systems, and extended the discussion to include some excavated evidence for the development of field systems on the chalk of southern England, and the relationship between fields and linear ditches.

Section 7.2 reviewed the basis evidence for Fowler's view that:

".. in some cases the fields..demonstrably go back to the earlier second millennium and probably to at least the second half of the third millennium" (1983,94).

It is important to recall that Fowler is talking specifically about extensive field systems of an "organized structural nature in plan, notably in their use of axial lines". The difference in the conclusions one would draw from the excavated evidence taken alone is striking, for direct evidence for the origin of extensive axial arable field systems in Britain does not at present predate the first millennium BC. If the inferences of early date based on the fieldwork evidence were backed by firm relationships between the different features and a firmly established early date range for the linear ditches in particular, this would be unimportant. But they are not.

If the excavation evidence for the date of extensive and axial systems is compared with the evidence from north west Europe, the gap in date discussed by Bradley (1978) in his comparison of British and European field systems vanishes. The evidence for the layout of these systems relates at earliest to the late Bronze Age/early Iron Age in both, and in both there is evidence they are superimposed over earlier settlement and cultivation.

The view that these field systems started early and continued unchanged but for a few modifications (notably the Romano-British elongation of individual plots) is by its nature difficult to disprove. Bradley noted of the linear ditches that "examples which have shown the later date .... serve merely to establish their longevity rather than their late beginnings" (1975,199); clearly this is so, and it illustrates the problem. But such an argument surely only justified where there is also substantive evidence for the early dates inferred.

Some of the arguments behind the early dating are rather dubious; the logic linking 'celtic' fields and linear ditches is particularly suspect. Confusion seems to result from the failure to distinguish extensive axial systems fulfilling Fowler's criteria from field groups showing a less "organized structural nature". And it is only the assumption that extensive axial systems represent primary clearance and land organisation (for which there appears to be little or no supporting evidence) that permits traces of cross-ploughing to be interpreted as evidence for such systems. This assumption clearly also influenced Bradley and Richards' (1978,53) suggestion that aggregate fields may be "additions to more orderly arrangements"; Richards (1978) is more cautious about this relationship.

If instead of concentrating on inference from visible field remains, one attempts to assess the chronology of field types chiefly from the excavated evidence, a different pattern emerges. The evidence can be briefly summarised.

The association of field groups with middle and later Bronze Age settlements was noted in section 7.2.1. Some survive as a few lynchets only; others, notably Black Patch, show larger field groups, with the use of a dominant axis appearing in their layout. The layout of settlements, often incorporating trackways, suggests that livestock may have been moved in and out of the settlements regularly. A similar pattern is seen in the Dartmoor reaves, where short lengths of track approach settlements, presumably to control livestock as it passes between the small plots close to the dwellings to which cultivation seems to have been confined (Fleming 1988,105). This explains the incorporation of domestic refuse in manures, manuring apparently becoming an established practice at this time (see Chapter 6).

The features of middle Bronze Age settlement discussed above and in earlier chapters may combine to form an agricultural package; intensive cultivation confined to field groups closely round the settlements, into which livestock was regularly driven. The interpretation of a number of structures as byres and pens was noted in Chapter 6.4. The collection of dung and domestic refuse within the settlements allowed manuring of the adjacent field groups.

It is suggested that the late Bronze Age or early Iron Age saw a change. The development of the extensive coaxial arable systems belongs to this period, and the evidence for the close association of fields and settlements ends. The evidence for manuring is also poor, although the limitations of the evidence for this period (Richards 1978,41; see Chapter 6 above) must be considered. It was suggested in Chapter 6 that heavy systematic manuring was not a feature of Iron Age cultivation, and that less intensive forms of cultivation reliant on fallow or grass leys were characteristic. The limited evidence for livestock housing or penning in the Iron Age (see Chapter 5) may relate to the grazing of the grass leys, with livestock kept in secure fields. This view has implications for both inferences of agricultural productivity and the interpretation of the archaeological record, especially the evidence of sherd scatters and lynchet deposits.

The apparent absence of settlement may be explained by settlements located outside the field systems, or by relatively insubstantial or impermanent structures within them leaving little trace. One interesting possibility is a relationship with hillforts. Stopford, assessing the evidence from Danebury, suggests that rather than being a "permanent residential site of tribal leaders exacting tribute and articulating exchange" (1987,74) it may have "functioned primarily as a communal storage centre within a system of seasonal exploitation of different environments" (ibid,70).

She reviews the evidence for seasonal occupation at a number of Iron Age sites; her comments on Farmoor are reinforced by recent work at Wytham Hill. Mytum (1986) suggests this shows that the two sites, one upland and one lowland, formed "part of the same economic system" during the early and possibly middle Iron Age. Pottery from the two was "identical". Stopford infers that "hillforts may have been part of the same seasonal pattern of activity", contrasting the "flimsiness" of the Danebury houses with the large storage capacity of the site.

Certainly the weed components of the carbonised plant remains from Danebury indicate the exploitation of a range of ecozones, including valley bottom areas as well as the immediate surroundings of the hillfort (Jones 1984,489). In the Lambourn Valley, Bradley has noted the "extremely striking" association of hillforts with field groups (1975,187,200). At Rams Hill, the Iron Age rampart overlay a negative lynchet. Interestingly, these field groups associated with the hillforts lack "the formal basis" of the larger field systems.

A possible parallel is provided by Hodder's description of pre-European towns in West Africa. In addition to cultivation within the defended areas, townspeople migrated daily to the 'near farms' up to five miles distant, and also cultivated 'far farms' up to fifteen miles from the towns (B.W. Hodder 1979,224).

Stopford emphasises the role of hillforts in two areas - ritual and the storage and protection of agricultural produce (1987,72,74). The evidence for development in the landscape which now appears to have occurred in the early Iron Age in southern England suggests that the role of hillforts may have been still more intimately connected with the organisation of agricultural production. The suggestion that this period saw a greater social regulation of arable production, illustrated by the development of a framework of landscape organisation comprising the extensive arable field systems and the linear ditches, is discussed in Chapter 10 below.

In the Romano-British period the evidence for the layout of extensive arable systems continues, but it is now accompanied by evidence of heavy widespread manuring (a change which may begin in the later Iron Age). The lack of evidence for livestock housing is a problem, but it can be suggested that this relates to the limited scope of many Romano-British excavations, with ranges of pens and ancillary buildings around villas often remaining unrecognised and unexcavated (see Chapter 5).

The layout of axial systems in the Romano-British period is not surprising. Dilke's account of Roman land surveying describes the "strip allotments" system as "an old one, but [it] continued under the Empire, sometimes alongside centuriation" There may even be an indirect literary reference to the practice: Dilke refers to a comment by Frontinus that arable land in the provinces was laid out in this way (1971,94-5). While there is no direct reason to associate this with Britain, Frontinus, who wrote a treatise on surveying, was governor of Britain in AD 73-4. It could explain why attempts to identify centuriation in Britain are generally unconvincing (the evidence is summarised by Dilke, ibid 190-5).

The longer fields do, as Bowen inferred (1961,24), seem to be a feature of the Romano-British period. The Streatley Warren excavations allowed Mills to suggest that these fields were elongated by amalgamation at this time, and Ford et al (1988,403) found the same modification elsewhere on the Berkshire Downs. The elongated fields on Totterdown are also dated by excavation to the Romano-British period, their "origin, use and abandonment" being contained in the first two centuries AD (Fowler 1964,185-6; Bowen and Fowler 1962,Pl.1b). The changes presumably relates to change in ploughing types or techniques; if this is so, the early date for the Totterdown fields is particularly interesting given the difficulty in establishing change in plough technology until the later part of the Romano-British period (see Chapter 3). This association with a new technology may reflect the economic context of the Romano-British 'celtic' fields, perhaps as a component in the organisation of large estates. This may account for the tessera from the ploughsoil in the Overton Down field system, regarded by Fowler (1965,137) as an odd find. The suggestion that domestic refuse at Frost Hill, Bullock Down derived from the Eastbourne villa was discussed in Chapter 6; new fields, defined by narrow ditches were laid out adjacent to the Frost Hill site in the Romano-British period (Drewett 1982,126-9). Maddle Farm, with its blocks of elongated "distinctly 'Roman' fields" (Richards 1978,47) has also produced evidence for systematic manuring over a wide area around the villa (Gaffney and Tingle 1985).

Some patterns of development in the organisation of the agricultural landscape have been suggested in this chapter. Links with other aspects of agricultural practice have been used to interpret the evidence, and it is argued that considering field systems without placing them in the context of the agricultural system as a whole precludes satisfactory understanding. The questions these developments raise about the organisation and practice of agriculture also need to be considered in their social and economic framework; without this relationship to both agricultural practice and socio-economic context questions of form too easily dominate over questions of function. This recognition of change reasserts the importance of prehistoric agriculture as a source of socio-economic evidence instead of allowing its relegation to the position of a static backcloth of little wider importance.

Chapter 8.
Social and economic organisation and the agricultural economy of Iron Age and Roman Britain: identifying the questions.

8.1. Describing agricultural systems.

An important assumption underlying this work is that an understanding of the social and economic context of agricultural production is necessary if agricultural systems are to be described. A list of crops and animals, tools and techniques is not considered adequate as a definition of the 'type' of agriculture practised at a particular time and place, and still less so as a basis for identifying and explaining agricultural change.

Failure to take into account social and economic factors must almost inevitably result in explanations being sought in terms of technological or environmental determinism. In this context, even where socio-economic factors are invoked as influences on agriculture, understanding of the form such influences take and how their operation manifests itself either in the functioning of the agricultural unit or in the archaeological record is usually deficient. Some discussions of the effects of the Roman Conquest on agriculture in Britain demonstrate this, perhaps particularly when the limited evidence for Roman introductions of new technology is acknowledged (for example, Wacher 1978,106-111).

The use of population pressure as a explanation for agricultural and social change is one particular aspect of this problem. The failure to recognise population characteristics as a response to social as well as biological factors and the acceptance of population size as an independent variable (as in the Boserup model) limits the scope of analyses, and hence also the explanations which can be derived from the evidence (Cowgill 1975, 513; Hassan 1981, 162-3).

To exclude socio-economic factors from discussions of agricultural practice also significantly restricts analyses of social and economic organisation in a wider context. In societies where the bulk of production is agricultural, how land, arable and pastoral, and its produce are controlled is crucial. The extent, nature and effectiveness of this social control - including how it relates to agricultural practice - is surely one of the key socio-economic questions at any time in prehistory.

Recognising that an agricultural system is defined by its organisation as well as its practices, and that socio-economic factors must be explicitly included in characterising this organisation, is an important step in approaching these questions. It will be argued below that failure to specify a level of agricultural organisation intermediate between agricultural practice and socio-economic organisation can result in attempts to relate elements of agricultural practice such as the pattern of land usage too directly to the social organisation of a community. Where landscape elements are long-lived, simple correlations between land use and social structures can often be seen to be unrealistic. Because of this, the evidence for the spatial organisation of agriculture may be disregarded as a source of information about specific societies or periods. It becomes seen as a continuous background, rather than as an integral part of socio-economic organisation. Definition of a distinct level of 'agricultural organisation' may allow more useful inferences to be drawn.

Where the socio-economic constraints and opportunities operating can be incorporated in the description of an agricultural system, they may also be valuable in assessing the significance of variations in agricultural practice, either between contemporary settlements or at different times. As well as variation in response to local environmental conditions, models such as Lipton's survival algorithm (Lipton 1968) predict differences in the 'package' of agricultural practices adopted by individual farmers. Settlements whose agricultural practices can be seen to have differed (perhaps considerably) may nevertheless have been following an essentially similar agricultural regime. The problem lies in distinguishing distinct systems from different selections of options within what is still essentially the same system.

Inability to draw this distinction can result either in identifying each individual farming settlement as representative of a separate farming system (the detail overwhelming the picture) or in failing to recognise significant differences, which will tend to result in a static and monolithic picture of 'Iron Age Agriculture' or of 'Roman Agriculture'. Differentiation between the two in the latter case is also more likely to result from prior expectation than assessment of differences in the material evidence.

In some cases the value of socio-economic factors in interpreting evidence for agricultural practice is unlikely to be disputed. Just as evidence for climatic change may suggest a reason for a change in relative importance of two cereal crops, so evidence for changes in the economic context of farming may suggest a significance greater than a shift in individual preferences. For example, Green (1981,133) has suggested that breadwheat may have been adopted as a specialist crop grown for urban marketing in the Roman period. Breadwheat is particularly useful as a traded and transported crop, because of the comparative ease with which it is threshed, halving its bulk.

It has been noted that the prevailing view of later prehistoric agriculture is essentially one in which little change is envisaged, with both the basic practices (such as land division, cross ploughing and manuring) and tools remaining virtually unchanged throughout a long time span. The earlier chapters argued that in fact processes of development can be inferred in several areas of agricultural practice.

It is taken as a starting point for this chapter that if the socio-economic context of agriculture can, in some way, be specified and changes in it identified, this is more than just an intrinsic part of an adequate description of a prehistoric agricultural system. It is also a possible key to breaking down the static picture which often prevails, and to recognising and interpreting processes of change which, if subtle, may still be significant. Additionally, this approach to agriculture may suggest which questions are of prime importance in understanding how a particular agricultural society functions and perpetuates itself.

It was with these factors in mind that the original eight-part framework for describing and analysing agricultural systems was devised. The eight aspects were deliberately defined to cross-cut the categories into which the archaeological evidence falls, so that the nature of the archaeological record did not determine the scope of or impose too rigid a structure on the discussion.

Nevertheless, the eight categories fall into three rough groups related to the nature of the evidence for them - those for which evidence is recoverable more or less directly from the surviving material evidence for agricultural practice (such as tools and techniques, plants and animals); those which can be inferred less directly from this evidence, incorporating a wider range of evidence relating to agricultural settlements (fertility maintenance practices, labour and population levels, types of investment); and those for which evidence will primarily be sought from outside the agricultural settlements themselves, whether from other forms of archaeological evidence, from literary evidence, or from theoretical considerations.

This chapter deals with the factors in this third group. They were initially specified as the relation between subsistence and surplus production; economic demands or constraints such as rents and taxes, and the autonomy of the productive unit; and the farmer's decision framework. The value of the eight-part framework will be assessed in Chapter 11.

The intention in this chapter is to summarise some socio-economic information relevant to agricultural practice and organisation, identify its limitations, and suggest how it can, potentially or actually, be used to clarify description and interpretation of past agricultural systems. An initial difficulty lies in defining the scope of the discussion. Clearly this has to be restricted, and for present purposes three key areas have been identified. While at one level the primary aim is to aid the interpretation of the material evidence for agricultural practice, this section is also intended to generate questions about agricultural societies and their organisation - in fact to suggest which questions are crucial in characterising agricultural economies.

8.2. The means of socio-political and economic control.

The first of the three issues considered is the widest, the means by which socio-political and economic control are enforced in societies. Its first aspect is mechanisms of social control, the nature and uses of power in society. This is perhaps the most fundamental aspect of social organisation, and as such it is too broad a question to cover in any detail in this context. One point which can be noted is that such questions are more frequently posed for prehistoric contexts than for the Romano-British period - and yet despite the range of information available about the society and economy of the Roman Empire, it is by no means clear that the mechanisms of social control of rural populations in Roman Britain are well understood.

Two questions seem of particular relevance to understanding the socio-economic context of agriculture. One of these relates to the status of 'laws' or 'customs' and their enforcement, that is the basis on which a society's control of its activities (including agriculture) was imposed. The existence of a capacity to enforce laws or judgements is not universal even in those societies where a judicial framework is well established. Similarly payments or tribute to a central authority can be based on consent, being at least notionally voluntary. The capacity of a elite group to, for example, increase the quantity of agricultural produce at its disposal will depend on the available social mechanisms for enforcing or encouraging increases. Where an elite group enforces such increases, and especially where tribute is 'voluntary', this may entail a significant change in the nature of the social obligations involved.

The second question, and this seems to be a key point in understanding agriculture and agricultural societies, is the relationship between status, power and agricultural production. Whether status and wealth derived, wholly or in part, from successful direct participation in agriculture may have been an important factor in agricultural change, as Cancian's analysis (Cancian 1967) of the complex relationship between social status and agricultural innovation implies. In many societies, social control is dependent on the control of agricultural production, whether by direct control over the land and other resources or through the ability to obtain control of a proportion of the produce. Yet in other cases, it appears to be independent of any ability to regulate agricultural activity, which implies, in the context of societies where the bulk of productive activity is agricultural, largely independent of the productive and subsistence base.

Closely related to the question of social control are the issues of land ownership, allocation and control and tax, rent and tribute. These can be regarded as ways in which social authority is enforced in the specific context of the agricultural economy, by means of control over the land and its produce.

The issue of land holding concerns both access to productive land and the conditions under which it is utilised. Land may be controlled individually, by a kingroup or community, or by an elite group or person. It may be allocated annually or for a fixed period of years, or rights may be permanent and inheritable. Different types often coexist in a society; this is one of the factors which suggests that some attempts to relate social organisation too directly to evidence for land use may be unrealistically simplistic. There may be a web of interacting rights over land. A fixed period of exclusive rights to arable land while crops are growing is commonly followed by general rights of access for grazing, or for cutting the straw. Recognition of the existence of a temporal element in land allocation and regulation in addition to its spatial aspects is an important factor in understanding how agricultural systems work (Sansom 1979).

Two aspects of the relationship between land and population can be noted here. Fluctuations in size of domestic units throughout the lifecycle of the family are general. These affect both the needs of a group and the area it can cultivate (Sahlins 1974,74; Kerblay 1971,155-8). Land holdings can often be adjusted in response to this, for example through a process of annual allocation or a system in which a group with surplus land can rent it to a group with a shortage. Some systems of land holding ensure that all adults (or at least all adult males) receive an allocation of land, while in others concepts of ownership or repeated subdivisions on inheritance result in some adults being either landless or with too little land for subsistence. The present discussion will avoid invoking the concept of population pressure on land. The presence of cultivable land and its availability are not the same thing, and it is questions of access to land which are under discussion here. Population pressure is a socially defined effect.

The issue of rents, taxes and tribute raises two questions. The first is the nature of the demands made on agricultural producers, that is, the form these demands took. The relationship between payment and the production achieved is one consideration. Payment, whether in coin, in kind or in labour, can be unrelated to the agricultural functioning of the unit (for example, a poll tax), related to the size and quality of the holding (like rents) or related to the crop actually harvested in a given season. The difference in the effects of these systems, especially in years of poor harvests, is clear. The extent to which payments are compulsory and enforceable is also important

- where these payments are regarded as 'gifts', the producer may be able to reduce or omit them in cases of crop failure or where an imbalance in the proportion of producers to consumers in the domestic unit results in a shortfall. The needs to make such payments (to maintain status, to obtain protection, to ensure future favourable allocation of land) can be balanced against the needs of the producers. The form payments take (coin, specified agricultural products, etc) is another factor, discussed further below.

The second question is the size of these payments and their significance in relation to overall production. Clearly a precise answer to either question will often not be achievable in prehistoric contexts, and indeed despite the more plentiful information on taxation in the Roman Empire, the answers there are far from complete. However attempting to specify the questions at least focusses attention on the problems involved.

An important question arising from these considerations concerns the degree of autonomy of the productive unit - the extent to which the individual farmer or farming group has control over land use, over levels of production, over the disposition of the produce. Any approach to agricultural change based on decision making processes must incorporate an assessment of which options are effectively open to the farmer. The constraints deriving from land holding practices and payments such as rents, taxes or tributes are as concrete as the constraints imposed by environment or technology, and must also be taken into account, even if doing so is still more problematic. Where there appears to be little change in environmental or technological constraints, these socio-economic constraints may be suspected of being the major factors in changes observed in agricultural systems.

8.3. The nature of the economy.

The obvious significance of the second issue, the nature of the economy, is the opportunity potentially provided by a market economy for an agricultural community to exchange its surplus produce for an easily stored, non-deteriorating form of wealth, coinage, which can in turn be exchanged for other objects. It is a factor often emphasised in discussions of Roman Britain, where the simple view of the introduction of a market economy as a positive opportunity for agricultural producers (for example, Wacher 1978,106-7) seems to obscure a more complex set of economic conditions.

However, the existence of markets and coinage need not imply the existence of a market economy, in which prices are fixed by supply and demand. The discussion of African markets by Bohannan and Dalton illustrates this, drawing a useful distinction between peripheral and dominant markets (1962,7-10,Table 1). They separate three types of society.

In the first, markets do not exist, and exchanges based on market principles, if they exist at all, are limited to "a few casual, interpersonal transactions" (ibid,3). The economy is multicentric, with several distinct transactional spheres.

This is also the case in societies with peripheral markets, where most subsistence goods are still acquired outside the market, which is important as a source of unusual or imported items, but not as a source of income. In these societies there is no single all-purpose money, and exchange may be either moneyless or involve one or more types of special purpose money whose usage is closely restricted. Prestige goods may be excluded from market transactions, as to exchange them in this way would undermine social relationships (Meillassoux 1962, 298). In peripheral markets, prices are affected by a wide range of social factors in addition to supply and demand. Customary prices may apply; for example, Sansom (1979a,172) notes that among the Southern Bantu, pots were traditionally priced at their own volume of grain.

In societies where the market principle is dominant, prices are fixed by supply and demand, money is all-purpose, and both buyers and sellers depend on market transactions for their livelihoods (Bohannan and Dalton 1962,9).

But for discussions of agricultural production, the most important distinction drawn by Bohannan and Dalton is that in peripheral market societies, "prices do not affect future production of the things priced", that is they "do not perform the function of allocating factor resources among alternative outputs" (1962,8). In contrast, in economies where the market principle is dominant, "the market prices for finished goods crucially influence production decisions and therefore the allocation of resources, including labor, into different lines of production"(ibid,9).

In the peripheral market societies described by Bohannan and Dalton, while markets may be perceived as important (socially, politically and as a source of particular items otherwise unobtainable), it is the case that the quantities of goods sold are normally small, and that marketing considerations do not influence production decisions.

This seems to be a key point. There are wide disagreements over the date of the establishment of a market economy in Iron Age and Roman Britain, or indeed throughout much of the Roman Empire (this debate is discussed later). In the terms defined by Bohannan and Dalton, there are two related questions to be posed: whether a market sector existed, and if so whether it was peripheral or dominant. It is not necessary to assume that the categories of market can be transposed unaltered from subsaharan Africa to later prehistoric and Roman Britain to suggest that examining the evidence for the development of coinage and market exchange in the light of these distinctions may prove highly informative. In particular, the proposed relationship between agricultural productive decisions and the nature of the market is a dimension omitted from discussions of the British evidence, and one which appears to offer considerable potential for examining agricultural change.

Writers on the Roman period in Britain often assume that the introduction of a market sector would in itself attract agriculturalists to increase production to achieve a surplus for market (eg, Rees (1987,449) writes of "the incentive, provided by new markets" and Wacher (1978,107) suggests farmers "realized that by extending .... production still further, [they] would have a profitable asset". But the societies described by Bohannan and Dalton are often characterised by a strong reluctance to participate in markets to any great extent. For example, the Arusha people initially "sold to the market just that minimum of traditionally grown crops that would fetch them sufficient cash to buy extra food and to pay taxes". Only subsequent economic pressure (land shortage which made cultivation of their subsistence needs impossible) brought about a fuller involvement, with changes in production in response to market prices. Livestock, beer and craft items were sold (Bohannan and Dalton 1962,21-22). Brewing and craft production have both been associated with inability to cultivate enough food to meet subsistence and other needs. Jones (1981,115,118) cites an example of brewing used to even out seasonal cash flow problems by

Tanganyikan agriculturalists, and suggests that some corn driers from Roman Britain could, because of evidence for their use in malting, be interpreted in this way.

Land shortage is often assumed to be a consequence of population growth; it is in many cases relatable to loss of land, for example due to expropriation by an occupying or elite group. Loss of access to pasture, woodland, etc, can have results as severe as loss of the arable itself, where the fertility of the arable is dependent on nutrients transferred from the wider area. In shifting cultivation, loss of apparently unused land (ie. land lying fallow) similarly renders the agricultural system unsustainable in the long term. Where "estates" are carved out of already farmed areas, detrimental effects on existing traditional cultivation systems are likely.

Bohannan and Dalton note that the simple establishment of market places is insufficient to bring about a market economy - in many cases, "heavy sanctions" proved necessary to compel production for sale (1962,22). Enforced participation in the market is also an indication of the political importance which often attaches to control of the market place. Bohannan and Dalton (1962,17) note that in all the different examples discussed in the volume, "control of market places is in the hands of the political authorities".

The requirement to pay money taxes in Roman Britain must have forced some farmers into marketing (Hingley 1983,22). Payment was always demanded in cash not kind until the tax reforms of Diocletian at the beginning of the fourth century AD. Similarly compulsory requisitioning of grain by the military in a sense imposed marketing on the producers forced to sell their produce in this way (Mann 1985,21-3). Even if as Mann suggests, this occurred at favourable prices, the effect on farmers producing for their own subsistence not for sale can hardly have been welcomed. Payment in coin is administratively simpler, especially in the context of net movement of wealth from the provinces to Rome (Hingley 1983,21). It is arguable whether there was additionally the deliberate aim of enforcing market participation. The encouragement to construct urbanised amenities by Agricola, according to Tacitus (Agricola 21), specifically included market places, although these had a wide range of functions of which the marketing of goods was only one. Without markets the development of Romanised towns would surely have been impeded. But this is one aspect of a fundamental problem, the extent to which there was deliberate control and manipulation of the economy of the Empire, and cannot be discussed adequately except in that context. One question relevant here is whether the smaller scale agricultural producers paid taxes directly, or via an intermediary, as for example it is known that landowners were responsible for their tenants' taxes, and even if that is unlikely to be a correct description of relations in land holding at the end of the Iron Age, a similar model of responsibility for payment might have been imposed by the Roman authorities, keen to minimise the number of imperial employees and costs of tax collection.

The assertion that by the imposition of money taxes the farmers of newly conquered Roman Britain were "forced into surplus production" (Hingley 1983,22) is a statement which needs qualification. Bohannan and Dalton (1962,13) state that "too often the term surplus is used simply to mean that which is sold, or exchanged on the simplistic assumption that if something were needed it would not be sold or exchanged". People involved in market selling include those "who by no stretch of terminology can be regarded as having a surplus of anything, including the items they trade". The disadvantage of the Roman rural poor (Jones 1964,10-11) as a result of selling their produce is an illustration of this point. Sansom (1979,170,174) notes that it is a common practice for women in Southern Africa to sell grain after the harvest with the intention of repurchasing it later, which he interprets as a form of borrowing with the grain as security.

On the other hand, where there was an apparent surplus, abundant items were not necessarily considered exchangeable for scarce ones. The Masai, for example, would not exchange cattle, the expression of wealth, for foodstuffs - "from the Masai point of view, there could be no such thing as a "surplus" of cattle" (Bohannan and Dalton 1962,14).

Where subsistence foods were sold in markets, it is not necessarily the case that producers would also buy basic foodstuffs, except in emergencies. For example, Reining (1962,552) notes of the Zande that "they believed it commendable to convert subsistence goods into money, but they did not want to reverse the process". The exception was where additional foodstuffs were required to fulfil a social obligation, rather than a subsistence need. Objects used in non-market spheres could be exchanged for subsistence goods - but to do so aroused moral disapproval. Bohannan and Dalton (1962,5-6) comment that conversions between subsistence and prestige spheres of exchange are always defined in moral terms, as good or bad.

Money acquired from sales of subsistence goods is thus often used not for cash purchases but as a prestige good itself, being used to fulfil social obligations (Reining 1962,553-4). Money acquired in the market is transferred to a different sphere of the economy - "rather than being accepted as a medium of exchange, [money] was added to the list of exchangeable commodities" (Herskovits

1962,x). In the same way as money can have these these two distinct roles, so the market itself may have differing economic significance to those participating in it. While to agricultural producers a market may be peripheral, their social role greatly exceeding their economic importance, to other participants, such as traders from outside the society, the market may be dominant, the source of their livelihood (Bohannan and Dalton,1962,7-8,15-19).

One important distinction which can be drawn between these traditional African societies and what is known about the Iron Age and Roman periods in Britain is a technological one. Hoe farming is the predominant form of traditional agriculture in Africa (Goody 1976,35), while there is considerable evidence for the use of the plough in Britain from the early third millennium bc onwards (Piggott 1981,55).

The use of a plough in tillage greatly increases the theoretical area an individual can cultivate. The plough therefore gives a greater potential for differentiation in production - the opportunity open to those with greater access to land and other resources to enhance their position is greater (Goody 1976,25). Some factors act to mitigate this. A larger cultivated area may imply utilisation of less favourable soils (as, for example, Sherratt (1981,293) suggests for the Neolithic of Central Europe). Such land may have lower yields per unit area and require more inputs to maintain fertility, hence reducing the labour advantage of the plough. Sansom describes social controls in Southern African traditional cultivation which restrict cultivation and maintain rough equality in cereal production (1979,152-6). The combination of the common exclusion of cattle from market transactions and the technological and social limitations on cereal production clearly act to reduce the possibility of wealth accumulation by means of market sales.

However this difference in technology may imply that cultivators in prehistoric Britain were in a better position to take advantage of the presence of a market than African hoe cultivators. Where the latter had the option to change to plough agriculture, there was often opposition to doing so; this might be related to environmental unsuitability or to "the men [being] reluctant to take on the additional burden of plough agriculture" (Goody,1976,25).

While women "frequently play the major productive role in hoe farming", "the plough is an instrument employed almost exclusively by men" (Goody 1976,35). The association of men with larger livestock in general and ploughing in particular appears to to an almost universally applicable rule, and can reasonably be assumed to have applied in European prehistory (Sherratt 1981,297-299).

These differences in male and female roles in cultivation are accompanied in the traditional African societies by differences in trading activities. In societies characterised by female hoe cultivation, married women tend to retain their rights over property, responsibility for their own support, and the right to sell their crops (Goody 1976,32-5, quoting Boserup 1970,50). Women were usually the principal traders in subsistence foods, and in foods cooked or prepared for sale (Herskovits 1962,xi). Other forms of trade were however carried out by men; for example, among the Guro imported foodstuffs were traded by men (Meillassoux 1962,297). In the case of the Yoruba, where the main form of agriculture was intensive hoe cultivation by men (Forde 1934/64,153) sales of the principal cash crops "bypass the market place, which remains a pin money affair for women" (Bohannan and Dalton,1962,10). Long distance trade and trade in some specific manufactured items were male preserves among the Yoruba.

In Britain, where male participation in agriculture can be assumed to have been substantial (even if tasks such as weeding and harvesting remained female activities), it is probably reasonable to infer that men will have had considerable if not exclusive control over the produce and its disposition. The role of men in subsistence goods trading may therefore have been more significant than in the African examples cited. If the factors which in the African examples are seen to have restricted the potential for wealth accumulation through the market place can be related to the placing of limits on female autonomy by men, such constraints need not have applied in a society where the production of and trade in subsistence foods was controlled by men. The need to maintain systems of prestige and wealth based outside the market sphere also requires restrictions on market development (for instance by the exclusion of certain goods); certainly political control of markets is general throughout the traditional African societies (Bohannan and Dalton 1962,17-8). However if status derived at least in part from direct successful participation in agriculture, incorporation of market activity as a measure of that success need not be regarded as threatening to the social framework, even if in the long term it almost inevitably was destabilising because of its effects on other relationships within the society. The pre-existing concepts of wealth in African societies have been identified as a major determinant of their response to developing market economies (Bohannan and Dalton 1962,23-4).

It is often commented that markets have a democratising" effect (that is, they allow easier access to goods previously restricted by socially controlled distribution). However as Dalton (1967,77) notes this "democratization of wealth" as a result of market participation had a "socially divisive impact" on traditional African societies. Undermining the rules by which only people of certain social status could own particular prestige items or accumulate substantial wealth also undermines the social order, which is why status items are often rigidly excluded from the market in peripheral market societies. In addition, as the market principle expands, so "the areas of life subject to the principles of redistribution and reciprocity are shrinking" (Bohannan and Dalton 1962,20).

In traditional African societies, the right to subsistence was guaranteed in two ways. By belonging to a community, individuals had rights to be allocated land to cultivate and rights to labour on a reciprocal basis as needed. Additionally they were entitled to subsistence in case of emergency, by means of redistribution from the chief or reciprocity from kin (Bohannan and Dalton 1962,72,74). Although transfers of food tend to be emphasised in this respect, reciprocity in labour may be a crucial element in maintaining traditional agricultural systems. A farming unit may otherwise be unable to cultivate sufficient land to meet its needs, for instance when there is an unfavourable ratio of producers to consumers or when a major task is undertaken. Cashdan notes that when a new field must be prepared for plough agriculture, the area a family can cultivate is significantly reduced, affecting all groups on a cyclical basis (1985,467-8). Sansom describes how limitation of the tilling period among the Southern Bantu acts to prevent wealthy cattle owners from using gifts of meat to working parties in order to greatly increase the area they cultivate and hence from denying poorer farmers the labour assistance they may need throughout the year (1979,154-6).

This essential labour reciprocity is known to be undermined by the availability of paid employment, which encourages neglect of socially important functions (Dalton 1967,77) and if the freedom to sell produce rather than the obligation to give to those in need encourages attempts to increase production, labour also may be diverted away from its reciprocal obligations. This decline in reciprocity therefore does not just remove an element of security from agriculturalists, it can seriously impair the functioning of the agricultural system of the community, and increases the likelihood of failure among its members.

These descriptions of African markets provoke reassessment of some of the assumptions commonly made about Iron Age and Romano-British economies, and provide a useful basis for investigating the interrelationships between trading activities and agricultural production in societies where markets are present but do not dominate the economy. The finding that in those societies where markets are peripheral, market factors do not influence the allocation of agricultural resources and inputs is potentially very important in understanding agricultural systems and agricultural change- provided it can be accepted as a widely applicable characteristic of such societies rather than one specific to those discussed here. There is also the general problem which arises when two social or economic 'types' are defined. The distinction may be valuable in analysis, but it is likely to be highly artificial, in the sense that intermediate or non-conforming types are bound to occur, particularly when a period of transition is involved.

It is not assumed that features of African traditional marketing can be applied as a matter of course to the societies under discussion here. One particular element which might lead to the expectation of some differences (ie. the use of the plough) has been noted. But the assessment of the links between marketing and the production of basic food crops may, if it does not necessarily provide the answers, at least generate some questions about the relationships between the economic organisation of a society and the economics of agricultural systems which have rarely been made specific in this context.

8.4. 'Social Insurance'

The last of the three socio-economic issues selected is 'social insurance'- the means which exist to allow either a single productive unit (household or family) or an entire community to withstand 'failure' (that is, being unable to produce sufficient to meet its subsistence needs in a particular year). Failure must be regarded as an inevitable aspect of traditional agricultural economies. As well as unpredictable events, changes with time in the composition of the family/household (Sahlins 1974,69-74) and the annual variability of the harvest imply that failure will not be uncommon at the level of either household or community. A society unable to limit the effects of these problems would risk being destabilised by population fluctuations and resultant social disruption.

It is important to distinguish between a level of 'normal failure' (ie where a proportion of households within a society fail to produce sufficient for subsistence) and failure affecting a whole community, where the society is not likely to be able to alleviate the situation from within its own resources. A different range of responses may be necessary or appropriate in these two cases. Surviving scarcity in the case of community-wide failure may involve large-scale breaches of normal rules of behaviour - including those which in normal years serve to allow the disadvantaged to cope with individual failure, such as food sharing (Colson 1979,25-7).

8.4.1. Failure in the 'normal year'

Storage is an essential element of the agricultural economy, as the limited harvest period requires food to be stored for use in the rest of the year. The ability to store food for longer periods, past the next harvest, provides a potential safeguard against subsequent failures. It is therefore easy to regard storage as the obvious or primary means of insuring against crop failure. But there are problems. Storage of food long term results in losses, even with grain, the most readily stored type of staple food (Colson 1979,22). Experimental work on storage in pits of the type used in the British Iron Age (Reynolds 1974) has emphasised its efficiency. But this depends on large quantities being stored together (otherwise the protective crust which forms would consume too high a proportion of the grain). It is also suggested that the grain (widely assumed to be seed corn; ibid,130) must be utilised at once when the pit is opened, as deterioration is then rapid. However, it is possible that roasting the grain immediately on removal would destroy the microorganisms responsible for decay and allow more gradual use as food. The use of pits to store grain and the change in grain drying technology seen at the beginning of the Iron Age (section 4.2.4.i. above) may be closely related developments, reflecting the need to dry large quantities of grain rapidly once they are removed from pit storage.

Recent ethnographic examples of pit storage discussed by Fenton (1983) all used this method for preserving grain from good harvests to bad years when it would sell for higher prices. Weevils do not seem to have posed a threat to stored cereals in the Iron Age, as they certainly did in Roman Britain (Osbourne 1978,34; Buckland 1978). An additional problem is that the occurrence of poor harvests may not be independent, in that yields may be depressed in the following year by factors such as scarce or poor quality seed corn or a debilitated work force. This effect could be recognised in the examination of mediaeval crop yields in Chapter 2. Colson (1979,21) suggests that food storage is the least important of the five means she identifies for lessening the risk of community wide food shortage. Its importance is in equalising food availability throughout the normal years, rather than in years of regional bad harvests.

In the normal years the other important means of social insurance is gifts or sharing of food. Winterhalder (1986) has shown that for hunter-gatherer populations, food sharing is both efficient in procuring an adequate diet and effective in reducing risks of food shortage. The latter can be achieved by sharing within even quite small groups. Winterhalder suggests food sharing may be "an ancient and pervasive feature" of human behaviour (1986,389).

Reciprocal gifts of food appear to differ from gifts of other goods (Sahlins 1974,215-9). Food is more often freely shared than transferred in balanced exchanges, a use which would tend to arouse disapproval. Among friends and relatives, it is not exchanged for other goods. Such exchanges occur only with outsiders, whether they are initiated out of necessity or are a regular element in a society's economy. The sphere of generalised exchange is often wider for food than for other goods, notably when it takes the form of hospitality to trading partners, with whom transactions involving other goods are carefully balanced. Although food is often given in return for labour (in agriculture, house building, etc), Sahlins suggests this should be seen not as "wages" but as a temporary incorporation of those giving labour into the household economy.

Cashdan (1985) has used a study of two agricultural groups in Botswana to investigate the functioning and differing usefulness of storage and generalised reciprocity in compensating for variations in household food supply. She makes the point that for reciprocity to act as an effective insurance, there must be a sufficiently large number of participants, failure must be accidental, and the risks must be such that there are unlikely to be a large number of households simultaneously facing food shortages. If a reciprocal exchange network is to act as insurance against the effects of the weather, it must cover an area including a variety of environmental or climatic regions, in which adverse conditions are unlikely to occur simultaneously. A wide area of reciprocal relations is more easily sustained by mobile populations; for sedentary populations, reciprocity may be effective in terms of the efforts expended in maintaining relationships only where a variety of environments are found in a restricted area. Cashdan therefore expects storage to be preferred to reciprocity in sedentary populations where the source of risk is regional rather than individualised in its effects (1985,457-8).

Cashdan's comparisons showed that while the Tswana and Kalanga peoples rely chiefly on storage of foodstuffs, the Basarwa are more dependent on generalised reciprocity. Basarwa households received more goods in this way, and far more of these gifts were of grain. The reason for this was the greater production achieved by the Tswana and

Kalanga, who averaged harvests more than 2.5 times larger (per person or per household). In both groups, low production of grain is associated with a greater number of gifts received. Tswana and Kalanga households often still had grain stored from one harvest at the time of the next, but none of the Basarwa households did in the survey year.

This differential productivity is not due to farming technology, environmental conditions or land availability. It relates directly to the size of the field cultivated, which itself depends on the number of years it has been in use. The labour involved in preparing a new field is considerable. The Basarwa are agriculturally disadvantaged because of their more frequent changes in residence location, which result from their greater reliance on a short-term cattle "loan" system. They own few cattle, on which they depend for draught power, apparently because they are economically unable to build up herds as the Tswana and Kalanga do. This is itself an interesting example of the interrelationships of different elements in an agricultural economy, grain, livestock and socio-economic factors.

This explanation for Basarwa differences in production implies that different households are affected by shortages in different years. Hence every household is at different times donor and recipient. Damage by various crop pests and cattle, the other important causes of food shortfall (apart from regional weather conditions), also tends to have localised effects.

The independence of the risks for different households and the low levels of production which make accumulation of a substantial store difficult make reciprocity and effective way of coping with household food shortages during the normal year. The Basarwa also rely on trade with their more productive neighbours. While gifts of food were received mostly from within their own group (81%), most purchases (67%) were made outside it. This is in contrast with the Tswana and Kalanga, for whom 60% of both gifts and purchases were intra-ethnic (Cashdan 1985,especially 462-8).

This study is interesting because of its attempt to identify the reasons why reciprocity rather than storage was the more effective way of coping with risk, and also because it deals with the 'normal year', rather than with strategies for the years of general food shortage, which have received more consideration, at least for agricultural societies.

8.4.2. Failure in the exceptional year

Colson (1979) reviews the techniques societies have for coping with the exceptional years of bad harvests. An important point is that these practices form part of 'normal year' behaviour - they act either to minimise the risk of failure or to ensure that, if it occurs, coping mechanisms can be brought into play. She identifies five risk-reducing devices. Three of these relate to the production or handling of foodstuffs. Diversification of subsistence activities lessens the impact of failure in one area. Storage of foodstuffs is, as noted above, unlikely to have been effective in most cases of widespread harvest failure. Maintaining knowledge of "famine foods" and their preparation is a device which may be difficult to recognise archaeologically. Rausing (1981, Appendix I) lists over 190 Scandinavian wild plants gathered and used as food in recent times (many also occur in Britain). Colson suggests that agriculturalists often have a better knowledge of local plant resources than do hunter/gatherer populations (1979,21-2).

The other two devices depend on social relationships rather than resource management. They are the conversion of food into durable valuables which can be reconverted into food in need, and the development of relationships which allow access to food produced in other regions.

8.4.2.i. The conversion of food into durable valuables

The obvious example of this device is where a market economy allows the sale and purchase of food. Two points can be noted. For a market to be effective in lessening the effects of a regional bad harvest, it must attract sellers from a variety of areas whose bad harvests rarely coincide. Additionally, food sold to a market trader must remain available in the market for purchase. If it is bought up for 'export', for example by a professional trader from a different society, it is no longer available to those who need it, even if they have sufficient money to buy it. This movement of produce is one difference between the 'grain-pawning' Southern African women and the starving Roman rural population referred to above (section 9.3.3).

Halstead and O'Shea (1982,93) argue that exchanges of food for valuable "tokens" occur also in non-market economies, with "at least the implicit understanding" that these "tokens" are re-convertible to food in case of need. This view is however disputed, for instance by Hodder (1982,150-1), who argues that exchanges of food and of prestige goods form separate spheres of exchange, a separation which plays a major role in maintaining political control in hierarchical societies (Rowlands 1980,46). Halstead and O'Shea suggest that the use of prestige goods to obtain food for consumption is confined to years of poor harvests, which has resulted in its being under-reported in the ethnographic literature. They further suggest that such conversions - which they term "social storage" - form an important stimulus to the development of social ranking, as wealth inequalities build up.

Bohannan and Dalton (1962,5-7) describe such "emergency conversions" in some non-market African societies. The crucial point is that these exchanges are always initiated by those in need, and always with people from outside the social group - that is, with people who have no obligation to help the impoverished individuals. Two of the examples cited by Halstead and O'Shea apparently carry out these exchanges within their own group (Tolowa and Kwakiutl). However, the accumulation of wealth is not seen as an end in itself in either society. It is the conversion of wealth into prestige which is the final aim (Gould 1966,86-7; Suttles 1968,60,64,67). Among the Tolowa, "the wealthy man had to dispose of his wealth for the best interests of his village" (Gould 1966,86). Food/wealth conversions took place within only two of the societies described by Suttles; in both "giving was certainly more honorable than selling" (1968,67). Conversions between subsistence and prestige spheres have a moral dimension (see section 8.3 above).

The other example cited is the Navajo. Here the exchanges occur in the context of a people accustomed to using money for more than a century. The prestige items (jewellery) can be used "to buy anything in exchanges between Navajo" but the "primary economic function is to insure credit". Jewellery is pawned at the trading posts (that is, not with other Navajo) as a "buffer against the lean months of the winter" (Downs 1972,114,118). Because of these factors, it is difficult to see this as providing real support for Halstead and O'Shea's social storage model.

Where inequality in production is persistent, it is unclear how the group whose subsistence base is deficient acquires the "tokens" to exchange for food. Restricted access to a valued resource would be one explanation, but is unlikely to have been general. Documented cases of trade in compensation for agricultural disadvantage, whether in response to a single bad season or as a regular element in a society's economy, seem to relate to utilitarian craft items (such as pottery and basketry) or other necessities (such as salt and charcoal) rather than prestige goods (Peacock 1982,23-4; Arnold 1978,56-8; Colson 1979,27; Cashdan 1985,469).

Where "token" exchange occurs, the tokens may be a manifestation of social obligations rather that explicit payments. They could be seen as symbolising the obligations of those with access to food and resources towards those without. Such tokens would perhaps be particularly relevant in a society where competition for allegiance existed between individuals of high rank. Tokens could establish an individual's claim against a particular person on the basis of past support (such as, perhaps, gifts of agricultural produce in years of sufficiency). A contemporary parallel for this might be impoverished war veterans displaying medals while asking for money - the medals are not for sale but to remind passers by of their obligations. If medals are actually sold to meet needs, disapproval is general, and attaches not to the seller but to society, especially the political leadership (for example, Daily Mirror, 1:7:88,7). This kind of interpretation would also explain the removal from circulation of such objects, for example in hoards and burials. An important part of their value would lie in the obligations they expressed, and would therefore end if these obligations were terminated. This process of removal is described by Halstead and O'Shea (1982,94) and also Haselgrove (1982,82) as a means of preventing 'inflation'.

This kind of competitive leadership is described by Sansom for the Bantu-speaking peoples of southern Africa. Among the western groups, the headman's ability to maintain a following depended on his ability to allocate land; among the eastern groups, the use of gifts or deprivation of possessions was the basis of control and competition (1979b,252-3,259,265). Mann (1986,39,62) stresses that choice of allegiance was the norm in "noncivilized" societies. Competition among German leaders to attract a warrior retinue is described by Tacitus (Germania, 13-15). The chiefs give their followers gifts such as weapons and horses; they themselves were supported by voluntary gifts of food from their own people, and received gifts of prestige goods (horses, armour, ornaments) from neighbouring communities and individuals. These gifts from individuals may reflect the possibilities of changing allegiance, and the benefits of maintaining links with more than one leader. Thompson (1965,49-50) notes that between the times of Caesar and Tacitus these retinues changed from ad hoc bodies formed for specific raids to more permanent associations. Similar competitive leadership may perhaps be inferred from the comments of Caesar; the German chiefs allocated land so as to keep the "common people in contentment" and the "leaders of parties" among the Gauls had to prevent their followers from being "oppressed and defrauded" or else they lost their authority (Caesar, Gallic War VI,11 and 22). Both suggest that the dissatisfied may have had alternatives available.

8.4.2.ii. Intersocietal relationships and the alleviation of food scarcity

Colson (1979,23) describes "social links with those outside ones immediate terrain" as "the ultimate insurance against famine". Spielmann (1986) has assembled evidence for interdependence among egalitarian societies, distinguishing "buffering" (periodic interactions to relieve shortages) from more routine exchanges of different foodstuffs ("mutualism"). In buffering, resources may be obtained in two ways - by exchange (including both trade and 'reciprocal' giving) or by dispersal (where the recipient population enters the donor territory and procures the food itself). Exchange is more likely where the donor population has already invested labour in procuring or producing the food itself, and wants to retain control over it. In egalitarian agricultural societies, a combination of dispersal and exchange is common; the recipient population moves to the donor settlement and is there dependent on exchange or gifts. This dispersal is aided by two sets of links between individuals - kinship and trading partnerships (Spielmann 1986,284,288,290-2,Table 2). Spielmann suggests that exchange by itself is inadequate in these egalitarian societies, because available surpluses are generally small and those in need usually lack items to exchange for food. Exchanges do occur, especially with craft items, but she considers this a "midlevel" response; dispersal follows if the quantity of food obtainable proves to be insufficient. The crucial links in this are individual, dependent on relationships between individuals and the relations and trading partners in other social groups.

Wiessner (1982) has described the hxaro system of the !Kung San hunter-gatherers as a "social method of pooling risk through storage of social obligations". These are distributed over "as many and as independent units as possible", which is made possible by the localised resources and conditions of the Kalahari (ibid,65). The system is a network of long-term relationships, carefully maintained by social interactions including the giving of specially made craft items (ibid,71,77).

Unlike egalitarian societies or segmentary tribes, in chiefdoms the internal economy is predominant, displacing external trade between individuals (Sahlins 1968,94-5). The trading links which gave individuals the expectation of aid in need are replaced by the centralised flows of goods in societies characterised by redistribution.

Redistribution - "chieftainship said in economics" - (Sahlins 1968,95) is added to in-group reciprocity as a means of relieving 'normal year' shortages.

The ability of a redistributive chief to alleviate hardship in bad years will depend on either the ability to accumulate and maintain substantial stores of food, or the ability to transfer food between regions unlikely to be simultaneously affected by shortage. Halstead and O'Shea (1982,94) consider that it should be "possible to predict the minimum size and likely intensity of an effective social storage system" on the basis of biotic community, topography and climate.

However, Brumfiel and Earle have noted the "accumulating evidence ... that the redistribution of significant subsistence goods across microenvironments is not a typical feature of chiefly economies and early states" (1987,2). In a detailed study of Hawaii, Earle (1977) showed that territories were defined so as to incorporate a variety of resources, and the subsistence strategies followed were designed to allow self-sufficient generalised economies rather than specialisation. However, the elites did have obligations towards communities suffering from uncommon periodic disasters due to destruction of their irrigation systems by flooding or tidal waves (ibid,226).

8.5. Limits to redistribution.

Mobilisation of foodstuffs by elites will only form an insurance against hardship for the community when the food channelled to the centre is made available to those in need. Sahlins (1968,90,92-3) notes the stresses which arise when a chief diverts too much of the centralised produce into promoting his own position. A chief may need to display his wealth and authority by means of material goods, but he must also maintain an appropriate level of generosity to the people on whose support his position ultimately depends. If his generosity falls short or his demands are too high, allegiances can be changed (Mann 1986,82)

Redistributive economies, like those based on reciprocity (section 8.3 above), can be undermined by contact with market economies. The wealthy may buy and display prestige goods, but by selling their surpluses of staple foods rather than giving them to those in need, they no longer build up the network of obligations which allow them to aggregate food surpluses from other households (Sahlins 1968,47). "Prestige goods" Sahlins notes "may awe people but do not obligate them".

Yet situations occur in which the elite continues to be able to obtain food from the producers, but is able to use it in its own interests, which can include supporting a "highly inegalitarian mobilisation economy" as described by Halstead and O'Shea (1982,98) or using the produce to acquire imported goods. The nature of the items traded between Late Iron Age southern Britain and the Roman Empire (Strabo 4.5.2-3; summarised by Haselgrove 1982, Fig.10.1) demonstrate the relevance of these questions. The problems inherent in this diversion of produce are summarised by Mann: "If the form of society which precedes the state is not unitary, why should the people develop only <u>one</u> storehouse rather than several competing ones? <u>How do the people lose control?</u>"(1986,62).

It may seem that such questions are remote from the starting point, the ways in which individuals and groups cope with bad harvests. But while storage and agricultural planning to reduce risk are at one level aspects of agricultural practice, they both also have a vital social dimension. It is primarily in the relationships between individuals and groups that security is achieved - or fails to be achieved. It was stated above (section 8.4) that societies need the means to cope with failure in order to maintain their stability. But the nature of 'coping' may vary. In egalitarian and tribal societies, survival is dependent on reciprocity and redistribution, and if one individual is allowed to starve, all are similarly threatened. In a more complex society, survival of the social structure may no longer be closely linked to the survival of individuals. Their failure, whether leading to outright starvation or to inability to continue as independent members, may not threaten the 'system'. In this situation, individual responses to the possibility of failure may be expected to increase in importance, but the communal responses which provided the greatest security in previous contexts are absent or reduced.

In these conditions, what happens to those who fail? Ultimately some form of dependency may be the alternative to starvation. Tacitus (Germania,25) describes slavery among the Germans, which differed greatly from Roman practice. The slave "remains master of his house and home", required to produce "a certain quantity of grain or cattle or clothing". To imprison a slave or enforce labour was rare. Thompson suggests that contact with the Roman Empire will have changed the nature of Germanic slavery, with the discovery that "men might be treated as commodities: they, too, might be bought and sold" (1965,19,24-5). But their value within society and in particular in agricultural production might also have changed. Thompson suggests that by the time of Tacitus, agricultural production may have come to depend on slave labour. Not only does the changed basis of land allocation imply that those of higher social standing received more arable land to cultivate, but the chiefs and their warriors no longer participated themselves in agricultural production, "having handed over the charge of their home, hearth and estate to the women and the old men and the weakest members of the family" (Tacitus, Germania 15).

Hingley (1983,14) suggests that in the immediately pre-Roman period in Britain chiefs were beginning to expropriate estates from what had previously been communally owned land. Crummy (1980) has interpreted Camulodunum as a royal estate, dependent on agriculture as well as trade and industry, consisting of a variety of settlements linked together and contained within the dyke system. In the context of such developments, a subject workforce gains new value, and failure among independent households could be one way of adding to its number. Actually selling impoverished members of the same tribe might be unacceptable - although those Germans of warrior status who gambled themselves into slavery were sold, to relieve the humiliation felt by both parties (Tacitus, Germania 24). Hingley infers possible examples of chiefly estates in Germania, from the writings of Tacitus (the palace of Maroboduus, a Marcomanian chief, Annals 2.62; the villa of Cruptorix, Annals 4.73, who is however described simply as a former Roman soldier). Tacitus also refers to the fields and villas of the Batavian leader Civilis (Histories 5.23). Thompson (1965,50) states that ownership of land, even by chiefs, still did not exist at that time, and the term villa might be being used to indicate farm buildings rather than the centre of an estate. Nor is a palace necessarily the centre of a productive estate. However, the building of a palace may itself indicate new social relationships. Sanders (1974,109) has concluded, from a survey of over 100 recent or contemporary societies, that while chiefs can often command labour for the construction of "public buildings", they cannot mobilise similar manpower to construct dwellings for themselves.

The inferred reduction of social support for coping with failure and the suggestions of a need for slave labour and the development of chiefly estates can be combined into a coherent picture of a new form of agricultural economy outside the north and west fringes of the Empire. But more evidence for the existence of such estates is needed before this development can be firmly advanced.

Factors such as a decline in "social insurance", the development of trade in foodstuffs and the imposition of a system of rents and taxes could have led to a sharp divide in the fortunes of agricultural producers. For the successful, opportunities would increase. Produce can be sold, reciprocal obligations are diminished, tribute formalized as rents or taxes need be no more onerous. Being able to buy food in need may allow farming methods which carry more risks but increase productivity over the long term. Wealth may provide access to labour, slave or wage, removing one potential cause of future failure and increasing production still further. But for the unsuccessful, the reciprocal labour which might prevent failure and the reciprocal and redistributive aid which might alleviate it are not forthcoming; rents and taxes are to be paid where gifts to a chief might not have been expected. Far from being able to risk more productive but less reliable practices, those without a safety net may be forced into less productive but more secure practices. In this context the opposition to market participation noted above is understandable.

The effects of social and economic changes are not uniform - not all agricultural producers will have experienced them similarly. Households following these divergent paths need have differed little initially. But if differences in the status of households already existed, in areas such as rights of access to land and other resources (including labour) or control over the produce, economic change could amplify these differences. The role of elite groups may be an important key to understanding these processes. A given economic change could undermine their means of control (for example, if market economies had a 'democratising effect' in societies where power was based on control of status objects). Alternatively it could reinforce its control, for example, if an elite with a role in land allocation became recognised as land owners. These considerations relate to the fundamental questions raised earlier in the chapter - the nature and basis of socio-political power in Iron Age and Romano-British society.

This chapter has considered three aspects of socio-economic organisation: the nature of social control, particularly as related to the land and its produce; the nature of the economy, especially in relation to the effects of trade in subsistence goods; and the forms of 'social insurance' available to agricultural societies. Each of these key elements is seen to be closely interlinked with the others. Together they define the context in which agriculturalists make their choices from the range of cropping and livestock practices available to them reflecting the criteria in Lipton's satisficing model of agricultural decisions: status, security and profit.

Chapter 9.

Some evidence for social and economic organisation in Iron Age Britain.

9.1. Archaeological approaches to the social and economic context of agriculture.

While the preceding section tried to identify the issues which are essential to investigating the relationships between social and economic organisation and agricultural production, it intentionally avoided considering how these questions might be answered in archaeological contexts. The aim was to avoid the nature and availability of the evidence becoming the determining factor in deciding the questions to be asked, and hence perhaps also the conclusions reached. But for this approach to have value, the questions, however arrived at, must be posed, or at least rephrased, in terms which allow answers based in the archaeological record.

It may be interesting to use a particular archaeological example to illustrate a theory, but if the application does not add to the understanding of the original problem, its value is limited. Conclusions of the kind that the evidence is not incompatible with the model, but cannot on the other hand be said to support it, may be unavoidable. But if the original question was such that this outcome was virtually inevitable, the usefulness of the exercise may be doubted. Similarly, a conclusion that more and different data are needed before a question can be resolved satisfactorily may be a valuable stimulus to further work, but raises a question as to whether the problem could have been rephrased or refined in a way which permitted a more informative conclusion. It is an underlying theme of this work that more information can often be extracted from the existing data.

The chapter considers some of the evidence for social and economic organisation during the Iron Age, with the main emphasis on assessing its relevance, potential and limitations in investigating the interactions between agricultural production and socio-economic factors discussed above. It considers two important classes of evidence for social organisation during later prehistory, classical and early mediaeval documentary evidence and analysis of spatial patterns of land use.

The immediate problem is, perhaps surprisingly, the lack of an accepted general model of Iron Age society (Hingley 1983,10). Even on a number of fundamental social and economic questions, no consensus exists. These include the function (or functions) of coinage and the development of a market economy (Collis 1971,1974; Haselgrove 1979,1987a; Hodder 1979; Rodwell 1976), where disagreements persist for the Roman period as well (Crawford 1970; Lo Cascio 1981), and the role of hillforts and the nature of their occupation (Stopford 1987; Cunliffe 1983,1984). Nor need a single model be appropriate - Hingley comments that "there seems to be no reason why there should not be a large number of .... types of society" in the Iron Age of southern Britain alone (1983,19). Diversity is well documented in areas such as pottery styles, coin use and settlement types and distributions. In this context, is the question, how was British Iron Age society and its economy organised, too generalised to have meaning ?

There are essentially two possible approaches. The first is to accept that summary can be attempted only when detailed regional syntheses are completed, and can be examined for their similarities and differences. The alternative is to attempt to arrive at some general organisational principles, while accepting that regional variations in environment, history and external relationships will imply that universal applicability cannot be assumed and that, in any example, these regional characteristics may override or modify the generalisations. The scope and context of the present work require the second approach, despite its admitted limitations.

Hingley, discussing inference from settlement patterns, comments that ".. to understand the signature of a society's spatial typology, we are required to understand that society as a whole. The best approach to the analysis of spatial relationships from material data, is to analyse spatial structure in terms of what is known of social structure." (1983,32). A similar argument could certainly be applied to agricultural organisation, whether it is crop choices, livestock management or the use of the land which is under consideration. Problems arise where the evidence for agriculture, and perhaps especially for the organisation of the landscape, itself becomes an important source of evidence for social organisation. Circularities in the argument are not always easy to detect. Additionally it is inevitably difficult, perhaps impossible, to derive models for social organisation which are genuinely independent of existing knowledge of its various material expressions. This remains the case even when, for example, literary evidence allows it to be attempted (compare Hingley 1983, pages 8 and 50). It can be argued that attempts to do so are in any case essentially artificial, and that models should be constructed using the full range of available information. Here it is important to distinguish clearly between interpretations of the material evidence built into the model and explanations of the material evidence based on the model.

9.2. Documentary sources and their use.

9.2.1. The classical sources.

One important source is the surviving literary evidence from contemporary writers such as Caesar and Tacitus. The reliability depends on the quality of the information available to the writers, a fact clearly acknowledged by Tacitus, who pointed to the contrast between his account of Britain, based on "ascertained fact" only available since the conquest was completed, with earlier accounts which "relied on graces of style to make their guesswork sound attractive" (Tacitus, *Agricola*,10; Penguin translation). Unfortunately where Tacitus omits details from earlier writers (such as Caesar's description of collective marriage in Britain), he does not indicate whether this is because they were incorrect (Mattingly 1970, 18-9). Similarly in his account of Germany, Tacitus recognises that reports merge into fables as distances increase (*Germania* 46). These factors must be taken into account when Caesar's brief description (Gallic Wars, V,14) of the people of inland Britain is assessed. Caesar records collecting information about Britain prior to invading (Gallic Wars, IV,20-1), but certainly repeated some tales uncritically elsewhere, as in the description of the animals of the Hercynian forest (ibid,25-7). But both writers based their accounts on information collected for use (Tacitus, *Agricola*, 24).

An important consideration is the context in which the writers viewed and interpreted their knowledge of these societies. In the specific context of agricultural economies, two examples of the significance of this can be cited. The first is the question of landholding. While Caesar describes the system of land reallocation among the Germans, his account of Gallic customs (Gallic Wars,VI,11-20) makes no specific reference to land tenure. The question is whether this should be taken as a simple omission, or whether it can be assumed to imply that the Gallic custom, if not identical to Roman practice, was perceived as sufficiently similar to make description unnecessary. Wightman (1985,23) notes that Caesar believed the Gauls recognised private ownership of land.

The second aspect is the restricted role played by cattle in the agricultural economy of Roman Italy. Their importance was as draught animals, and dairy products were obtained primarily from sheep (White 1970,275-8). It is against this background that the comments about the importance of dairy products and meat in Britain and Germany should be seen (Caesar, Gallic Wars,V,14 and VI,22). Despite Caesar's remark that the Germans lacked interest in agriculture (Gallic Wars,VI,22), Thompson (1965,27) has inferred from other parts of the book that it was not unimportant. Cereal cultivation clearly played an important social role in Germanic society in the time of Tacitus. Grain was used for voluntary payments to chiefs, and as obligatory payments by slaves to their owners; yoked oxen had an important symbolism in marriage agreements (Germania 15,18,25,). What Tacitus comments on is the absence of the other basic crops of Roman agriculture (Germania 26). Thompson comments that the lack of involvement in agricultural production noted by Tacitus (Germania 15) relates to the chiefs and their retinues rather than to all German men (1965,51,note 3). The contrast is with the at least notional role of the wealthy Roman landowner as a working farmer. Similarly comments by Caesar on the wearing of skins as clothing (Gallic Wars V,14) cannot be taken to imply an absence of woven cloth, a point reinforced by Tacitus' more detailed discussion of the clothing of the Germans (Germania 17), as well as the archaeological evidence. It is the contrast with Roman custom which is being stressed.

Difficulties also arise in relating information available from a variety of classical sources written by different authors at different times and about different groups of people. This point is made clearly by Nash (1976,121-3). While Tierney (1966) regarded Caesar as derivative from and less reliable than Poseidonios (whose account of the Celts, written around 80 BC, survives only as fragments quoted by later writers), Nash stresses his value as an independent source, writing about different Celtic peoples at a later date (probably 52 BC). The discrepancies between the two sources illustrate the problems in combining them into a unified picture of 'Celtic society'. The period in question was one of rapid change in many ways in northwest Europe; Thompson (1965) has shown in his discussion of the Germans how the literary sources can be used to identify social changes. The problem is made more acute when early literature from Ireland is used to augment these. Some of the similarities are striking, and the material can be combined into a plausible and coherent picture of 'Celtic society', as for example by Cunliffe (1983,165-171). But this is achieved at the expense of ignoring the possibility of change - it can be argued that the assumption the sources can be combined in this way excludes the recognition of change. If Cunliffe's "belief that Celtic society was organised in a broadly similar manner across time and space" (ibid,166) is acceptable at a general level, it probably involves too great a degree of simplification to have substantial utility in investigating the relationships between social and economic organisation, such as the context of agricultural production.

The concept of a 'Celtic' type of society may be misleading not only by tending to obscure regional and chronological differences in social and economic organisation, but also because it tends to emphasise the distinctness of 'Celtic' societies from other societies with similar socio-economic characteristics. Todd (1975,26) suggests that while the "sharp distinction" drawn by Caesar between Celts and Germans, with the Rhine as their boundary, has been very influential, it is "entirely spurious", oversimplifying the ethnic situation and overstating the cultural differences. Caesar's aim was justification of his military activities. Todd stresses instead the "marked homogeneity in such basics as economy, social structure and kingship" and the close links between Germanic and Celtic peoples (1975,42-9). Nevertheless, there is a distinct geographic divide in the evidence, with a number of social and economic developments, notably coin use and oppida, restricted to the area to its south (Collis 1976, Figs.4,10; Champion _et al_ 1984,307-9,321-1).

A wider range of ethnographic analogy is also available. There are for example marked similarities between the Gallic and German peoples described by Caesar and Tacitus and some traditional societies in Southern Africa. These include the role of cattle as wealth, assessed by their numbers rather than their quality; voluntary payments of produce to chiefs; the allocation of land by local and tribal authority; the need for chiefs/headmen to build up and maintain followings (Caesar, Gallic Wars VI,11,13,15; Tacitus, _Germania_ 5,11,15,26; Sansom 1979a, 148,152,; Sansom 1979b,265). Cattle-based clientage systems, resembling those described in the early Irish literature (MacNiacoll 1972,60-5), are common in traditional African societies (Sansom 1979a,164,166; Cashdan 1985,462). They are apparently not mentioned by either Caesar or Tacitus.

Hodder uses several kinds of information from African traditional societies to interpret material from Iron Age Britain (1982,15-8,26,51-2,68-71). However, he specifically excludes agriculture from the areas in which such comparisons are acceptable, because of the relationship between rainfall patterns and agricultural practices (ibid,26). Certainly differences in agricultural practices are considerable, but in the area of the interrelationships between social organisation and the organisation of agricultural production, these societies may be a valuable source of analogies to augment and interpret the small quantity of contemporary written evidence.

9.2.2. Irish sources and Iron Age society.

The early mediaeval documentary evidence from Wales and Ireland remains the primary source of ethnographic analogy. The Irish evidence has been especially emphasised, because it was "untouched by the heavy hand of Roman imperialism" (Cunliffe 1983,166). But although Ireland was not invaded by the Romans, it is accepted that elsewhere in Europe, the Roman Empire affected societies outside its boundaries. This is often advanced as an explanation of social changes in Gaul and Britain prior to their incorporation into the Empire. Contacts between Roman Britain and Ireland are recorded by Tacitus: "..its approaches and harbours have now become better known from merchants who trade there" (*Agricola* 24, Penguin translation).

There is also an increasing amount of archaeological evidence for this trade, although the total amount of material is small (Warner 1976,282). Bateson (1973) suggested the trade with Roman Britain formed the most plausible explanation for the majority of the objects found; refugees might be another source, and some fourth and fifth century AD objects might be the products of raiding. Graves containing Roman goods and following Roman custom suggest the presence of Romans (or perhaps Romanised Britons?) in Ireland (ibid,30). Warner (1976) associated many of the objects with first century AD refugees from Britain, but also inferred the existence of a "secure, sizeable Roman community in a most important trading position" (ibid, 277-8). Later Irish literary traditions record the first century exile (also recorded by Tacitus) and subsequent triumphant return of "a presumably highly Romanised group of Irish aristocrats" (ibid, 281-2). In the light of this evidence, it seems unreasonable to assume that, by means of some form of celtic purity, Irish society remained uniquely "untouched" by these influences.

The centuries before the earliest documents were a period of substantial change, both in the Irish language (which MacNiacoll (1972,1-2) notes must have affected the transmission of the material) and in religion, with the adoption of Christianity. There is no reason to doubt that the heroic tales do reflect an older tradition. But the law codes, detailing relationships between a man's land holding and agricultural equipment and produce and his social standing and obligations (M. and L. de Paor, 1958,78-9; MacNiacoll 1972,59-69; Binchy 1972) relate to the situation at the time, probably the eighth century AD, at which they were written (Mitchell 1986,165). Mitchell describes considerable changes in Irish agriculture, with a "dramatic expansion" from c.300 AD inferred from pollen diagrams. He suggests this was due to the introduction of the coulter plough from Roman Britain, although he does not cite any direct evidence for this, and the tool illustrated is from the seventh century. He attributes further changes in the pollen evidence (in the types of arable weeds), dating to the period c.500-800 AD, to the introduction of the mouldboard plough, first attested in a manuscript illustration of c.650 AD (Mitchell 1986, 121,144,153,160-2). In this area, therefore, there may be substantial divergence between the early records and Iron Age practice.

Interpreting the meaning of the laws is far from straightforward. Binchy comments that the Crith Gablach is "characterised by an extreme, and at times ludicrous, schematisation" and "bears only a very limited relation to the realities of legal life in ancient Ireland" (1970,xix). Because a man's legal status depended on his property and obligations, these are detailed in the laws, (ibid,xviii),and the relationship between a man's standing and his land holding, and his store of agricultural equipment and produce, is explicit (M. and L. de Paor, 1958, 78-9). Interestingly, Binchy (1963,56) quotes an eighth century jurist as saying that before the Senchas Mar was compiled, all men were equal in status, whether king's son or churl's son. The law itself was transmitted and applied by a specialised class (MacNiacoll 1972,47), but responsibility for prosecuting wrongdoers and enforcing judgements remained with the aggrieved (Binchy 1963,60-1; MacNiacoll 1972,52-3).

The documentary evidence for the organisation and practices of Irish agriculture in the eighth century AD is summarised by Mitchell (1986,165-9). But for the reasons referred to above, assessing its applicability to earlier periods is difficult. Technological and other changes have been identified, but similarities in environmental conditions and, probably, an emphasis on cattle remain. An interesting aspect of the documents is the distinction between summer and winter foods - dairy produce in the summer and meat and cereals in the winter (M. and L. de Paor 1958,77,90).

9.2.3. Welsh laws and Romano-British society.

While the Irish sources have been used particularly to reconstruct Iron Age society, the early evidence from Wales has been applied to questions of land holding, inheritance and settlement patterns in Roman Britain, notably by Stevens (1966) and Applebaum (1972, especially 46-54; 1982).

Two points underlie this use of the Welsh laws and charters. The first is the recognition that local law and Roman law could coexist in the Empire and that local laws could therefore be readopted after Roman withdrawal (Stevens 1966,108-110). The second is the conclusion by G.R.J. Jones that documents of the ninth century show that by then "settled rights in land use were old-established in Wales", and that the customary tenures recorded "appear to have ancient roots" (1972,320).

However, more recent work by Davies, based on the Llandaff charters, casts doubt on this use of the Welsh sources. The charters form "a large and miscellaneous collection" written in the twelfth century AD and "purporting to be records of transactions carried out in and around South Wales between the sixth and eleventh centuries" (1978,5,7). For present purposes, her most important conclusion is that before the eighth century, property rights in Wales derived from late Roman practice, sharing a common Roman background with much of continental Europe. Divergence occurred during the eighth century, a period of "immense changes" (1978,63,160-4). Nor can 'celtic' characteristics such as partible inheritance, the importance of the kindred in land holding or the existence of a free peasantry be distinguished in the earlier documents. Land could be inherited, but there was "really no usable evidence on partibility". While a free propertied aristocracy is demonstrated, "the existence of untied, completely free peasantry is neither demonstrable nor deniable". The role of the kindred seems to have been greater after the eighth century than before, and the kindred does not seem to have had a limiting function in land transactions. Davies concludes "there is every suggestion that much of the land was worked as large estates ... by a politically and economically dependent population" (1978,47,55-6,111,161,163). It was not until the ninth century that the structure of land ownership and use "was no longer a recognisable Roman inheritance" (1979,161).

The argument that pre-existing economic and social systems affected the nature of Roman settlement and economy, in Britain or elsewhere, is unlikely to be seriously disputed. But Davies' work has two important implications. Firstly, it is no longer reasonable to take Welsh law of the ninth century or later to represent the survival and resurgence of an ancient celtic system. The essentially Roman nature of the earliest mediaeval evidence also, as Davies notes, raises questions as to the status of native law in the later Empire (1978,163). Specifically British forms of land tenure and inheritance may have persisted after the Roman conquest, but the Welsh evidence neither indicates their existence nor provides a basis for reconstructing them. It is also worth noting that partible inheritance - often claimed as 'celtic' practice - was in fact the normal Roman custom (Hopkins 1983,43,76-8,96-7).

The detailed information available about the management and practice of early mediaeval agriculture in Wales is, like the Irish data, interesting because of its closeness in environment, climate and technology to Iron Age and Roman Britain. Jones (1972,366-373) describes the techniques and organisation of arable cultivation, but because of the differences in the type of plough in use, they cannot be regarded as good indicators of earlier practice. The evidence for the management of meadows and the seasonal grazing of uplands and stubble is interesting, illustrating the temporal as well as spatial aspect of land use regulation (ibid,355-8). Fertility maintenance practices are recorded, the laws stipulating the frequency of fallowing or manuring depending on type of land and type of manuring. The different value to the soil of grazing by livestock, folding livestock and carted dung are clearly recognised (ibid,340-1); this is not always the case amongst archaeologists. The description of the lesser reeve as the "dung reeve" may, as Jones (ibid,301) suggests, be contemptuous, but it may also reflect a major part of his role, and the importance of fertility maintenance measures in the arable economy.

The Welsh evidence can also be used to illustrate some general points. The two tenure systems of tir gwelyog (hereditary land) and tir cyfrif (reckoned land) clearly do not represent separate social systems. They are different components of a single social system, and are held within the same overall system of land division and administration, described by Jones (1972,299-300). Bond and free communities both paid "food-rent" to the king or his officials (ibid,300-2,326-8). Nor is tenure system uniquely linked to settlement pattern. Not all bond settlements were nucleated. The dispersed girdle of settlement characteristic of many tir gwelyog communities also occurs in at least some cases of tir cyfrif (ibid,331,339). And while strip fields have been taken to indicate bond communities (Stevens 1966,112-3,124; Applebaum 1982,441), inheritance and subdivision led to "long narrow parcels of land" under tir gwelyog (Jones 1972,331). It is by no means clear that we know "what a bondman village should look like theoretically" (Applebaum 1982,441). There seems no particular reason why redistribution of land should necessitate long rather than square divisions, except in the context of the mouldboard plough. Applebaum cites an example of redistribution within a system of square fields in Ireland; no details are given, but possibly the field shape reflects spade cultivation, in which there is no advantage in elongated plots. The data from early mediaeval Wales illustrate the dangers of simplistic correlations between settlement patterns or field systems and land holding, and between land holding and social system.

However, the spatial patterning of settlements and the nature of landscape divisions are fundamental characteristics of agricultural systems, and the organisation of agricultural production is an important facet of socio-economic organisation. Like agriculture, the utilisation of space is an area in which the social, political and economic nature of society and the constraints of environment and technology are closely integrated. Relationships will be complex, and as suggested above, circular arguments can be difficult to avoid. But the investigation of these problems may be a crucial step towards understanding agricultural systems.

9.3. Inferences from the use of space.

Two approaches to the questions are particularly interesting - Hingley's interpretation of the distribution of settlement in the Upper Thames Valley (1983; 1984a; 1984b) and Fleming's discussions of the social context and origins of coaxial field systems (1982; 1984; 1985; 1987). In different ways each stresses the same problem, the need for (and lack of) a theoretical framework for relating social organisation and land use (Hingley 1983,24; Fleming 1987,195).

9.3.1. Hingley's discussion of settlement in the Upper Thames Valley.

Hingley approaches his data with a model of Iron Age ("Celtic") society derived from classical and recent ethnographic sources (but see section 9.1 above). He presents a "bridging argument" based on three principles to allow the model to be tested and supplemented (1983,32). These principles relate to the social significance of space. Where the means of transport are simple, space is "an important constraint, and thus a major medium for the creation of social form". Each society has its typology of space, which must therefore be bounded, with the "bounded levels of the spatial typology" representing the hierarchy of levels of social organisation (Hingley 1983,32).

In order for these principles to be applied, he augments them with a series of generalisations (drawn from ethnographic data) about relationships between space and society at two levels, the region and the site. The generalisations are essential to his detailed arguments, although he does not claim they are universally applicable (exceptions are noted, for example, 1983,33). His bridging argument is "not a general law" but a "culturally relative principle" (ibid,36). The distinction between these ethnographically generated generalisations and his theoretical principles is important in evaluating his discussion.

In his analysis of settlement in the Upper Thames Valley, Hingley was able to distinguish three areas with different patterns of settlement. He then attempted to identify the levels, in spatial terms, at which agricultural resources were controlled in these areas. He equated these with the levels at which his three societies functioned as corporate groups, and related this to differences in social structure (1983, 187-193, 208, 211, 223). To an extent he advances both social structure (kinship) and environmental factors to explain his data, particularly for the "gravel" society. A subsequent paper clarifies his views on this point: as well as being "the way a particular society relates to its environment through production", kinship relations are "also a consequence of past practical experiences gained through exploitation of the environment" (1984b,76). The simple correlation between kinship and settlement patterns [in particular the distinction between kindred and lineage based groups stressed in Hingley's thesis (1983) but not in two later papers (1984a; 1984b)] is difficult to accept at face value, given the distinct environmental conditions of the two main areas involved. In the context of Hingley's strong rejection of ecological determinism (1983,39), the neat association of environmental conditions and kinship type suited to their exploitation also requires comment.

Hingley's major theme - that "every society creates a typology of space" (1983,32) - and the significance he attaches to the "scales of corporate organisation within society" (1984b,86) seem to be of fundamental importance in discussing these problems, as is his demonstration that the levels at which societies functioned as corporate units can be inferred from the spatial and typological patterning of settlement. But although "space is utilised in human society to symbolise social relations" (1984b,76), it is an unjustifiable extension of Hingley's "bridging arguments" to assume that social relations are the only (or necessarily the major) determinant of a society's use of space. The question is how a range of factors (including socio-political organisation, environment, and technology) were integrated into a "typology of space".

Hingley emphasises the social relations of production (which for the Iron Age he considers "fairly likely" to correspond to kinship relations) as the crucial element in understanding a society and its use of space (1984b,76,86). There are however problems in assigning kinship the central role in examining agricultural economics. Kinship structures themselves are arguably not archaeologically recoverable, and testing models based on them may almost inevitably be inconclusive. This might not be a serious problem if there were regular ethnographic correlations between kinship structure and the organisational structure of agricultural production, but this has not been shown to be the case.

The assumption that the "household", however constituted, formed the basic unit of agricultural production in the majority of cases in both the Iron Age and in Roman Britain is reasonable, and if the stress is shifted from kinship to household as the locus of the social relations of production, many of Hingley's arguments are perhaps easier to accept. Factors such as the size and composition of the household group are potentially inferable from the archaeology of residential sites, as in Hingley's discussion of single and multiple unit compounds (1983,58-9,64-5).

The importance of the household group as the source of agricultural labour, and its composition appears to relate to the labour needs of the means of subsistence. A cross-cultural survey by Nimkoff and Middleton (1960) showed that extended families were more common in agricultural than hunting and gathering societies, particularly where agriculture was co-dominant with other activities (fishing, hunting and, especially, animal husbandry). Studies in Fiji by Sahlins (1957) and Nigeria by Netting (1965) showed that extensive agriculture and spatially separate resources are related to extended families, and intensive cultivation to nuclear families. The family type reflects the pattern of labour needs. Among the Kofyar, agricultural change, with the addition of extensively worked cash cropping at a considerable distances from the traditional intensive farms, resulted in change in household type, with an increase in the proportion of both extended families and polygyny (ibid,427).

The potential multiplicity of "types of society" envisaged by Hingley (1983,19) forms a marked contrast to Cunliffe's pan-Celtic similarity. If Cunliffe's view is too broad a simplification, Hingley's threatens to allow real similarities (and, perhaps more importantly, significant differences) to be overwhelmed by a mass of variation in detail. The question is in part one of definition - what aspects of a society constitute its 'social organisation' as opposed to, for instance, its methods of exploiting its environment? Separating social and economic structures is arguably an artificial exercise in tribal societies where these were "not so much different institutions as ... different <u>functions</u> of the same institutions" (Sahlins 1968,15).

However, it is argued here that in order to interpret the evidence for agricultural practice, it is essential to identify those aspects of the structure of a society which are concerned with the organisation of agriculture - in fact to distinguish a structure of agricultural organisation. Even so, it will only be by integrating this structure of agricultural organisation within a wider understanding of the socio-political nature of its society that its functioning will become explicable. This 'intermediate level' of agricultural organisation is seen as a means of investigating the structure of a society rather than a level in the structure of a society. Separating out this structure of organisation should suggest approaches to two of the problems raised earlier, how economic factors operated to influence agricultural decisions and how ecological, technological and social factors combined to determine the use of space.

The latter problem (integration of social and ecological factors) is one of the key difficulties in Hingley's arguments, as can be seen by comparing his comments on kinship as an outcome of exploitative experience (1984b,76) with his rejection of ecological determinism (1983,39). The discussion by Sansom (1979a,b) of the southern Bantu-speaking peoples is one of the examples of the ecological determinism of settlement patterns cited (and dismissed) by Hingley.

9.3.2. Environment and the social organisation of agriculture: an example from southern Africa.

Sansom describes two patterns of land use and settlement, located (roughly) in the eastern and western parts of the region. There were no significant differences in knowledge, technology or crop species between the two areas (1979,137). The eastern area contained "small-scale repetitive configurations that contained a variety of natural resources". The district formed the "unit of exploitation", the area self-sufficient in arable and pastoral land, water and other subsistence resources, throughout the year. Fields could be scattered to minimise risk and take advantage of different soil types within a few miles, and cattle were herded from the kraal (ibid,140,143-4). In the western area, the land was uniform over wide areas, and to exploit a variety of terrain, farmers needed access to an extensive area. Low and unevenly spread rainfall and scarce water supplies reinforced this. A farmer might in some cases cultivate fields as far as 25 miles apart. Cattle were herded from separate cattle posts (ibid, 142-4). The "unit of exploitation" was the tribal territory.

These differences were expressed in both the distribution of settlement and in the administration of agricultural resources. In the eastern area, settlement was in dispersed kraals, and administration decentralised, mainly under the control of the district headman. In the west, settlement was concentrated in substantial villages or towns, with administration in the hands of the chief. Land was allocated to individuals by the headmen; in the east, the headmen controlled a single block of land, while in the west each controlled a number of scattered parcels of different types of land. The differences are summarised by Sansom (1979a, Table 5.1). The interesting point is that the "apparatus for regulation" is essentially similar throughout both regions, the difference lying in the "contrasting uses of this machinery for control" (Sansom 1979a,145, Fig.5.1).

The shift in the locus of control can be seen for example in the temporal restrictions on agricultural activities imposed to avoid conflicts. The start of the sowing season is determined by the chief, and in the western economies, a single time applies throughout his territory. In the east, the chief initiates the sowing season, after which each headman authorises a time for his district. The different roles of chief and headman are reflected in the (voluntary) payments of beer and corn as tribute. The headman receives this in the east, but not in the west; the chief receives it from the whole tribe in the west but only from his own locality (ie, where he is also headman) in the east. In the east, the headman may also receive labour payments, restricted to the chief in the west (Sansom 1979a,147-8).

So within what is essentially a single socio-political structure, the level at which agricultural resources are controlled and surplus produce can be centralised appears to have shifted in response to the practicalities of arable and pastoral farming in different environmental conditions. Hingley suggests that the use of ecologically determinist models (such as Sansom's) depict societies as "relatively static and stable" and fail to consider their origins (1983,39); what Sansom's analysis seems to show is a flexibility within a given socio-political framework, and a potential capacity for change or adaptation to new conditions. It is interesting to note the close comparability between the "units of exploitation" defined by Sansom and the "scales of corporate organisation" recognised by Hingley.

An important implication of the differences between the two tribal economies distinguished by Sansom lies in the different sources of power available to the chiefs. In the western societies, the "Tribal Estates", the chiefs were "manipulators of bounds and grants", with direct control of land and the ability to regulate its use. In the east, the "Chequerboard Realms", the control of land is decentralised and the chief less able to exert direct control - he is "deprived of a locus of authority". Instead he was "forced to elaborate the means towards direct control over material goods and the status of persons" (1979b,251,257-9).

9.3.3. Agricultural organisation and social organisation.

The suggestion I want to make here is that a given socio-political organisation can accommodate a range of different structures of agricultural organisation, depending on which of the available loci of control are used. (Whether the resulting variety of configurations constitute different 'social systems' is a question of definition, or perhaps theory, which it does not seem necessary to consider here). Mann has argued that power in societies derives not from a single stratified social structure, but through four distinct networks of social interaction (ideological, economic, military and political), whose "boundaries and capacities" differ. Each network is characterised by its own "distinctive forms of socio-spatial organisation". One network may come to be the primary organising force in society, and to "exert more general, promiscuous shaping of social life" (1986,26-7).

In tribal societies, whose generalised nature and lack of separate institutions are widely stressed (for example, Sahlins 1968,15), these networks of power may be envisaged not as separate entities, but as utilising different combinations of loci within the structure of society (for tribal societies, often predominantly the kinship structure). Different loci will be emphasised by the different power networks; elements important in the organisation of agricultural production may well differ from those essential in other contexts, such as political control or kinship relationships. Sansom's comments (quoted above) suggest that there may be compensatory effects where one aspect of control is weak at a particular level; the eastern chiefs needed to reinforce their notional but difficult to enforce authority over land allocation by imposing controls over people and goods.

The implication of these arguments for the analysis of the spatial patterning of settlement and land use is that there need be no direct correlation between the structure of agricultural organisation and the structure of political organisation. These must interlock in the functioning of a society, but there will be points of difference as well as points of coincidence. To argue directly from the spatial patterning of a society to its socio-political organisation is therefore too large a jump. Identifying the structure of agricultural organisation - the means of obtaining livelihood from the landscape - can be seen as an essential intervening step in the argument. It should allow more realistic discussion of the relationships between social organisation and settlement patterns, in addition to (and this remains the main aim of this work) allowing more informative analysis of the increasing quantity of detailed information on later prehistoric and Romano-British agricultural practice. It may also provide a partial key to a basic conundrum in Hingley's work - a society's use of space can only be understood if its social organisation is understood, but, archaeologically, its use of space forms a major source of information about a society.

9.3.4. Field systems and social organisation.

The other illustration of the problems and potential of this approach to social organisation is Fleming's work on the Dartmoor reaves and the origins of coaxial field systems. Fleming used the layout and constructional detail of the reaves and their associated settlements to infer the existence of four levels of organisation in the society responsible for their construction (this probably occurred in a relatively short period around 1300 bc).

The first level, the household, is represented by a variety of recurring combinations of house types and enclosures (1984,10-11). Individual 'farms' associated with these households cannot be identified. Fleming therefore suggests that the next level, the neighbourhood, represented the working unit, which he compares with cooperative dairying communities described in early Welsh laws. They consist of distinct clusters of households, and there are indications that some neighbourhoods had defined outer boundaries (ibid,11). Construction of the reaves (along the line of the pre-existing fences) appears to have started near the houses. Fleming suggests this implies the separate identity of neighbourhood groups, distinct from the community, the next level of organisation. The community, Fleming infers, was responsible for the coaxial systems and the management of pasture between these and the contour reaves beyond them, "acting as an autonomous political unit" (ibid,11,13). The fourth level, the regional authority, is less well attested in the field evidence. Fleming suggests that the synchronism and interdependence of the reaves of different groups implies its existence. He suggests that the contour reaves were imposed by this level of authority, defining the area of intercommoning. They are frequently unfinished, perhaps indicating that this regional level was weak in relation to the community; the radial reaves separating communities always seem more important than the contour reaves and often stretch beyond them (ibid,13-14).

Fleming suggests that the land boundaries "reflect the objectives of a hierarchy of social and socio-political groups and the space which they used", relating primarily to "the management and control of communally owned land" (1984,14). The household and the neighbourhood, working together "in ways which have not been clearly determined" were the fundamental social and agricultural productive units (ibid, 14,17); the community was concerned with "the internal management of a territory" (ibid,14). Fleming notes (1982,54) a unit of land use is not necessarily identical with the area occupied by a socio-political grouping. But his interpretation in this way of the Dartmoor evidence is convincing, although the pattern may not be complete (the question of how far the systems extended off the moor remains). It is interesting that while three of his levels of organisation, those he interprets as being directly concerned with the organisation and practice of farming, are inferred directly from the field evidence, his fourth level, the regional authority is less demonstrable. Other evidence is cited in support of this - the possible existence of similar regional organisation elsewhere in southern Britain, and a possible link with the control of tin extraction (ibid,13-4,16).

This approach to land boundaries allows the structure of social organisation to be mapped, but leaves unanswered a wide range of questions about the nature of the society, a point made clear by Fleming (1987,195,197; 1982,54). The Dartmoor reaves, like other coaxial field systems, can be interpreted in terms of an egalitarian society based on communal decision making or a society dominated by an autocratic elite.

Coaxial field systems are now known to have been laid out over a very long time scale (Fleming 1987, Table 1). The earliest, at Fengate, date from the mid third millennium BC; the most recent may date from the middle or late Saxon period, (South Elmhams: Williamson 1987,428-9). Recognition of this timespan effectively rules out an association with a single type of society. Fleming stresses the persistence of the coaxial system as a concept, part of the "ritual landscape", suggesting they may have had "powerful ideological or symbolic meaning" (1987,197). Both the "coaxial concept" and the knowledge necessary to lay out the systems, he concludes, must have been maintained by strong oral tradition (1987,198-9). At the beginning of this chapter it was suggested that where a landscape element was long lived, it tends to be discounted as a source of specific information about a particular society, or even about its agricultural base. The emphasis placed by Fleming on the conceptual aspects in addition to the functional (1987,197) is important, but by inferring a single "coaxial concept" throughout the entire period of construction and use of these varied systems he is arguably undervaluing their potential as sources of information about the individual societies which established and used them.

It is worth looking more closely at the background to this. Some of the evidence for early field systems was assessed in Chapter 7. What is clear is the lack of knowledge about these field systems, whether they are referred to as celtic, cohesive or coaxial. Few are securely dated, or have had their origins and development studied. They are regarded as systems of land management, but how they functioned is not well understood (Fleming

1987,195,201). Even in the case of the most thoroughly studied, the Dartmoor reaves, this remains a problem (Fleming 1984,17). Many cannot be related to contemporary settlements. In the absence of evidence to suggest a common tradition and purpose for these systems, the assumption that they represent a single "coaxial concept" is potentially misleading.

The varied evidence for date, context and usage suggests that a multiplicity of concepts may be represented. Can the expression of community identity and organisation of territory at different scales inferred for the Dartmoor reaves really be said with any confidence to represent the same "concept" as the field boundaries at South Elmhams, interpreted as part of "a single large middle or late Saxon estate" (Williamson 1987,429)? The earliest dated coaxial systems have all been interpreted as concerned with the organisation of pasture; their fields are defined by banks not lynchets. Do these represent the same "concept" as the extensive coaxial "celtic" field systems of southern England, with their often substantial lynchet accumulations, none of which yet appears to be securely dated by excavation to before the early Iron Age? (The dating of these systems is discussed in Chapter 7.) Is the persistence of a technique of layout identical with the continuity of a concept of landscape organisation?

It is argued that the field systems have substantially more potential for inference about the societies which constructed and used them than an emphasis on them as a unified phenomenon would suggest. But the need to establish chronologies and to investigate their patterns of use and development is crucial. One problem is the relative lack of attention paid to these questions. Field systems often seem to be viewed as appropriate subjects for survey rather than excavation, perhaps because of an assumption that their dating is not an issue. There is also, it sometimes seems, a lack of a clear idea of what the important questions about the functioning of these systems might be. (The question of how these might be answered is secondary, but not necessarily any easier.)

It is suggested here that attempting to analyse field systems as a framework for the regulation of agricultural production (and hence aiming to reconstruct the social organisation of agricultural production) will ultimately be the most informative approach to the questions of socio-political organisation and ideology which they also generate. This is not to deny the possible significance of a "ritual" element in their form - or in any aspect of agriculture. A fundamental question is how the boundaries themselves functioned in the agricultural landscape, whether they acted to subdivide a particular agricultural resource (eg a group of arable fields); defined different areas of land use (eg dividing arable from pasture); or separated land controlled by different individuals or communities. Fleming (1984) has shown that these distinctions can be drawn by careful examination of boundary systems; Hingley's analysis (1983) of the gravel societies of the Upper Thames Valley has shown that similar inferences can sometimes be drawn from settlement patterns in the absence of surviving physical divisions, using the concept of "buffer zones".

If a framework for the size and internal structure of agricultural communities can be inferred in this way, and additional information on agricultural practice be incorporated into it, it then provides a base against which different models of social organisation can be tested. The nature of a society, its political and economic characteristics, are crucial influences on the operation of agricultural systems, placing on agricultural producers a variety of demands, constraints and opportunities, which may at least in part be predictable. Attempting to identify their effects at the different levels of agricultural organisation may be one key to evaluating different models of social organisation.

9.4. Agricultural organisation and the economy of Iron Age and Roman Britain.

This chapter has argued that the analysis of settlement patterns and boundaries has the potential to reveal a structure of organisation at different levels. However the nature of a society cannot be directly inferred from this. It will include some levels important in the organisation of agriculture, and others which may relate to social, socio-political or ideological divisions in society. The structure of these will be incomplete as only the levels important in the definition of space will be strongly defined in the physical evidence. The inevitable relationship of agriculture to the physical environment gives the units of agricultural production an essential spatial dimension. For this reason identifying a structure of agricultural organisation from the spatial evidence is a realistic aim. It is suggested here that it also forms an essential step in attempting to reconstruct social organisation from the same base, because of the position of agricultural organisation as the area where social and subsistence factors interact. For tribal societies, it was suggested that the levels of agricultural organisation can be regarded as occupying particular loci in a generalised socio-political structure. These concepts should be useful both in using the spatial and agricultural information to investigate social form, and in investigating the ways in which social, economic and political factors influence the practice of agriculture.

It was an initial assumption of this work that an agricultural system is defined by its organisation as well as its practices. Identifying the organisational structure of agricultural production and the social context of the exploitation of agricultural resources is therefore a key question. The levels (which here implies the nature of the social groupings) at which economic factors and agricultural decisions are related is crucial to an understanding of the ways in which economic change in society comes to affect the practice of agriculture.

The discussion in this section has concentrated on the pre-Roman period. But the issues raised are as crucial for the Romano-British period. The questions to be asked about the organisation of agricultural production are the same; identifying the level at which economic factors and agricultural decisions interlock remains an important step in understanding agricultural systems and agricultural change. The sources of evidence which have been most frequently used in discussions of the socio-economic context of Romano-British agriculture are documentary, especially relating to tenure and taxation, although the uneven nature of this evidence and the uncertainties regarding its applicability to Britain makes its assessment against a wider range of evidence vital. It is questions of taxation and, in particular, tenure and inheritance on which writers have tended to concentrate; wider questions of socio-economic organisation have received less attention, presumably because they are rarely regarded as problems. But the economic context of agriculture in Roman Britain is by no means as well understood as sometimes appears to be assumed. The approach outlined above - attempting to define an organisational structure for agriculture and to relate it to models of social organisation - should be equally applicable to this period.

Chapter 10.

Inferring economic relationships: control of the land and its produce.

10.1. Introduction.

The previous chapter concluded with the view that the same questions about the nature of rural societies and the ways in which social and economic factors act on them apply in the Romano-British period as for the Iron Age. The fundamental questions for both concern the 'ownership' of land and the control and disposition of agricultural produce, including the ways in which it was made available to people other than its producers. These factors determine the economic context of agricultural decisions; they define the limits on the autonomy of producers in determining the use of agricultural resources.

Much of the archaeological literature concerned with these problems divides sharply at 43 AD; for the Roman period there is of course a range of documentary evidence not available for the earlier period. But much of this relates at best only indirectly to Britain; very little of the information about the agrarian economy of the Roman Empire is specifically known to have applied to Britain. It is increasingly being recognised that few changes in agricultural practice can be attributed directly to the Roman conquest. Major landscape reorganisation (such as in the Upper Thames Valley) can often be shown to predate it; most of the important changes in agricultural technology of the Roman period appear to have significantly post-dated it.

This chapter covers two main areas, firstly evidence for the nature and development of the economy, and secondly the nature of land 'ownership' and the imposition of tribute, tax and rent.

10.2. The nature of the economy.

10.2.1. The development of a market economy.

As discussed in Chapter 8 above, the question of whether or not a market economy existed is fundamental to understanding agricultural systems, because of the role of market factors in determining the allocation of productive resources. Consideration of traditional African markets illustrated the complexity of real situations; a simple distinction between 'embedded' and 'market' economies appears as oversimplification. It was suggested that Bohannan and Dalton's concept of 'peripheral markets' may be particularly useful in interpreting the evidence from Iron Age and Roman Britain, where trade and the existence of markets may have significantly preceded the market economy and the fixing of prices and production levels by the laws of supply and demand.

Evidence for the presence of trade and a market economy can be sought in two main areas - the goods traded and the medium of exchange used. In some cases, such as iron currency bars and blocks of salt, items may be both commodity and currency. Coinage is an obvious starting point for this discussion, but it should be noted that extensive trading systems can exist without coinage, as Allen (1976,199) notes of the Carthaginians. Similarly, coinage need not imply a market economy, since acting as a medium of exchange is only one of the four main uses of money identified by substantivist economists (summarised by Haselgrove 1987,19). Coinage is only one form of money; Dalton (1977, 198-9) provides a three part classification of items used as money. These comprise primitive valuables (valued objects used for political and social transactions), primitive money (items used as a medium for market place transactions, often standardised but capable of imitation and hence not centrally controlled; these are sometimes referred to as 'commodity money') and early cash or coinage. The latter, Dalton considered, is confined to state societies, its issue being tightly controlled, and used for both political obligations and as a medium of exchange. Haselgrove (1987,21) points out that this definition of coinage is inadequate in the context of Iron Age Europe, where coinage existed in societies which were not states, and where issuing was not necessarily centrally controlled and 'forgeries' common (ibid,22). Iron Age coins, he concludes, were therefore, in Dalton's terms, more like primitive valuables or primitive money than early coinage. Even in the Roman Empire, indigenous types continued to be struck for some time after the conquest of Gaul, and the existence of 'forgeries', marked to distinguish them from official issue, suggests that provided the state received its dues in official coin, the issue and use of copies for market transactions was tolerated, at least in some circumstances (ibid,206).

In assessing the coinage, it is also necessary to distinguish between why it was produced and how it was used. One illustration of this was noted above (Chapter 8), where coinage obtained in the market was treated as a commodity rather than used as a medium of exchange. The question applies as much to the everyday coinage of the Roman Empire as to the Gallic gold coins imported into pre-Conquest Britain.

For Britain, interpretations of the Iron Age coinage vary greatly. Collis (1971,75-6) distinguished the use of gold coins "primarily for social purposes" from the use of bronze "for the minor transactions of the market". Interpreted this way, he notes, the introduction of bronze coinage represents "a new way of life", the introduction of the money market. His arguments have provoked two markedly different responses. Rodwell, who criticises Collis' use of the coin distributions, concludes that neither archaeological nor documentary evidence provides any "reason to refute the probability that coins were used primarily for moneymarket transactions from a very early stage after their introduction" (1976,289,297,313-6). Hodder (1979), on the other hand, finds the evidence for market trade unconvincing, disputing the view that silver minims and bronze and potin II coins (cf Collis 1974) were used in market transactions. He suggests that their use was restricted to payment and standard in the collection of goods by elites from their tribes, or in exchanges among these elite groups. While accepting that the evidence remained inconclusive, he infers there was little or no pre-conquest disembedded market trade. The evidence of 'tribal' boundaries to pottery distributions, he suggests, also implies that market exchange may not have become commonplace in Roman Britain until the late second or early third century A.D. The underlying problem behind these incompatible conclusions is a general one - where evidence is limited, it is possible to defend a position on the simple basis that the evidence is insufficient to refute it. To move the argument further, two things are essential - detailed analysis of the Iron Age coins, their chronology, contexts and usage, which has since been provided by Haselgrove (1987), and a clearer understanding of the nature of early trade and markets.

10.2.1.(i). Haselgrove's discussion of Iron Age coinage.

The production and use of coinage in Iron Age Britain was restricted to the south, southwest and east (ibid, Fig.4.3) and was characterised by great regional variation, seven distinct coin-using regions being defined. Haselgrove's survey is restricted to South East England. He emphasises the "underlying dependence" of coin production and use in Britain on Continental developments (ibid,217), and his discussion is particularly useful here because of his assessment of the changing nature of cross-channel contacts in the period from the mid second century BC onwards.

Haselgrove divided the Iron Age coinage in Britain into three production periods. In Period I (c.140-80BC) there is no evidence for indigenous manufacture. Gold coins were imported from Gaul in, he suggests, the context of exchanges between elites. Haselgrove also suggests that the extent of such exchanges during the Middle Pre-Roman Iron Age tend to be underestimated, with La Tene II influences seen in British weapon types and pottery finewares, as well as the presence of some possible imported items (ibid, 193-4,217).

Period II saw a substantial increase in the quantity of gold coin imported, and widespread production of coins in south east Britain. This was mostly gold, and probably also potin, again in the context of a "network of relationships and international transactions between warrior elites" (ibid,194). Haselgrove suggests that the gold and potin coins are "just the most conspicuous manifestations of the gradual reintegration of Insular and Continental material culture" (ibid,195), which he related to a process of socio-political change encompassing relationships within Britain and between Britain and Belgic Gaul, intensified by the Gallic Wars, but beginning before them. The Gallic wars resulted in a large influx of gold coin into Britain, which may have been the stimulus for the issue of extensive bronze coinages in Gaul. These were of both practical and symbolic importance, used for payments where gold was scarce and for asserting the "continuing authority (and notional autonomy)" of the issuers (ibid,197). By the end of Period II (c.20BC) silver and bronze coins were being struck in Britain (ibid,75), and the potin coins appear to have changed in use (ibid,217; cf. Collis 1974). Haselgrove stresses that at the time the bronze coins were first struck, southeast England was "effectively an extension of Belgic Gaul"(199) and the reasons for striking the coins and "less certainly" the ways in which they were used should be similar. The start of bronze production in his phases 6-7 (end of Period II and beginning of Period III) is associated with "marked changes" in the patterns of coin use. From this time, there is a rapid turnover in coin types, which (ignoring possibilities such as recoining and political suppression) "must indicate high frequencies of transactions using base-metal coinage, whether as standard, payment or means of exchange." (ibid,210). Haselgrove suggests that use was "primarily as a standard", and this development reflects a change in interactions between centres, from the elite exchanges of earlier periods to movement of commodities such as staple foods, raw materials and slaves. A secondary role may have been as means of payment to specialists producing goods for elite groups; Haselgrove suggests they may have been increasing in number at this time (ibid,210,212)

Period III (from c.20BC to the conquest) was characterised by direct contact with the Roman Empire rather than the indirect contact seen in Period II. There was a greater homogeneity of coin types, in contrast with the heterogeneity of the previous period, and the coins were almost all inscribed. The direct contact with the Roman Empire, as British rulers made treaties with Augustus, was reflected in Romanising tendencies in the coinage. Indeed Haselgrove notes that the degree of Romanisation of the different coinages correlated with the volume of imported Romanised goods in their areas. This was accompanied by a change in the pattern and volume of Roman imports, with a greater spread both geographically and socially (ibid,75,196,202,218).

In the South East, there seems to have been a "relatively unimpeded flow" of silver and bronze coins between rural and nucleated settlements; although most losses occurred at the nucleated sites, the proportions of coins of different phases is similar for both (ibid, 212). In southern central England, developments in coinage had diverged from those of the south east during Period II, with a number of early insular coins in the central southern area deriving from continental antecedents not reflected in the south eastern coinage (ibid,192,218). Period III coinage, though inscribed and finally highly Romanised, remained bimetallic in contrast to the trimetallic series of the south east (75,198). However a "rhythm of circulation" can also be discerned in the southern region, despite the absence of bronze coinage and scarcity of site finds. Haselgrove suggests this indicates that it differed from the south-eastern and eastern regions "less in the socio-political transactions using coinage than in the cultural forms and settlement pattern through which these were mediated". Throughout the area studied, there was "a definite association of coin deposition with the leading settlements and probable residences of the elite" (ibid,212,217).

The restricted distributions of the silver coinage of the southern region resembles those of the bronze coinages of the rest of the South East, contrasting with wider distributions of gold types (ibid, 212,217). A number of "peripheries" continued to use only gold coins up to the conquest. Gold coins from the South East, Haselgrove suggests, as 'primitive valuables', crossed onto these areas, while the contrasting use of bronze and silver coins as 'early cash' is implied by their restricted distributions, essentially within their territories of origin. The implication that, despite the differences in types and distribution, the uses of coinage were essentially similar throughout the South East is important. However, Haselgrove had earlier stated that the southern silver coinage, "even in fractions, is not equivalent to bronze in the South-East" (ibid,160) and his position on this therefore seems ambiguous.

The question is therefore what these uses were, and how they differed from the usage of the precious metal coinage in the 'peripheries'. Haselgrove (ibid,212-3) concluded that throughout the South East the reason for the issue of coin and its primary use was in "vertical" rather than "horizontal" relationships. That is, the coins were used in transactions between issuers and their subordinates. Exchanges between other individuals were "essentially a characteristic acquired through circulation". The reasons for issue, Haselgrove suggests, were firstly related to the development of long-distance trade in staple foods, raw materials, slaves,etc., and secondarily to the need to pay specialist craftsmen. Haselgrove states that, like trade in staples, craft specialisation was increasing at this time, a point which will be discussed further later. However the uses of gold coin remained different. Within the South East, the non-site finds of gold coins appear mostly to derive from deliberate deposition, "of a social or ritual nature". This does not change during the pre-conquest period, although Haselgrove notes a shift in favour of "more formalized religious foci" in the later Iron Age (ibid,216). They continued as primitive valuables, crossing into the gold-using peripheries, and may have played a political role in "buttressing essentially autonomous clients", some of which were ultimately absorbed (212-3). Presumably if some of the goods used for export were acquired from these areas, they also acted as payment for these. Haselgrove stresses the need to view the coinage in terms of a "controlled and socially embedded process" and not as the "unfettered spread of an economically useful device" (ibid,213).

However, Haselgrove's conclusions leave a number of questions unanswered. He does not, for example, attempt to assess the relative extent of vertical and 'horizontal ' transactions in the use of the coinage. Nor is his explanation of the reasons for the issue of bronze entirely satisfactory. Issue to pay specialist craftsmen seems to imply the pre-existence of a market in which the coin can be exchanged for food and other necessities - in this case the 'vertical' transactions presupposes the possibility of the 'horizontal'. Brumfiel and Earle (1987,3-4) note that it is once subsistence goods can be obtained through market exchange that rulers can use valuables to pay for specialists services. They describe this as a system of "wealth finance" replacing one of "staple finance" (payment in subsistence goods) (ibid,6). The existence of a system of market transactions is an important feature in the development of specialisation, particularly of independent specialists. In its absence, full-time specialisation tends to exist only among craftsmen "attached" to a patron, who frequently meets their subsistence needs (ibid,4-6). Coins or other valuables can be used to recognise and reward for services or goods without the expectation of conversion to subsistence use; rewards for military service are better seen in this light rather than as payment to mercenaries. It can be noted in this context that Reece (1973,250) has doubted that the Roman bronze coins of the first two centuries AD were sufficiently small in value to be suited for small scale market transactions.

If striking bronze was "the administrative response" to the development of long distance trade in staples, its use in this context still poses questions. Given the restricted distribution of most bronze types, bronze was presumably used in the accumulation of grain by elite groups for exchange rather than in articulating the long distance trade itself. There is the question of whether it was paid to the agricultural producers themselves, or whether it instead played a role in amassing grain via a hierarchy of political obligations. That is, if the coin was used by members of one elite level to reward or pay those on the next level down for grain they had received in tribute from their own subordinates. The "hierarchy of currency metals" reflected in the inscriptions on the later coins would fit such an interpretation, of payments at different levels in a hierarchy; fewer names appear on gold coins than on silver, fewer on silver than on bronze (Nash 1987,132). Bronze it can be suggested reflects the process of acquiring the goods for long distance trade from within the society.

Hence despite the existence of long distance trade in grain it can be argued that there is no necessity to assume that individual producers were in any sense selling their produce as part of this trade. It is as easy to assume that the grain was amassed through pre-existing patterns of payment of tribute to chiefs, perhaps arising from their role in land allocation. The difference implied by trade in staples is that these foodstuffs did not remain within a society for potential redistribution to those in need. If such redistribution had previously formed a part of the mutual obligations between elite and producers, this represents a changed relationship, with implications for the security of the producer and raising questions about the continued maintenance of social power.

One potential if indirect source of information for the nature of later Iron Age coin use is the subsequent use of the coins after the conquest. Haselgrove (1987,216) notes their use continues with "no major dislocation of pre-existing patterns of circulation" except in relation to local changes in settlement pattern which he attributes to the conquest. However, in contrast with Gaul, where the conquest apparently stimulated the production of bronze coinages, indigenous minting ceased in Britain . Even where a need for bronze coin existed (ie, where it had been in use pre-conquest) it was met by using copies of Roman coins, many imported from Gaul (ibid,204-5). Haselgrove suggests several possible reasons for this, such as the more rapid establishment of Britain as a province, a greater number of legions stationed in Britain, and a longer history of coin use encouraging the acceptance of Roman coin. He stresses the need to separate "indigenous and Roman needs and uses", with the distinction between Roman civilian and British uses (eg the losses in Colchester compared with those from its extra-mural settlement) and between the conquered territory and the client kingdom of southern England forming the "most striking aspect" of the post-conquest record (ibid,206).

In the client kingdom, he notes that "by inference then, British coin usage ... continued largely as previously until Romanisation rendered it irrelevant" (ibid,208). Despite this continued use, the British coinage "never apparently penetrated the class of newly-emergent smaller nucleated settlements" in the region. If this is taken to imply that the British coinage did not meet the needs of these sites, it may also argue against its role as an everyday market currency in this area in the pre-conquest period. In the area north of the Thames, British coins are found on similar settlements. Whether this reflects pre-conquest differences in coin use between the two regions (this is a point where Haselgrove seems ambiguous-see above) or post conquest differences is uncertain. In the conquered territory, disruption of the pre-existing pattern of movement of goods through socially embedded channels may have removed the specific role played by the Iron Age coins, and hence removed some of the distinctions between them and Roman coins in use, leading to wider usage of British types in market transactions. Certainly if elites were issuing coins as part of the centralisation of grain and other commodities for export, change in their role would explain why they no longer needed to issue coin. Purchase or requisition by the army might bypass them; if they acted as tax collectors the need to recompense their subordinates for supplies would be removed. Payments they were obliged to make to the Roman authorities would have been demanded in Roman coin.

10.2.1.(i). Some other models of the development of coinage, trade and markets in Britain.

The use of Iron Age coins has also been discussed by Collis. He describes the context of the coinage in terms of whether or not power was territorially based (centralised or decentralised), and whether or not the issue of coinage was subject to political control (Collis 1971,74-5). He suggests that because the earliest coins were uninscribed, it can be inferred that it was the "prestige of possession", the social prestige gained by the use of the coins, rather than the "prestige of production" which motivated the issuers (1971,75-6). He suggests that the restricted distributions and the presence of possible coin moulds on minor settlements imply that coin production was "uncontrolled", although it is not possible to decide whether this was in the context of a "centralised" or "decentralised" society. The earliest inscribed issues, especially in Kent and Essex, are characterised by overlapping distributions and a "proliferation" of names; he infers this represents a controlled/decentralised situation. It is, he considers, the later inscribed coins, those of Cunobelin and Verica, which seem to have been minted for reasons of propaganda and political control in the context of territorially based power, his controlled/centralised situation.

The social distinction Collis draws between the two earlier groups is not entirely convincing. It seems unlikely that the issue of coinage ever had "no political significance as a vehicle for propaganda"; "anyone rich enough to possess the necessary resources and technical skill" to produce coins would have done so for a reason, and that reason was presumably connected with the enhancement of socio-economic or political status. The suggestion that only inscriptions carry a message appears biased by the viewpoint of a literate society. A wide range of social information pertaining to status and relationships can be carried by exchanged objects (Binford 1983,227-8). Similarly it is not clear that enough is understood about the social status of settlements in the period to make Collis' use of the term "minor settlements" valid in social terms. Both of Collis' two earlier groupings seem understandable in terms of a "decentralised" society, with competing high-status individuals, and the grounds for separating them are not convincing.

But the distinction between the early multiplicity of users and the later "centralised" issues with their distinct territorial bases is important. As Collis notes, the interwoven distributions of the earlier coins suggests that this change does not simply represent the amalgamation of small territorially based political units; the earlier situation, Collis infers, is of non territorially based elite power, with individuals competing for position within an area. The potential significance of such a situation was discussed above (Chapter 8); it may imply a degree of choice in allegiance for agricultural producers and hence a constraint on the demands placed on them by elite groups. If elites over-exploit their following, they can lose it (Mann 1986,62).

The concept of territorially based power is often accepted uncritically in discussions of British prehistory - the central place implies central person view in particular. Yet the evidence for 'central persons' such as for example 'chiefly' residences is at best scarce. There are possible examples at Hod Hill (Richmond 1968) and Crickley Hill (Dixon 1988), but in general they cannot be identified. Ethnographic evidence suggests that chiefs are unable to mobilise the labour and resources to construct for themselves markedly different residences ('palaces'), in contrast to their ability to mobilise labour for 'public works' such as temples, defences or agricultural constructions (Sanders 1974,109). Yet a larger focal building or one identified by particularly rich finds might be anticipated if central places were regularly associated with a single high status person, and the scarcity with which they have been recognised may indicate that such an association was not present.

The expectation of territorially based power possibly derives from the territorial pattern of feudal power in mediaeval Europe, and it is relevant to note that this was one specific historical case rather than a universal form. It was not, for example, the form aristocratic land holding took in Roman Italy. As Hopkins notes (1978,49), substantial land holdings in Roman Italy usually consisted of a number of scattered estates, and the Roman aristocrats therefore were in general unable to build up regional power bases by control of a particular territory.

By the end of the Iron Age, Collis suggests that minting was under centralised control (1971,75), with the coinage of some lesser leaders evidently struck in the mints of the more powerful such as Tasciovanus and Verica (Nash 1987, 132,135). Similarly Cunobelin, Nash suggests, monopolised the issue of gold over a wide area within which local rulers still issued silver and bronze coins (ibid,134). This "hierarchy of currency metals" (ibid,132) may be significant in understanding their use; Nash notes that gold coins display the fewest names, silver rather more, and bronze has "the most unresolved complexities". This centralisation may be presumed to be reflecting other changes in the relationships between leaders, presumably a decrease in the political autonomy of the subordinated elite. Whether this extended to a change in the circumstances of agricultural producers is a matter for conjecture; if local rulers acquired territorial control and this replaced competition for followers it would have implications for the status of the common people, whose ability to shift allegiance would presumably be lost. If, as in Gaul, the tribal chiefs were registered as landowners after the conquest (Rankin 1987,130), it would be interesting to know whether this represented the imposition of a new relationship or a formalisation of a pre-existing trend of this nature. Rankin notes there is no literary evidence for the form of pre-conquest land holding in Gaul. [These issues of land ownership are discussed further below].

A different view of the development of markets is provided by Nash (1984). While stressing that all the celtic societies in the first two centuries BC were agrarian in nature, she distinguishes two forms, warrior (agrarian) and (purely) agrarian. In the purely agrarian societies (ibid,97-9), the bases of social wealth were agricultural produce, raw materials and finished goods, "produced within a society itself". Internal marketing systems developed early, under elite control, and valuables were accumulated by means of exchange within the society and through external trading. These external trading relationships made substantial demands on the society, resulting in "a large and heavily exploited population", whose military commitments were therefore minimised. The importance of exchange of goods led to the development of nucleated settlements, with political and economic functions including manufacture and storage. This, Nash suggests, represents the situation in western Gaul and south western Britain.

In contrast, in warrior (agrarian) societies (ibid 99) the surplus production of the peasants (her use of the term is significant) was appropriated directly by the elite, and marketing was unimportant, limited to the exchange of environmentally restricted resources. Wealth goods were distributed by elites as gifts or payments, and specialised craft production concentrated on wealth goods rather than everyday items. Wealth was acquired from outside the society, as tribute or plunder (especially slaves) from weaker societies, and as the luxury goods for which they were exchanged with stronger societies. Military service by warriors for these stronger societies was another important source of wealth, one which Nash suggests accounts for the introduction of gold coinage into Britain (ibid,101).

The emphasis in these societies was therefore on the build up of military followings (as these constituted the prime source of wealth) rather than investment in agricultural production, manufacture or exchange. Agriculture also suffered from a drain on labour power for military purposes, and tended to develop "the less labour intensive but territorially more demanding pastoral sector at the expense of intensive arable cultivation" (ibid,100). This resulted in pressure on land, and hence for territorial expansion. Land, in Nash's model, is explicitly "freehold".

The largest and most important settlements in these societies are "the inflated households of the dominant nobility, attached to their estates" (ibid,101). Nucleated settlements with "clearly defined distributional functions" were "lacking", and the "development of craft production for distribution and exchange" was "inhibited". This Nash suggests was the situation in Belgic Gaul and southeast Britain. Most of the "inflated households" described by Nash are, it should be noted, described by Cunliffe (1974,80,92) as "urban or proto-urban settlements". One of these, Camulodunum, has been interpreted by Crummy (1980) as a "royal estate", but one which was "an area of intense industrial and commercial activity" and "flourished chiefly as a port and riverside industrial centre". The emphasis on productive activity does not support Nash's interpretation of these sites.

Nash's paper addresses several of the major problems considered in this section, such as the nature of exchange and the economy, the nature of land holding and the labour force. The detailed arguments on which her assessment of the socio-economic organisation of Britain are unfortunately not yet published (Nash 1984,note 1). In the absence of a statement of these arguments, which the 1984 article does not provide, it is difficult to evaluate the conclusions drawn. The interpretation of the "territorial oppida" forms one objection to the application of Nash's warrior model to southeast Britain, and her comments on the different agricultural bases to be expected in her warrior and agrarian regions are still more problematic. The inference that arable farming should be emphasised in southwest Britain and pastoral in the southeast certainly runs counter to generally accepted views on Iron Age agriculture (not, of course, that that necessarily matters). But it does not seem to be supported by the evidence, for example for increasing arable in the Upper Thames Valley (Hingley and Miles 1984,65) or for extensive field systems apparently of Iron Age date which are beginning to be recognised in areas such as East Anglia (Williamson 1987). Similarly the documentary evidence for the trade in grain, its importance perhaps reflected in the design of some of the coins of Cunobelin, suggests a strong agrarian economy in the southeast, as do Caesar's descriptions. And in interesting contrast to the warlike descriptions of the Celts so often quoted, the comments of Diodorus, writing shortly after Caesar's invasions, can be noted: "[Britain] is held by many kings and potentates, who for the most part live at peace among themselves".

Haselgrove (1982) has interpreted the economy of southeast England in the later pre-Roman period in terms of a prestige goods economy. Haselgrove argued that the prestige goods system of lineage societies - where elders exercise control by the manipulation of prestige items in the absence of control over land or the means of production (ibid,81) - was changed as a result of differential access to new sources of prestige goods, ie. by an elite monopoly over the import of luxury goods (1982,81, Fig.10). In this way "prestations to elders became tribute to a chief". Haselgrove stated that this change should be accompanied by intensification of production, both to produce goods directly for export and to allow the mobilisation of goods for export from other areas, and resulting in technological innovation and a greater investment of labour in production. This is presumably achieved by direct elite involvement in production, leading to the expectation of "specialist workshop areas" (ibid,82).

In his discussion of Belgic Gaul, Haselgrove (1987b) argued that although the system was based on "control of circulation and exchange, rather than on production *per se*", it also depended on the elite's "ownership of almost all the productive land" (ibid,106,n.4). The increased production was thus achieved via clientage relationships and the imposition of increased tribute in addition to the manipulation of wealth items within the society. The prestige goods thus play a role in the control of agricultural production by reinforcing the relationships controlling land, rather than acting instead of them. This parallels Sansom's reference to the importance of the control of material goods among some southern Bantu groups where direct control of agricultural is difficult because of the distribution of productive areas (1979b,251,257-9).

Brumfiel and Earle stress the importance of the "production/procurement/distribution of wealth" in the political economies of early complex societies; wealth forms the means of defining statuses, and the rights and obligations attached to them (1987,4,7). Sites like Camulodunum (see below) suggest the later Iron Age elite controlled the production as well as the manipulation of wealth (cf. Gosden's (1985) discussion of prestige goods in Early Iron Age Europe).

The situation for subsistence production is different. Brumfiel and Earle note that elite involvement in the subsistence economy in early complex societies is very variable, ranging from "nearly all encompassing" to " non-existent", extending no further than ensuring the mobilisation of resources for its own support (1987,4). However, Haselgrove's view that the British elites lacked control over land is problematic. It is argued below that there was some degree of social control over agricultural land throughout the Iron Age, and that elite groups played a role in this.

10.2.2. The nature of the economy; the evidence of the traded goods.

Much archaeological discussion of trade has focussed on the longer distance movement of goods, and especially their transfer across physical or social boundaries. In part this is attributable to the greater visibility of some of the goods involved in these transactions. It also stems from a theoretical approach to 'trade' which emphasises its separateness from socially embedded exchange interactions within groups, and hence its location in boundary areas, such as ports of trade (Hodder 1979,189,192). Models such as Hodder's envisage reciprocal gift exchange as the fundamental means by which goods moved around within societies, up to and beyond the Roman conquest. Even where specialist production is demonstrated, Hodder considers, such embedded mechanisms are adequate to account for the distribution of Iron Age products (1979,190). Movements of goods within individual Iron Age societies are thus regarded as either part of "the socially and politically controlled collection of goods from the local tribal areas" by elites, elite exchanges between centres, or as "reciprocal gift exchange" (Hodder 1979,190-1).

As the scope of this work concerns the economic context of agricultural production, the key questions here concern how agricultural producers obtained goods they did not produce themselves, and how these processes might have affected productive decisions. It is therefore the movement of subsistence and utilitarian objects within societies, perhaps the least visible aspect of trade, which is considered here. The movement of specialist-produced goods is the most readily detected form of this trade, and the question is whether the three classes of transaction described by Hodder are adequate to account for their perceived distributions, or whether some other form of trade is needed to explain the evidence.

Brumfiel and Earle (1987) draw important distinctions between attached and independent specialists, subsistence and wealth products, and full and part time specialisation. Full-time specialisation requires an exchange mechanism which ensures supplies of subsistence goods and raw materials to the producer. For attached specialists, patrons can often meet these needs, and full-time specialisation can occur among attached producers when exchange mechanisms are insufficiently developed to allow full-time independent specialists. Attached specialisation occurs because of the need for control, typically in the production of wealth items, weaponry etc (ibid,5). Control of subsistence goods does not appear to carry the same importance for maintaining social control; Brumfiel and Earle note that specialisation in subsistence goods production is often "either absent ... or carried out with little assistance or interference by political elites" (ibid,6). Independent specialists produce subsistence or wealth goods; specialisation develops in response to factors such as resource diversity and the levels of skills needed. The development also reflects the marketing systems and the stability of supply and demand levels.

The evidence for specialised production of pottery is often cited as evidence for trade. Petrological analyses of pottery, notably Malvern ware (dating from the first two centuries AD), Glastonbury ware (second and first centuries BC) and Durotrigian ware (from the early first century BC and continuing into the Roman period) have shown that pottery from individual clay sources was distributed over a wider area (Peacock 1968,1969; Williams 1977). Because of the correlation of typology with petrology, it is the movement of finished pottery rather than the acquisition of raw clay which is implied. These distributions can be described either in terms of 'trade' or in terms of socially embedded relationships. The feature which most strongly suggests that a network of individual gift exchanges is not an adequate explanation for this evidence is the relationship stressed by Peacock between specialist pottery production and a weak agricultural base resulting from poor environmental conditions. This is based on both ethnographic observations and consideration of the environmental context of the production areas of the Durotrigian/black-burnished wares and the Malvernian pottery (Peacock 1982,23-4,82-6). The development of specialisation and the apparent stability of the distribution patterns suggest an ability to rely on craft production to sustain livelihood in a way a network of individualised gift exchange obligations would have been unlikely to allow. In the consideration of social insurance by Spielmann discussed earlier, craft production was a intermediate response, and the capacity of exchange of craft items to compensate for agricultural failure within the egalitarian societies discussed was seen to be limited. The specialist production of the Late Iron Age may therefore have been sustained by a more developed set of relationships.

In the case of pottery, it is the producers who depend on being able to exchange their products for food. In the case of some other traded goods (salt, iron) they are rather necessities which the agriculturalists must acquire, and it seems unlikely that the social networks which were adequate to encourage the supply of scarce socially valued elite objects in earlier periods (eg Sherratt 1976) would prove adequate to ensure the supply of economic necessities. The distinction between trade in commodities and trade in "gew-gaws" (see Binford 1983,231) is important. Trade to define alliances and symbolise relationships is distinct from trade to move goods, although it may be a necessary prerequisite for or accompaniment to it (Dalton 1977).

Metal ores have geographically limited sources. Ores of copper and tin are found chiefly in the 'highland zone' of the north and west, and ores of iron, though more widespread, are not ubiquitous (Tylecote 1962,17-8,175-9). Hence it is clear that there must have been substantial movement of bronze into south east Britain, and in the Iron Age a trend from small scale iron smelting for immediate use to specialist production and distribution has been demonstrated (Ehrenreich 1985, 98-9; see also Sellwood 1984,361). The supply of metal for edge tools (that is, as an economic necessity rather than in the context of elite artifacts such as jewellery or weapons) is therefore potentially informative about the context and extent of 'trade' in the first millennium BC.

Rowlands' (1976) discussion of the organisation of the bronze industry in the Middle Bronze Age distinguishes three patterns of supply. Raw metal appears not to have been a "specialist trade item" in the MBA (ibid,166) as hoards of this period do not contain either raw metal ingots or scrap metal, in marked contrast to the hoards of the Late Bronze Age. The later MBA is distinguished from the earlier by the appearance of hoards (early MBA metalwork occurs predominantly as single finds) containing finished or semi-finished implements, which Rowlands suggests implies increased demand and greater centralisation of production, in the context of seasonal production by part-time specialists anticipating year-round demand (ibid,164,5).

Rowlands interprets this evidence as indicating that MBA smiths did not organise the supply of their raw material; supply by clients, acquisition through generalised exchange or as an aspect of political control are the means of procurement he suggests. Yet anticipatory production would seem to suggest smiths were able to build up stocks of metal for use. There is a change in the source of supply. Analyses by Northover (1982 50,54) suggest that while in the earlier Middle Bronze Age the source of supply was Wales, from the later Middle Bronze Age the bronze was imported as scrap from mainland Europe.

The Late Bronze Age saw another change, with the development of sophisticated mechanisms for the acquisition and distribution of metal in the form of both ingots and scrap (Rowlands 1976,166-7).

The introduction of iron appears to have occurred within the context of the bronze industry (Ehrenreich 1985,87-9; Champion et al 1984,289-290); an early use of iron may have been for tools used in incising decoration into bronze items (O'Connor 1980,84). No substantial changes in the nature of exchange relationships need be expected. It is interesting that in Britain the earliest objects of iron were utilitarian (agricultural tools) and not weapons or jewellery (Ehrenreich 1985,87-9). The use of iron may have resulted from an increased demand for metal tools, perhaps accompanied by problems with the supply of bronze (Champion 1975,142; Champion et al 1984,289-290).

Production during the earlier part of the Iron Age appears to have been characterised by widespread small scale iron smelting. However the situation changes during the Middle Iron Age. From the second century, the evidence for iron smelting suggests it occurred on fewer sites than before, but with an increase in scale and specialisation of production (Cunliffe 1974,272; Ehrenreich 1985,98-9). Standardised ingots ("currency bars") occur, their form reflecting their origin and the quality of the metal used (Ehrenreich 1985,67-9,78). High phosphorus iron (deriving from a limited range of sources) was widely available by the start of Danebury ceramic phase 7, ie c.250 BC (ibid,82). Evidence from several nucleated settlements suggests that within a particular area there may have been only one source of iron exploited (Sellwood 1984,360)

Hence a number of changes in the organisation of the supply of metal can be outlined, even if much of the detail is lacking. The important point is that these mechanisms were presumably all "socially embedded exchange". This can therefore be seen to encompass a variety of forms, of which generalised gift exchange may be the dominant type of exchange in only one; in the context of ensuring the supply of essential commodities such as metal, it arguably ceased to be the dominant aspect during the Middle Bronze Age.

In the case of the iron industry, it may be suggested that the evidence for specialisation reflects changes in the economic context of production and exchange of craft items starting as early as the third century BC. As argued above for pottery the evidence for specialisation suggests an established means of distributing produce and acquiring needed subsistence and other goods in reply. 'Marketing' may be inferred, but a wide range of factors in addition to supply and demand would probably have influenced prices (Bohannan and Dalton 1962). Customary prices, as described by Sansom (1979a,172), may have applied. Standardisation, it can be suggested, would be particularly important in this context of agreed conversions, more so than in either gift exchange or in the more developed market system where prices are haggled over. This resembles Sahlins' 'balanced reciprocity'; in exchanges of the same goods between different societies, there is no reason to suppose the price was not keenly argued over. Such a development of specialist production dependent on 'marketing' might be expected to require a pre-existing system of distribution and exchange via established centres, such as Cunliffe's developed hillforts (1984a,556-9). Association with centres and the elite would be expected both because of the dependence on the existence of earlier exchange relationships and because of the political importance usually attaching to the control of markets.

Trade at this level would be expected to influence agricultural producers little. 'Prices' fixed at customary levels are not affected by factors of supply and demand. Producers would probably be involved chiefly in "target marketing" (Bohannan and Dalton 1962), that is, sale of produce in order to obtain specific objects, whether essential tools or luxury items (such as metal ornaments or fine pottery).

Such purchases would be made out of the 'surplus' - not something deliberately produced, but as inevitable a part of agricultural variation as harvest failure. The ability to exploit the 'surplus' will have been limited by social obligations such as gifts to social superiors ('chiefs'), which even if notionally voluntary may have been effectively compulsory for those with a good crop, especially where the chief played a major role in allocating the land for next year's cultivation. Similarly, obligations to kin and other community members will have made demands on the 'surplus', and meeting these would be vital in ensuring the producer's own security in case of a poor harvest. The role of marketing is likely to have been limited, at least initially, by long-standing social obligations. It is, in Bohannan and Dalton's terminology, likely to have been 'peripheral' and to have had little impact on agricultural decisions and the allocation of resources (1962,8).

The evidence for specialisation in craft production and metal supply does seem to suggest the development of 'trade', still 'socially embedded' but distinct from either reciprocal gift exchange or the payment of tribute to superiors, by perhaps the early second century BC. And this therefore provides a backcloth for the developments at the end of the Iron Age when changes in the structure of exchange may may come to have a more significant effect upon the economic context of agriculture.

10.2.3. Markets, trade and the agrarian economy in the later Iron Age.

It is necessary to start this section by restating the limits to the discussion in this chapter. The aim of this thesis is to describe and interpret agricultural change, and not to attempt to write an economic history of Iron Age and Roman Britain. But the fundamental disagreements seen in the literature about the social and particularly the economic organisation of the period have demanded an attempt to resolve a wider range of social and economic questions. In order to discuss agricultural change in its socio-economic context (and it is a basic premise of this work that agriculture cannot sensibly be discussed without doing so) a position must be taken on the nature of that context. This chapter has been working towards building up a coherent picture of economic relationships, but it remains the case that, at a stage when firm conclusions might be hoped for, basic questions about the economic framework of agriculture are still emerging.

The social, economic and political questions have been approached from the standpoint of the agrarian economy - it is the movement of agricultural produce and inputs which has been emphasised. If this results in an unfamiliar viewpoint at times, it is argued that it is a valid one. The production of food is after all the central aspect of the economy. The suggestion made above (Chapter 9.3.3) that identifying a structure of agricultural organisation may be a key step towards reconstructing social organisation suggests how the two approaches might ultimately be reconciled.

For the later Iron Age, considering the movement of agricultural produce and the movement of coins as aspects of a unified system, some suggestions can be made about the economic context of agricultural production. Coins can be seen as functioning within a hierarchical system (itself perhaps reflected in the hierarchy of currency metals) centralising agricultural produce to enable its exchange by elite groups for luxury imported goods. It seems possible that the role of the coinage was largely 'vertical', possibly involving 'horizontal' exchanges between elites, and that the existence of coinage affected most agricultural producers very little. What can be expected to have affected primary producers directly is the large-scale removal of grain from the local exchange and consumption system. This presumably reduced the sources of grain available to those whose crops failed or who were unable to cultivate sufficient for their needs. This applies whether such needs were normally met by local purchases, by reciprocity among neighbours, or by redistribution by elites. It is an interesting question to consider whether in the case of bad years local elites could or would use coin to acquire grain from elsewhere to redistribute to their followers or dependants, or whether changes in the nature of their power had enabled them to discard any such responsibilities. A loss of social insurance would provide a clear motive for individual producers to try to provide security by other means, and the conversion of surplus grain for coins is one obvious method. But it might conversely lead to an emphasis on reciprocity within a community, and strong social aversion to market sales by those with plenty.

It was an implicit assumption in the above paragraph that agriculture in this period was essentially based on the household within its community, and that direct participation elite groups in agricultural production was similarly limited to household scale production. Production at the level of an 'estate' producing for sale depends on the ability to own or control an increased area of land [cf the introduction of land allocation according to status among the Germans between the times of Caesar and of Tacitus (Thompson 1965,18,25-6)] and also to control additional labour to work the land [the Germans did not work slaves on their own land, but allocated land to them in exchange for part of the produce (Thompson 1965,19,25,52; Tacitus Germania 25)].

Agricultural estates have two important economic roles. They enable elite groups to support their dependants, and simplify systems of staple finance in early states. In addition, estates form a more reliable source of surplus product than household producers, and hence "make it possible to depend fully on the market as a supplier of subsistence goods" (Brumfiel and Earle 1987,6). If their origin was to ensure the former, their impact in the latter may be crucial in understanding relationships between agricultural and economic change in both the later Iron Age and the early Romano-British period.

There are two possible indicators that a non-household agrarian sector may have been developing in some areas in the later Iron Age. The first is the suggestion, made by Hingley (1983,14) and discussed above (Chapter 8) that this period saw the appropriation of estates by tribal elites. However one example within his study area in the Upper Thames Valley, the North Oxfordshire Grim's Ditch, may relate to a group of Roman villas (Hingley 1984,82) rather than to an Iron Age 'territorial oppidum'". The 'territorial oppida' are yet another aspect of the Iron Age for which there are several profoundly different interpretations. The sites described by Nash (1984,101) as "inflated households" are precisely those described by Cunliffe (1974,80,92) as "urban or proto-urban settlements" and interpreted at Camulodunum by Crummy (1980) as a "royal estate" with both "intense industrial and commercial activity" and a substantial agricultural estate. More evidence is needed before the general existence of agricultural estates controlled by elites can be assumed, and the agricultural area at Camulodunum may have existed to serve the needs its inhabitants (ie to service a staple finance system) rather than to have produced food for trade.

The second class of evidence which may be relevant here is the evidence for substantial landscape reorganisation in the Upper Thames Valley and elsewhere. In the Upper Thames Valley, "new types of settlement", for example at Barton Court Farm, are established in a landscape which appears "more nucleated and tightly organised" during the early first century AD (Hingley and Miles 1984,65). The innovative economy of Barton Court settlement was contrasted by Jones (1986,120) with the conservative regime at the nearby declining site of Ashville. The agricultural changes included the introduction of breadwheat, the value of which as a traded crop was noted above. The site also produced pre-Roman coinage. Barton Court subsequently developed into a "Romano-British farmstead" and in the later third century into a small villa, with "the appearance of a family house" and "few pretensions to luxury" (Miles 1986, 30-1). Similar changes occurred at Odell, Bedfordshire (Dix 1979, 1981). Interestingly, neither Barton Court nor Odell saw the construction of Romanised buildings (ie a 'villa') before the late third/early fourth century AD (Branigan 1982,86-7), which may be suggestive about their place in the social hierarchy.

It is possible to suggest that the new settlements and the reorganisation of the landscape at this period represent the introduction of a new type of agrarian economy, geared to produce crops and livestock products for sale. A possible source of such changes would be the lower levels of the elite hierarchy; a group directly involved in the allocation of arable land (cf Hingley's analysis of the levels of organisation of different types of land use in the Upper Thames Valley discussed in Chapter 9 above). These individuals would also have been responsible for collecting produce as tribute from their followers, and transmitting it on to their own superiors in the socio-political hierarchy, for which they would be rewarded, perhaps with coins among other items. Such a group, intimately involved in the agricultural process in a way which those further up the hierarchy might not have been (especially if the warrior aristocrat model of the Celts and Germans is taken to apply), would be in a position to enhance their status by means of agricultural production. Following Cancian's relationship between status and innovation, they might be particularly prone to innovate in order to maintain their social position. Yet in the overall hierarchy, their status and wealth might be insufficient to allow them to join the ranks of villa builders in the earlier part of the Roman period.

If their status as land allocators explains their ability to appropriate more land, there is also the question of how they acquired the labour to work it. It was suggested in Chapter 8 that the reduction of social insurance in the form of redistribution by elites to those in need could have resulted in some individuals or households becoming unable to continue to function as independent units. The social environment in these areas of Britain may have changed in ways which resulted in the unsuccessful being compelled to attach themselves to the households of the local elite or to offer labour in return for sustenance. In these conditions, followers have become dependants. There are other possibilities, the use of slaves being an obvious one. Another is the use of beer or other foods to persuade others to do agricultural work; Sansom suggested that the restrictions of the cultivating season among the Southern Bantu was designed to minimise the ability of the affluent to further enhance their position in this way (1979). In the absence of restrictions, those with gifts or hospitality to offer might have been able to increase the area they could cultivate substantially.

The local elites, with their own produce and that collected in tribute from their dependants/followers could have been in a position to engage in trade on their own account as well as to enhance their position in 'vertical' transactions with their superiors. Sites such as Abingdon in the Upper Thames Valley, which has produced concentrations of Celtic coins and imported pottery as well as early Roman coins may "represent the emergence of new marketing centres" in the period immediately before the conquest (Hingley and Miles 1984,65). The appearance of agricultural 'estates' (or farms geared towards production for sale) would have been a significant economic change (Brumfiel and Earle 1987,3-4,6). The production of possible "royal estates" such as Camulodunum may have been generated for internal use; sites like Barton Court Farm and Odell may represent a level of more trade orientated farming which had a greater impact on the development of the economy and market trade.

10.3. The control of land and its produce in the Iron Age.

10.3.1. The development of control over land and its use.

The possibilities of identifying levels of control of land use from the archaeological evidence for settlement distributions and field systems were discussed in Chapter 9, along with the use of classical and early mediaeval documentary sources.

One important model for the development of rights in land is that proposed for Wessex by Cunliffe (1984b,30-1). He suggests that during the sixth and fifth centuries BC, the elite took over the ownership of land, this being symbolically represented by the creation of hillforts (and the abandonment of earlier hilltop enclosures) and the siting of some of these on "focal points in the old ranch-boundary system". As a cause for this, he suggests that the breakdown in cross-Channel 'trade', between Wessex and Armorica, deprived elite groups of access to a range of products (particularly bronze) formerly "manipulated by the elite and quite probably used by them to maintain authority". In order for the "hierarchic structure" of the society to be maintained, new means of enforcing control would have been required, and the "appropriation of land and thus ... the control of its productive capacity" would have supplied them. This model poses a number of important questions, relating to the nature of social control and land ownership/regulation during the Bronze Age as well as to the social and economic organisation of the Iron Age itself.

It is the decline in the evidence for the movement of bronze objects into Britain which is the basis for Cunliffe's model. In order to assess the likely socio-economic importance of this, it is necessary to separate two aspects of this 'trade'. The movement of prestigious goods such as jewellery and weapons must be distinguished from the movement of bronze as a commodity, in the form of raw material or tools. It is not necessary to assume this represented a concrete distinction to the people using these items - the categories may have been meaningless in those terms - but it may be useful as a way of approaching the problem of the socio-economic effects of the changes described by Cunliffe (cf. Brumfiel and Earle 1987,4). The difference between the well-defined regional groups of axe types, often confined within small areas, and the wider spread of many weapon types suggests the distinction has some validity in the Middle and Late Bronze Age (O'Connor 1980,303).

Lowland Britain lacks the ores of copper, tin and lead found in the highland zone. Northover (1982,50,54) considers that from the later Middle Bronze Age most of the bronze in Britain was imported from France as scrap (contra O'Connor 1980,303-5). It is evident from the bronze artifacts that south east England and north east France, areas which each lack indigenous copper sources, were able to "engage in mutual exchange of [bronze] artifacts throughout the Bronze Age" (O'Connor 1980,305). [Exports from Brittany to Britain are in fact scarce compared to objects from north east France (ibid,305), despite the emphasis placed on them by Cunliffe (1988,145-6).]

There is no reason to suppose that the exchange of prestige items of metal ceased at the start of the Iron Age. O'Connor notes that the Early Iron Age Thames daggers "demonstrate continuation of the adoption and adaptation of Central European weaponry" (1980,316-7); Champion notes that southern Britain "exhibits every type of fashionable Western European sword and dagger, from the Middle Bronze Age to LT III" (1975,139). Cunliffe himself comments that the Thames daggers, and their bronze sheaths, are a development which "runs parallel" to continental sword and dagger production, and notes the influence of La Tene II swords in Britain (1974,280,Fig.14:13). [In this context it can also be questioned whether the appearance of Early Gallic gold coins in Britain really represent a "reintegration" as Haselgrove (1987,195) suggests, or are simply a new and conspicuous type of item within an existing pattern of exchanges of valued items, as is perhaps implied by his other comments (ibid,193-4;) on elite exchanges in the Middle Iron Age.]

The decrease in quantity seen in imported material (Cunliffe 1982,162) might relate to the need to import less bronze as iron replaced it as the metal used for edge tools and weapons. The absence of a recognisable burial rite involving grave goods and the cessation of hoard deposition (Champion 1975,139) may have resulted in decreased visibility of imported metal items.

If the social importance of bronze as a traded item in the Bronze Age derived from its use in the long-distance trade of prestige items and their use in maintaining social power, there is no obvious reason to suppose that the prestige iron and bronze items of the Iron Age did not fulfil a similar role. Indeed a wide range of archaeologically 'invisible' goods (such as fine textiles) could have been used in this way. Why should a change in the basis of power have been necessitated, rather than a change in or extension of the range of goods regarded as 'prestigious', perhaps to stress locally produced wealth items? Indeed, while Cunliffe's initial scheme envisages elite control over "rare commodities", his reordered scheme has hillforts acting as "centres for manufacture and exchange" (1984b,30), which perhaps suggests that elite control remained in the sphere of control of the production and distribution of goods. This interpretation of the role of hillforts has been challenged by Stopford (1987) in a reassessment of the evidence from Danebury. She suggests that the evidence for imported goods and manufacture at Danebury is essentially similar to that found on most other Iron Age sites, and that there is little evidence for high status or social stratification.

The second question is whether it was the bronze itself, its value as an essential raw material, which rendered its import so socially powerful. It is worth noting that Brumfiel and Earle (1987,4) consider that elite control of subsistence goods production (including "protection-production technology"; ibid,4) is not an essential element in developing social complexity; elite involvement often is limited to ensuring resources for its own needs only.

If it was the control of imported bronze as a material for manufacturing weapons and tools which was crucial, the question remains why the control of iron did not simply replace it in importance. At first sight the obvious answer lies in the distribution of iron ores, which are widely available in much of Britain (Tylecote 1986,124-5). This, it has been suggested, makes its exploitation less easy to control. Yet if this difference in availability of iron led to changes in the way production and acquisition could be controlled, it is difficult to see why it should have led to an emphasis on the control of agriculture rather than the control of either iron resources or the productive technology of iron. The point is reinforced by the view that the introduction of iron occurred within the context of the bronze industry, and its early use in Britain was for agricultural tools rather than prestige items such as weapons or jewellery. This led Ehrenreich (1985,89) to suggest that iron "may not have been part of the prestige system". He suggested that possession of land rather than control over metals may have been "firmly established" as the "method of maintaining power" before introduction of iron into Britain. Of course control of both agricultural land and metal resources might be linked in the context of tighter control of territory. But as arable land is even more widely available than exploitable iron ore sources, why should it be easier to control?

There is a problem in understanding what Cunliffe implies by "the elite taking over the ownership of land" (ibid, 30). He notes the evidence for earlier communal control of pasture; although this is based on an interpretation of linear ditches which now seems dubious (see Chapter 7), the basic point may be correct, given the early evidence for coaxial field systems used in regulating pasture. The nature of this communal control is problematic; it is probably better expressed as community level control, which carries fewer implications as to the nature of this control. In the examples discussed in Chapter 9, the regulation of commonly held resources lay with elders or elites. The regulation of pasture probably pertained to a particular level in the elite hierarchy.

The dating of linear ditches no longer seems to support the concept of a ranch boundary system replacing field systems during the middle Bronze Age, and an early Iron Age (or later) date for many of them seems likely. The siting of hillforts such as Sidbury and Quarley Hill may symbolising not the overriding of an earlier system, but the integration of a newly emerging system of regulation during the early Iron Age, in which both linear ditches and hillforts have a role. Cunliffe (1982,162) noted that field systems had already established for 500 years by this time, but this view also must be modified (Chapter 7), and an early Iron Age origin seems likely for systems of large scale layout of arable land. The evidence so far available suggests that extensive arable field systems may be linked with rather than superseded by the linear ditches.

Hence the evidence to support the reordered hillforts being involved with the control of land is in fact stronger than Cunliffe suggested (1984b). Yet it is not clear that concepts such as "ownership" and "appropriation" (ibid,30-1) are helpful. One unposed problem in Cunliffe's account is the question of how an elite whose power base was weakening were able to extend their social control to encompass land, and how they could enforce this control.

The value of being able to appropriate land is limited by the extent to which labour can also be appropriated to work it. This is not a straightforward a problem as it might seem (cf. Hopkins on early Roman agricultural labour and the introduction of slavery in Italy; 1978,23-5). The position of slaves in Tacitus' description of the Germans was noted above; the important point is that this did not constitute direct estate-based exploitation of land and labour by the elites. In the early Irish sources, the exploitation of the land by elites was via a mesh of social relationships. At one level, wars and raids rarely involved the occupation of territory; instead (when not simply concerned with seizure of wealth) they reinforced hierarchical relationships, enforcing payment of tribute for example (MacNiacoll 1972,53; Binchy 1954,65). At the level of agriculture, clientship relationships provided the elite with returns from land (as well as livestock and iron tools) they did not directly exploit themselves (MacNiacoll 1972,61-5).

The question of land ownership in Gaul is discussed by Rankin, who notes that although the Romans registered the land as belonging to the tribal chiefs, there is "no evidence this was a system native to the country" (1987,130). He suggested that in celtic societies, land was generally regarded as the "property of the tribe, rather than the king, or chief" (ibid,170), noting that this did not limit the access of the chiefs to "power, wealth and obedient servitors" (ibid,130-1,133).

It is argued here that an increased degree of social control over agriculture is seen in the early Iron Age. But it is not accepted that a diminution in elite ability to maintain its position by the exploitation of imported goods provides an adequate or convincing explanation for an expansion of elite power into this area. The ability of an elite group to extend its role in allocating land and regulating its use may be a more appropriate explanation for the changes seen than one based on concepts such as "ownership" and "appropriation". Explanations for the development of increased regulation of agriculture and the mesh of social obligations allowing elite groups access to its products must be sought both within the dynamics of agricultural systems themselves and in the developing socio-economic structure of the later Bronze Age and early Iron Age.

10.3.2. The interpretation of centralised storage.

The marked increase in the occurrence of four-poster storage structures (accepting Gent's interpretation of these) during the Late Bronze Age and Early Iron Age (Gent 1983, Fig.1) also can be taken to support the inference of an allocative and regulatory elite. The regulatory activities of the elite entitled them to part of the produce, and yet in some ways it remained common property, with members of the group also having claims on it in need. As a parallel, among the Southern Bantu-speaking peoples, although gifts were made to all chiefs, voluntary payments of agricultural produce were made primarily to the chief or district headman directly responsible for allocating land rights to the individual concerned.

Four posters as secure storage are in many ways surprising, and it is perhaps only familiarity with the traditional granaries of eighteenth and nineteenth century AD Britain which obscures this. Before the seventeenth century agricultural produce was normally stored inside houses for security (Harris 1987,54). They form conspicuous targets - for security, concealed pits such as the excavated storage pits and the subterranean stores of the Germans described by Tacitus (*Germania* 16) are more practical. They must also have been highly vulnerable to fire - the evidence from Glastonbury may be atypical chiefly in its survival, and may indicate the scale of the problem. Although, as Gent shows (1983, Fig.5), they occur most frequently on defended sites, it seems an odd juxtaposition of investment in defence and the creation of a conspicuous target. Unless, that is, the motivation is understood in terms of an explicit statement of wealth and strength.

The four posters arguably say, look at us, we have food. Whether it is seen as competition between groups for members or by elites for followers, the four posters advertise and boast their status. Grain stored in pits may fulfil an entirely different role; as noted elsewhere, recent usage of pit storage (discussed by Fenton 1983) has tended to be to store the glut in years of exceptionally good harvest, and the assumption pits were routinely used for seed corn, experimentally shown to be possible, may be incorrect. The potential to distribute food to group members in need and to use it to acquire non-local or prestige items is displayed prominently by the four post granaries.

It is not being suggested that this represents communal storage in the sense of being the common food supply of all the group. Gent (1987,92-3) has suggested that the concentration of granaries at defended sites and their clustering within these sites implies that "storage had been taken away from the household and placed under central control". But there seem to be no specific grounds for assuming that the individual household based storage ceased. [His similar interpretation of rotary querns in terms of communal milling is also not entirely convincing (ibid, 142-3)]. Gent identifies the purpose firmly in terms of their function: "reflecting the pressure to store larger quantities of grain". But the four posters have a wider distribution than the large storage pits, a difference not entirely explicable in terms of subsoil or climate (ibid,135).

Similarly, the association of four posters with defended sites is related by Gent simply to the needs for defence, and the paradox of setting up an obvious target and then defending it is not commented upon. As he concludes, the need for defence may explain their location, but "it does not in itself explain the development of centralised food stores" (ibid,136).

Here it is suggested that the four posters reflect change in the organisation of agricultural production, representing the emergence of an allocative and regulatory elite able to centralise and disperse a proportion of the harvest, both to aid group members and to boost its own position. It is suggested this change emerged as the result of increased productive demands being placed on the land and the resultant need to control land use in new ways. An understanding of the agricultural systems of the middle and later Bronze Age (see section 10.3.3. below) provides the key to understanding these changes in their organisational structure.

The grain stored in the four posters is the sum of the gifts and tributes to the allocative elite, available to them both for redistribution and to enhance their own status. Its public display reflects its public role - the elites' use of the stored produce is constrained by their need to retain their support and to attract additional followers. Elites in this position are competing on two fronts - for followers and for the favour of their own superiors in the hierarchy, where a higher level also with an allocative role existed. The allocative system of the Southern Bantu again provides a possible parallel; the chief allocates resources to the district headmen, which they in turn allocate to their supporters and subordinates. Mann's discussion of competitive leadership and his specific equation of this with competing storehouses also offers a useful insight into these problems (1986,62).

Competing hierarchies of this sort may be reflected in the hillforts themselves. They may also represent a statement - look what we can do, how many we are. This statement may be as important as actual defensive potential. Bowden and McOmish (1987,76-80) stress both the symbolic importance of hillfort defences and the scarcity of the evidence for hillforts actually coming under attack. Cunliffe also notes that the defences of the developed hillforts of his "re-ordered system" were elaborated "beyond the reasonable needs of defence" (1984b,30).

The hillforts may represent a different level of competition, uniting several of the competitive leaders in competition with other groupings. This would explain the absence of an identifiable 'central person' in these central places (the few exceptions to this have already been mentioned). Where one individual did have superior status to others in the grouping, the distinction in material terms may not have been great (this was, it can be noted, the position in early historic Ireland; MacNiacoll 1972,59).

10.3.3. The economic framework of Iron Age agriculture.

It can be argued that the substantial field systems of the Iron Age imply some form of regulatory and allocative system, whether coordinated by elites or community decisions. The increased recognition of these systems in the Iron Age in areas outside the 'celtic field' zone (eg. Williamson 1987) is important; it suggests that these systems and the organisational structures accompanying them may have been much more widespread than previously supposed (see Fleming 1987, Fig.1). The spread of four post storage structures (Gent

1983,Fig.2) could be interpreted in the same way. It will be interesting to see whether the development of the techniques used by Williamson results in a massive increase in the numbers of such systems identified. It would however be valuable to have the dating of these fields confirmed by excavation or at least by well-established relationships with excavated features. Nevertheless, it now seems possible that coaxial field systems were widespread throughout southern Britain in the Iron Age. But the points made earlier about the dangers of treating all coaxial systems as a unitary phenomenon can be restated; it is entirely possible that in their relationships with each other and with settlements that these fields will turn out to imply an entirely different organisational structure from the 'celtic fields'.

The recognition that, even with a similar social structure, the way in which agriculture is organised through it can vary is important (see 9.3.2 and 9.3.3 above). Within Sansom's "Tribal Estate" regions (of nucleated settlement resulting from unevenly spread agricultural resources) the ability of the chief to impose his authority by means of his allocative role was much stronger than in the "Chequerboard Realm" region (of dispersed settlement in a uniform environment). In the latter the chief, less able to impose his authority directly has to reinforce it by other means, such a luxury gifts to his subordinates. This may prove a valuable point in comparisons between different areas of Britain, perhaps particularly between the 'hillfort zone' and the southeast (Cunliffe 1982, especially 174). It may suggest an interesting perspective on developments in the Later Iron Age in some areas, including the distribution of imported luxuries and the motivations for coin use.

The essential point is that the organisation implied by the coaxial fields is different from that implied by the small groups of fields associated with settlements, such as the MBA sites in Sussex discussed in Chapter 7, and others throughout England such as Gwithian (Megaw et al 1961), Houseledge (Burgess 1983,147-153) and Stannon Down (Mercer 1978, Fig.25.2). In these cases individual households or small groups of households appear to have their own defined plots close to their dwellings. Their exploited area must of course have been larger, and the regulation of pasture and grazing at a wider community level may have been a very early feature, as the early systems of fields apparently for livestock control in both Britain and Ireland suggest. Hingley (1983,17-8) provides a useful discussion of the organisation of pasture, although mostly relating to pastoral rather than agricultural communities. In agricultural communities, pasture may not have been regarded as a 'wild' resource, especially when it is clear that deliberate action was taken to maintain and regulate it.

Why should the increased role of elite involvement have occurred and change in agricultural systems ? Cunliffe's proposal that it resulted from a decrease in long distance trade and the manipulation of valuables was discussed above (section 10.3.1). The important point seems to be that the later Bronze Age appears to have been a period of intensification of production in a range of areas (Champion et al 1984,292; Rowlands 1980,41). Champion (1975,142) suggested that it was an increased demand for tools and weapons which brought about the adoption of iron for their manufacture. An increased demand for agricultural production may have accompanied the increasing demand for metals (and would clearly explain an increased demand for metal tools). Such a change is often associated with increasing social complexity (cf. Brumfiel and Earle 1987,3; though in the examples they cite, direct elite/government involvement in the subsistence economy often extended only as far as ensuring its own needs were met).

In the specific case of later bronze Age and early Iron Age southern Britain, if increasing agricultural production was demanded, the pre-existing system of agriculture, represented by the middle Bronze Age settlements and their adjoining small fields groups, may have been incapable of increased output. Systems dependent on the intensive cultivation of restricted areas may have distinct limits to the extent to which production can be increased by increased labour inputs. Such systems demand the support of labour intensive practices such as effective manuring (at high levels by prehistoric if not recent historical standards), achieved by intensive management of livestock, such as daily movements of cattle to byres and the provision of fodder.

The limits of intensive small plot agriculture may have been reached. As returns from increased inputs from the intensive fields diminish, the use of additional extensively cultivated plots would allow an increase in production. Expansion of cultivation into wider areas without the framework of intensive management may have been unstable, causing soil loss in the areas used (the appearance of colluviation at Itford Bottom preceding the layout of fields (Bell 1983,131-143) may reflect pressures of this kind). It could result in conflicts between individuals, not least resulting from conflicts between standing crops and the needs of grazing livestock.

A new more extensive system (it is a mistake to assume only intensification produces increased production) based on a wider spread of arable usage and the regulation of fertility achieved primarily through the use of fallow (perhaps grazed) may have provided the basis for an increase in the productive potential of agriculture.

Extensive field systems to regulate cultivation and boundaries (the linear ditches?) separating areas of arable and pastoral usage could have resolved problems of declining fertility and conflicts over use. The ability of the community (whether by consensus, or through the authority of elders or political elites) to assert control over the management of the land for cultivation could derive from a long-standing existence of community level regulation of grazing, represented by the early pastoral coaxial systems, by perhaps as commonly expressed by temporal as spatial limitations on grazing rights. Such a role could also legitimise the rights of the allocators to part of the produce.

The allocators would be in a position to strengthen their position by use of produce to obtain wealth and cement allegiances, but if it is correct to envisage competitive leadership, the ability of followers to change their allegiance would limit the extent to which the elite could divert produce for their own advantage.

If such a balance existed for much of the Iron Age, the changing economic context of the later Iron Age probably altered it irrevocably. Allocators may have become owners, in the context of an increasing market for staple foodstuffs and increasing access to imported status objects. The abandonment of many hillforts during the first century BC (Cunliffe 1982,176-7) may reflect the decline in the allocative role of elites. New forms of settlement and landscape organisation seen in the later Iron Age in some regions may reflect the emergence of individualised land control reflecting private rights in land in these areas, at least for certain sections of society. A corresponding ability to control the labour of others may have accompanied it.

Caesar's descriptions of the Gauls may reflect such a change from competitive leadership to imposed power. He noted the existence of factions at all levels of society. The leaders of the factions were those who were most respected; their authority depended on their ability to protect the interests of their followers, the common people. This was described as an ancient custom. Yet later, Caesar described the common people as of no account, "crushed by debt or heavy taxation or the oppression of more powerful persons" which led them to commit themselves to the service of men of rank, effectively as slaves (Gallic Wars, VI.11 and 13; Penguin translation, 30-1).

Developments in agriculture and the control of agricultural land may relate closely to socio-economic changes at the beginning and end of the Iron Age. Potentially therefore, as more is understood about the basis of agricultural systems in this period, it will prove to form a valuable source of information on these changes. As more is learnt about the social economy of the Iron Age from other sources, it will be possible to modify or reject the suggestions about the organisation and economic context of Iron Age agriculture put forward in this chapter.

10.4. The economic context of agriculture after the Roman conquest.

If the marketing of goods had developed in parts of southern Britain during the late Iron Age, it still seems to have been under close socio-political control with elite control over trade and, in so far as at least the majority of agricultural producers were concerned, to have remained 'peripheral', probably with customary pricing and having little or no impact on agricultural decision making. There is a clear expectation in many archaeological considerations (written from a range of viewpoints) that the conquest will have drastically altered the economic context of agriculture, encouraging and enforcing increased production by imposing demands and presenting opportunities.

Yet the basis for such expectations is not entirely sound. Salway (1981,616) disputes the proposition that the conquest resulted in "the imposition of a fundamentally alien system, rooted in completely different attitudes to society and exchange", identifying as the main error of that argument the failure to take into account the coexistence in the Roman world of both social and commercial exchange. In particular, the existence of the clientela, a system of patronage with mutual obligations, leads him to conclude that "we cannot use a supposed violent antithesis between the attitudes of the British elites towards money and exchange and those of the Roman invaders to explain political tensions or invent economic ones" (ibid,617). Todd (1987,204-5) also stresses the continuity between the later Iron Age and the first two centuries AD, with the "peasantry" continuing to owe obligations to those higher on the social scale. Such relationships may have continued outside the context of a developing or expanding market element in the economy, and despite a different legal formulation of the relationships involved.

There are also substantial disagreements as to the role of money within the Roman Empire. Crawford's examination of money and exchange in the period 200 BC-AD 200 concluded that coinage was issued by Rome for the sole purpose of making state payments. He suggested that "an economic and social system in which coined money played a major role as a means of exchange, although it existed in the Roman world, was not common". Outside the cities, this use was very rare (Crawford 1970,40,43,46). There are two distinct issues here - why the coin was issued and how it was used - and both arguments have been disputed.

Lo Cascio (1981) has argued that the Roman authorities in the period discussed by Crawford did make deliberate efforts to ensure a supply of coinage to meet the needs of the (market) economy. They were however at times prevented from doing so by problems in maintaining metal reserves. This implies a deliberate "monetary policy" based on "an empirical understanding of some economic notions" (ibid,76). Crawford suggested that coinage issued to make state payments was then "demanded back by the state in payment of taxes" (1970,46). Hopkins' analysis of the relationship between tax and trade stresses the importance of trade. In particular, he argues (1980,102), the sale of foodstuffs to artisans who produced goods of higher value and lower volume than the foodstuffs for both local sale and export to other regions, was a vital element in allowing the peasants to obtain the money to pay cash taxes. This suggests that the "increased monetarisation of the economy" described by Hopkins may have been an essential element in this reclamation of coinage as taxes, and in this context attempts to ensure sufficient coinage to permit the necessary sequence of conversions are not implausible.

The extent to which such considerations might have applied to Britain is an additional difficulty. Reece (1979,214) comments that it is "difficult if not impossible to talk convincingly of Roman monetary policy" and that to do so in the context of "monetary policy for newly conquered provinces" is "no more than a jungle of speculation". However it is the other aspect of Crawford's argument, the virtual absence of the market economy from the countryside, which is the important question for discussing the agrarian economy.

Millar (1981) has used an examination of the role of money in Apuleius' novel The Golden Ass to assess Crawford's views. The Golden Ass provides a wealth of monetary detail, relating mostly to activities in cities and villages, where the importance of buying and selling, and of working for cash, are well illustrated. Millar also cites (ibid,73) three examples of money transactions relating to agricultural workers. What seems significant is that two of these involve an owner being cheated by slaves, who sell goods or produce for their own benefit. The third case, a goat herd selling milk and cheese, could be similar, or could represent an independent specialist producer like the market gardener also mentioned. In light of the comments made earlier about rural poverty, it is worth noting that the market gardener had been reduced to eating overgrown and gone to seed vegetables, having no money and nothing left to sell. The references to coin use do not therefore relate to the peasant farmer or to the cultivation of staple crops such as grain. Certainly a wide range of specialist craft activities and cash transactions in rural villages is attested; but Millar's assertion that "all the food producing operations are specialised and the products are exchanged for cash" is not substantiated by the evidence he cites.

What does seem clear is that, at least in the area on which Apuleius (a Greek from Asia Minor) drew for his novel, towns and villages in the countryside (perhaps the kind of settlements archaeologists would tend to describe as small towns) did provide the opportunity both for buying and selling and for earning money in both regular and casual employment (Millar 1981,72-3). How important these opportunities were to peasant agriculturalists throughout the Roman Empire is a different question. Hopkins' (1978, Fig.1.2, 16-8) "crudely hypothetical" estimates of the uses to which 'average' peasants put their crops suggest that at most 20% of the crop was used in market transactions, less if rent or tax was paid wholly or partially in kind. And only "a very small proportion" (2 or 3%) was available to spend on manufactured goods.

The effect of the market on productive decisions may not have been great. Peasants may have sold what they had to in order to meet the demands for rent and tax ('target marketing') and as Bohannan and Dalton point out, what is sold to meet such needs does not necessarily represent surplus in any real sense. The inherent variability in agricultural production suggests that the market could have presented the possibility of sales in good years and storing money against future hardship. But the descriptions of the starving rural poor (Jones 1964,10-11) and the tendency for crop failures, because of their relationship to weather conditions, to affect entire localities or regions suggest that this would have been of limited effectiveness. It was the urban poor who were able to compel the Roman state to alleviating their food shortages, by rioting or via politicians dependent on their support (Hopkins 1978,14-5; Garnsey 1983).

Hopkins (1980,101-2) assertion of the importance of taxation in monetarising the economy was noted above. Problems of Roman taxation therefore relate to agricultural production in two distinct ways. As well as estimating the level of the productive demands the tax system placed on agriculturalists, it is also necessary to consider the role of taxation in the economy and the changes its imposition may have initiated.

Taxation in the Roman provinces before the late third century took two principal forms - the <u>tributum soli</u> (a tax on land and property) and the <u>tributum capitis</u> (poll tax). There were three stages in the administration of these taxes. The census of people and property was conducted by the governor or a specially appointed official, and an assessment imposed, not on individuals but on communities and their territories. The third stage "devolved on the local authorities" who were "responsible for the physical exaction of tribute" (Burton 1987,427). The indirect nature of their collection is important in considering how they may have affected agriculturalists in Roman Britain. This system, Burton (1987,429) notes, worked to the advantage of both the Roman government and the provincial elites, the latter being able to enhance their social and political authority and also to manipulate the spread of taxation to minimise their personal liability.

In the first and second centuries AD these taxes were almost always paid in cash - the notion of a corn-tax at this time is "a modern myth" (J.C.Mann 1985,21). There are a few examples of payment in kind; the Frisii paid in ox hides and the Batavi in recruits for the army because of their poverty. Grain was obtained by the Roman authorities by requisition, that is, by compulsory purchase at fixed prices. Mann (ibid,22) comments this need have given "little cause for complaint" where it was operated without abuse, as he regards the price paid for the grain as "generous", a view arrived at by comparing the requisition price with recorded prices from Italy during the first century BC and the first two centuries AD (although famine year prices were higher). However, farmers producing little above their subsistence needs must have been disadvantaged if their crops were compulsorily purchased. The additional demands Roman authority could make - labour and money to maintain roads, and the <u>hospitum</u> (unpaid hospitality) and <u>vehiculatio</u> (transport and supplies paid for at fixed prices) which could be demanded by certain state agents and soldiers on official duties - were "perceived .... as one of the most onerous burdens imposed" (Burton 1987,429), and Mann's assessment of the effects of requisition is probably unrealistic. Jones (1964,30) notes that prices paid "varied according to the honesty of the government", but they seem to have been "normally inadequate". Again, the data relate to Italy. As with the main taxes, responsibility for these levies rested with the city authorities (Jones 1964,12). The levels of these demands cannot be determined; effects were uneven, with communities close to important routes worst affected (Burton 1987,429).

In addition, there was also a range of other taxes, on manumissions, inheritance (at 5%) and on goods in transit which crossed certain boundaries (2 to 2½%) (Burton 1987,428). Local taxes were imposed by city authorities, who also derived income from rents on city land. The state however protected its own position by limiting the powers of local authorities, including their ability both to raise taxes and to spend them. Local taxes always took second place to ensuring payment of imperial taxes (Burton 1987,435-8).

The tax system underwent substantial changes in the third century AD, when military crises and repeated debasements of the coinage led to increased use of exactions in kind. At the end of the third century, the restoration of political control led to the institutionalisation of taxation in kind, within a different framework of provincial administration (Burton 1987,429).

The changed system introduced by Diocletian consisted of a poll tax (<u>capitatio</u>) and a land tax (<u>iugatio</u>). the <u>iugum</u> was a measure of land, assessed according to its quality and use, and the <u>capita</u> assessed people and animals on a scale of equivalences, which varied in different parts of the Empire. Initially the two were separate, the capitatio being collected in cash and the iugatio in kind. After 311 AD, the two were combined.

This combined system applied in Asia, but is known not to have applied to Egypt, Africa and parts of Gaul. Liebeschaetz (1987,463) suggests that land tax and poll tax remained separate in the western European provinces. There is some information on the form of taxation in Gaul (Jones 1974,287-8). Land was assessed in capitulum, a local standard unit, and a poll tax (capitatio plebeia) was levied on men and women within a certain age range. It is not known if this was levied on urban as well as rural populations. One example of a land survey and tax assessment survives (Dilke 1971,159-177). In some of the Gallic provinces, the landowner was responsible for collection of both taxes from his tenants; in others, the poll tax was kept separate. Where it was separate, the poll tax may have been paid in cash. One important implication of this change is the greatly increased level of supervision of the collection of tax in kind. Liebeschaetz describes it as "a bureaucratic exercise without parallel in the early Empire" (1987,462).

The system in Britain is likely to have been closer to the Gallic system than the iugatio and capitatio system. One of the very few Roman legal documents referring directly to Britain relates to tax collection. Dating from 319 AD, it states that a decurion was liable to pay tax on his own land, whether held by himself or let to coloni, but not liable for the obligations of another decurion in the same town (Stevens 1947,132; Stevens' interpretation of this in terms of 'Celtic law' appears to be pure speculation).

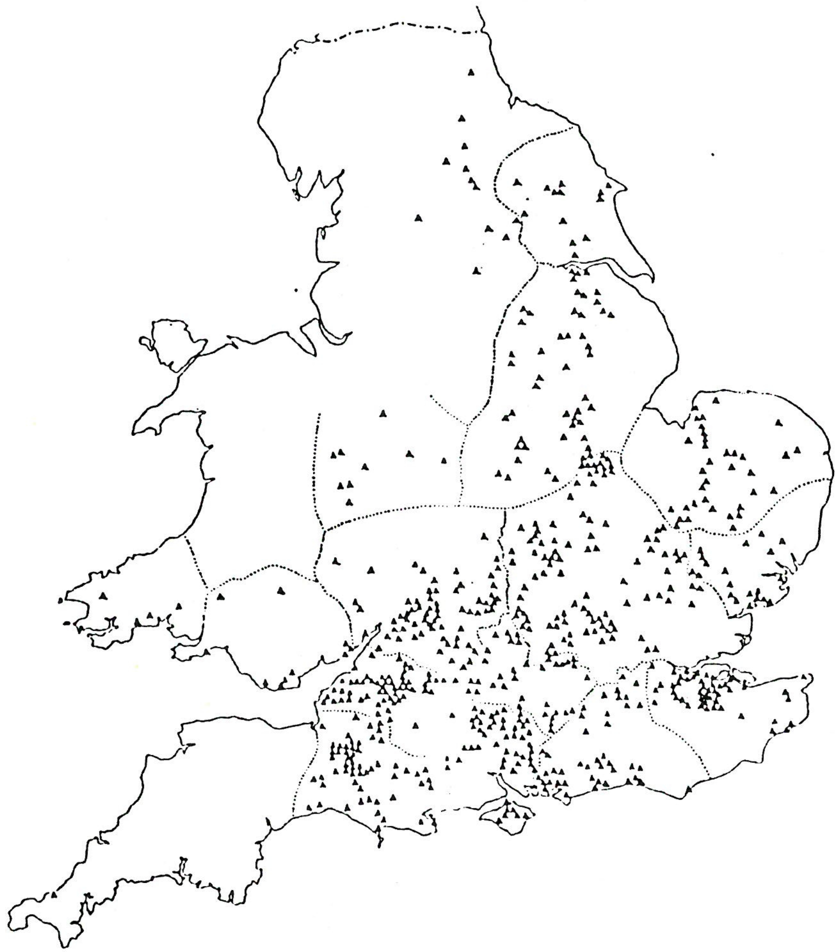
10.5. The social and economic context of the Romano-British villas.

It is reasonable to argue that social and economic development in Roman Britain will have been influenced by the pre-existing social structure of the Iron Age as well as by changes during the Roman occupation. One area where this has received considerable attention is in the social context of the villas. Such considerations are relevant to the development of the agricultural economy. Patterns of labour, investment and market orientation can be expected to have differed between a villa farmed as a estate by a single owner, and a villa which existed as the combined holdings (essentially family farms) of a celtic kin group, as envisaged in Smith's model for the unit system villas.

Steven's (1966) paper relating regional variation in villa wealth to the two main tenurial systems of mediaeval Wales has been very influential (eg Percival 1976, 139-144). But recent work by Davies on the early Welsh documents (see Chapter 9.2.3) calls this interpretation strongly into doubt. Some other criticisms can also be made. As Stevens acknowledged (1966,127), the pattern identified relates chiefly to the fourth century, and this seems a poor basis for inferring differences based on pre-Roman conditions. But a major influence on the pattern of villas and wealthy villas seen derives from the distribution of building materials. The correspondence, in southeast Britain, between the distribution of villas and the use of either stone or chalk and flint in vernacular buildings is striking (see Figure 10.1). Dunnett has commented on the problems in recognising villas in Essex and Suffolk because of the lack of stone buildings (1975,94). Because of the costs of transport, the local availability of stone must be considered in assessing the input of wealth involved in villa construction. Isolated bath houses, regarded as significant in Stevens' model,

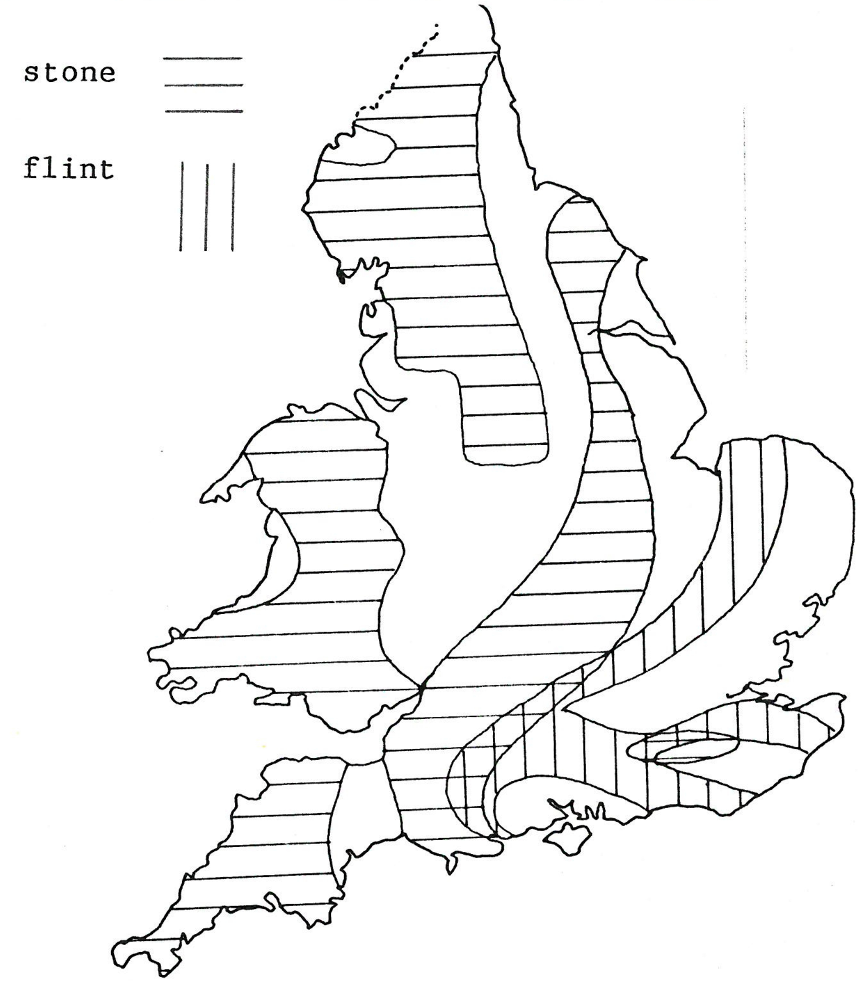
Figure 10.1. Building materials and the distribution of villas.

a. Distribution of villas in Roman Britain.



Source: Rivet 1969, Fig. 5.6.

b. Walling materials used in vernacular buildings



Source: Brunskill 1971, 173-5.

may well be a product of the local scarcity of building stone. [Aisled buildings may show a similar relationship with the availability of timber: Hadman 1978, 189.]

The second element in Stevens argument was the distribution of strip fields. The association of strip fields with a particular type of tenure seems unconvincing (see Chapter 9.2.3); a relationship with cultivating techniques seems more likely.

However, work by J.T. Smith has also stressed the 'celtic' aspect of many villas in Britain. His discussions focus on two main aspects, the aisled buildings usually described as barns, and the recognition of 'joint proprietorship' from the plans of a number of villas.

There are a number of problems in accepting Smith's interpretation of aisled buildings. Smith (1964) argued that the aisled buildings served the similar functions of courthouse and communal dining room to the mediaeval hall, with some living accommodation. He suggested they derived from the longhouse tradition, combining living accommodation and cattle housing. Applebaum extended the argument, asserting that "if there is to be a recognisable form of the kinship group's joint dwelling, it should be the independent self-contained aisled farmhouse" (1972, 45-50).

If these buildings do derive from longhouses of northern Europe, this is an obvious innovation. Evidence for such structures is absent from Iron Age Britain (Chapter 5). Applebaum's suggestion (1982,445) of the "aisled barracks" of the fifth century BC at Crickley Hill as their (sole) British antecedent is unconvincing. Todd (1973,88) suggests these buildings are "best viewed as an insular development of the Roman period". However, the earliest aisled building at Gorhambury (<u>Current</u>

Archaeology 8,1983,117,120) appears to be pre-conquest. Morris' study (1979) found little to suggest use for cattle; the strongest evidence for use related to cereal processing (see Chapter 5 above for discussion). Early villas in Britain, Percival notes, "had already shaken off the influence of the hall", and were, excepting the early rich villas, "simple corridor villas" (1976,95,135). One problem with their interpretation as a hall is the general lack of hearths: Smith found only 2 or 3 out of 30 buildings considered, yet notes that "every hall must have been heated" (1964, 25-7). The type was an "ideal multipurpose unit, easy and cheap to erect and extremely adaptable", and a variety of industrial as well as agricultural uses are known (Hadman 1978,192-4). It seems dubious to use a structural type as an indicator of social and tenurial relationships in the way Applebaum (1972,50) does.

Smith's concept of 'unit system' villas, consisting of "two or more houses .. laid out carefully in relation to one another, without, originally, being joined together" was described in 1978, and expanded in a series of articles on individual sites since. These villas, he argues, "embody the kind of social relations characteristic of celtic society, which were based on the kindred or extended family" (1978, 162,170).

I have examined the published evidence from a few of these sites in detail, incorporating evidence on dating and status where possible. Smith's analyses rest heavily on the plans of the buildings, not least because in so many early excavations little additional information was recovered (1978,149). For reasons of space the detailed discussion is omitted here. But in the cases examined, the interpretation of contemporary and equivalent units is not well supported and is difficult to accept. At Beadlam, the domestic west building appears to have been downgraded during its later occupation while the reverse was true of the north building (Stead 1971, 180,182,184), which despite changes including the insertion of a mosaic floor in one room during its last phase, seems to have remained mainly agricultural in use. The two domestic buildings at Thisleton Dyer are part of a larger complex of buildings, described by Todd (1978, 207) as "a considerable settlement of late Roman date". They are published only in interim form (Journal of Roman Studies 1957,212; 1958,138; 1960,224; 1961,175,Fig.22). But they are clearly different in date, one being second century with third century additions, and the other early fourth century. At Gayton Thorpe, Smith's assertion that the buildings were "comparable in social standing" (1978,153) appears unconvincing when the occurrence of hypocausts, types of flooring and small finds are compared (details from excavation report: Atkinson 1929). The south building may have had the impressive facade Smith notes, but Atkinson noted that, except for the frontage, the masonry of the south building was inferior to that of the north building. There is a strong impression of a marked difference in status between the two.

The differences in status and date cast doubt on Smith's interpretations. Even where apparent duplication of facilities exists, because of the early date of many villa excavations, evidence that they served similar domestic functions is lacking. This point is also made by Wightman (1985,110-111), discussing evidence for duplication of the main rooms in early villas in Belgic Gaul. It is a common feature of agricultural areas that one generation's farmhouse is the next's outhouse (cf. Branigan 1982,93).

One problem with Smith's work is that while in his 1978 paper it is the replication of facilities that leads to the inference of this form of celtic kin group/joint proprietorship, in later papers (1980,1985) differences are regarded as to be expected. He notes that "it is characteristic of such division that the two parts of the holding are unequal and they commonly have houses of different type and size" (1980,67). If architectural arguments are to be used as a key to social structure, surely an essential assumption is that social structures are reflected in architectural forms in a consistent manner, that is, that residential groups supposedly similar in status should occupy similar structures. Smith asserts that "social reasons are the prime determinants of architectural form" (1985,347), yet he offers no explanation of the social reasons for his related family units occupying such different homes as the diverse buildings in the Barnsley Park north, central and south yards.

Again details of the consideration of these sites is omitted. At Rapsley (Hanworth 1968; Smith 1980) the site seems more readily interpretable in terms of the separation of residential and ritual elements from agricultural, industrial and subsidiary living accommodation. There is a clear distinction between the large rectangular building 1, entirely rebuilt once and with evidence for some agricultural uses, and building 6, which developed piecemeal through additions and modifications, and included only domestic accommodation and a bath suite.

The reinterpretation of Barnsley Park (J.T.Smith 1985; rebutted by Webster and L.Smith 1987) was referred to in the discussion of livestock housing in Chapter 5. One problem here is that neither Smith's interpretation of the circular stone structures in terms of houses nor Webster and L.Smith's interpretation of them as pens (1982,80,89) has a particularly strong basis, as comparisons with the stone build houses and yards of

Romano-British settlements in Northumberland (eg Jobey 1973) show. The nature of the excavation reports makes assessment of some of the points difficult. This type of publication - with interpretative plans but little of the evidence of which they were based - seems inadequate. But the round stone structures and the rectangular building described by Webster as a barn and Smith as a hall, do seem better interpreted as primarily agricultural in use. The dual occupation of the main building seems to be assumed rather than demonstrated by Smith (1985,347). Webster and L. Smith's interpretation of the building as a central 'business' area, with a domestic wing to the south and a "service wing" with bath suite to the north (1987, 83-7) remains more convincing.

Smith (1987) interprets the villa at Ironmongers Piece, Marshfield (Blockley 1985) as demonstrating the "social transformation" from a building adapted for two to four households into the "house of a landed proprietor" (1987,254-5). He suggested that each heated room was occupied by a family; yet the difference between the ovens in two rooms and fireplaces in the other two surely reflects differences in function. He disputes Blockley's account of the phases of the building's development, asserting that "the resultant problem posed by the pottery is for others to resolve" (ibid, 247). The dating evidence seems to argue strongly against his reinterpretation, based largely on the location of a single stone (ibid, Fig.3). Assessment of the evidence for use suggests that the building can reasonably be interpreted as a north end characterised by higher status domestic use, and a south end with agricultural, service and subsidiary domestic use.

Smith's reanalyses of villa plans fail to convince, especially when data on status, date and function can be added. While some villa plans can be interpreted in terms of this kind of subdivision, there is little in the way of evidence for duplication of function and status to suggests that they should be. But Smith's attempts to understand the social and economic relationships within Romano-British agricultural economy are interesting and serve to draw attention to a significant gap in current understanding.

There are some interesting indicators to the social role of villas. The well-known differences in the occurrence of mosaics is one. There were two main periods of mosaic production in Britain, the later second century and the period from just before 300AD (D.J.Smith 1969, 78-9). As Smith notes (ibid,72), mosaics should probably be viewed as much as status symbols as private amenities. In the intervening period, the locus of display shifted. In the second century, the bulk of the mosaics were laid in town houses (Smith 1969,77-8; Johnson 1987,15,26-7,Fig.1). This in itself was a change from the first century, when elaborate townhouses were rare (Walthew 1975) and most of the few non-military mosaics were from rural buildings (Johnson 1987,14-5). The late third/early fourth century revival in mosaic production coincided with a period of construction and improvement in villa buildings. Branigan comments that "in the early fourth century landowners who had previously lived in town houses and visited their villa estates reversed the habit" (1973,126).

This raises some interesting questions. Wealth is of course not necessarily displayed where it is accumulated, and Greene has pointed out that wealth gained in commercial activity was often invested in "land and other 'respectable' pursuits" (1986,89). He suggests that the owner of numerous estates would erect a "sumptuous building" at "a pleasant place to spend time" rather than because the particular villa was especially profitable. The problems in relating villa buildings to the economic position of the farming unit are also stated by Branigan (1982,94-5). But numerous villas of this period also saw investment in ranges of stone buildings, apparently agricultural in use. And there is also the evidence for developments in agricultural tools. There seem to be two categories of innovation in the Roman period: introductions of existing Roman types (the type Ia scythes, iron pitch fork tips and spade shoes) and the development of new types during the period (the long type Ib scythes, and the asymmetric winged shares and the bar share and coulter 'sets'). The latter appear to originate in Britain during the later third or fourth centuries. The mosaics may represent not only the elaboration of villa houses but also a period of investment in agricultural production and the development of new agricultural technology.

Features such as the appearance of mosaics in aisled buildings and Smith's workhalls may reflect related changes in the socio-economic context of agriculture, perhaps especially the increased administrative responsibilities devolving on landowners as a result of the introduction of tax in kind. Mosaics in these contexts display the landowners wealth and status; they need not be seen as a domestic amenity. The late fourth century second "dining suite" at Chedworth (Goodburn 1976,23), with its adjacent store room and dias could readily be interpreted in this way. Smith's workhalls (1978,153) can be interpreted in terms of both agricultural usage, and use for business activities, involving the payment of rents and taxes.

These arguments are clearly compatible with Reece's "alternative structure for the province, based on the villa and village" rather than towns (1980,78). It is not intended here to comment on Reece's views on the towns themselves, except to note that the finds of the large agricultural tools in the walled towns and the continuing prosperity of the villas suggest that towns functioned as a source of agricultural inputs and also presumably destination for agricultural produce.

Rivet (1969,200) argued that the construction of villas occurred only when towns were sufficiently well established to provide markets which allowed "capitalist farming". But there is also a converse side to this. The importance of estate production for the development of a market economy has been stressed by Brumfiel and Earle (1987,6). Because estates form a reliable source of supply, they make dependence on the market as the source of supply of subsistence goods possible. The development of estate production and the market economy during the first two centuries AD in Britain may have been closely related.

It was suggested above that some steps towards private land ownership and production for sale were developing in some areas during the later Iron Age. The ability to gain access to labour and move beyond purely household production may have been involved. But there seems to be no significant evidence (except possibly at Camulodunum) that Iron Age elites at the higher levels were themselves involved in agricultural production. The rich early villas may in some cases have belonged to the British elite, as Rodwell argues for Rivenhall (1978,15) and Cunliffe suggests for Fishbourne (1973,82). Todd notes that the early rich villas are all located close to good harbours and suggests a "preoccupation with commercial activities" (1978,201). It is by no means clear they should be regarded as the centres of agricultural estates. Even where their wealth was based in land, the elite may have derived their wealth and position from tributes and rents rather than direct management of their land.

The appearance of wealthy later third and fourth century villas perhaps represent a new development: the elite coming to regard themselves, as in the traditional Roman model seen in writings of the early Roman agronomists, as not just landowners deriving income from rents and tributes, but as 'gentleman farmers' overseeing and deriving profits directly from their own large estates. Reasons for this can be suggested speculatively; the inflation of the third century and the development of the market economy could have provided the incentives.

There are two key issues here: the development of estate as opposed to household agriculture, and the extent to which the social elite were directly involved in agricultural production. Both questions are important in understanding the organisation and socio-economic context of Romano-British agriculture, but they have been raised rather than resolved in this discussion.

Chapter 11.
Conclusions.

11.1. Evaluation of the approach taken.

This thesis has two main aims - the investigation of agricultural systems and agricultural change in later prehistoric and Roman Britain, and consideration of ways in which agricultural systems can be described and examined. A basic premise is that agricultural systems are defined by their organisation as well as their practices, and that, when they are considered in ways that take this into account, the evidence for agricultural production forms a potentially valuable source of information on socio-economic organisation and its development.

A number of difficulties can be acknowledged. The broad scope, chronological and geographical, and in terms of the range of specialisms within archaeology, raised a number of problems. In order to amass information on agricultural practice, data from various parts of Britain were used. Nevertheless, the work is heavily biassed towards southern Britain, and consideration of questions of agricultural organisation is essentially limited to that area. A wide time scale was considered necessary if questions of change were to be treated adequately (see Chapter 1.2), but this resulted in some unevenness in coverage. The approach to agricultural systems taken implies that virtually any aspect of settlement, economy and social organisation can be taken as directly relevant to the organisation and socio-economic context of agriculture. The limits to the work were therefore difficult to define.

One particular difficulty is that of a non-specialist reviewing specialist reports across a wide range of specialisms relating directly or indirectly to agriculture. This is an inevitable outcome of taking a broad approach to the subject. Simply accepting specialist summaries of the state of knowledge was often not considered to be adequate, perhaps primarily because the questions answered in these were often not those posed by taking a wider perspective on the subject. The frequent 'marginalisation' of much specialist data was also noted; excavation reports with substantial sections on, for example, pottery and metalwork, sometimes had only brief outlines of the information on plants and animals. Again, priorities in excavation failed to emphasise agricultural themes, some substantial settlement excavations being accompanied by only one or two short sections through field banks or lynchets claimed to be associated with the occupation. This was often still the case when the 'landscape' aspects of the sites were stressed in the reports. The lack of consensus in the literature about many key social and economic questions meant that these also required discussion.

Despite these problems, it is argued that the broad approach offered the chance to make connections and to consider the interrelationships between the different aspects of the agrarian economy in a way which more detailed consideration of limited aspects would not have done.

The approach to the evidence for agriculture took the form of defining an eight part framework to describe agricultural systems. The reasoning behind this was that the lack of a clear concept of what constitutes an agricultural system and of a framework for analysis of agriculture in its economic context was limiting the information which could be obtained from the increasing quantity of data available about agricultural practice. In addition, it also offered a initial framework for structuring the research.

The framework was based on preliminary reading, chiefly in economic anthropology and studies of peasant agriculture. Two main considerations influenced the choice of categories used. The intention was to use criteria relevant to the functioning of agricultural systems rather than to the archaeological evidence as it survives, and to avoid categories suggested by the nature of the archaeological evidence, as these would tend to channel and restrict the scope of the discussion. In this way it was hoped that the different classes of archaeological evidence could be more constructively integrated.

The eight aspects had then to be interpreted in terms of the archaeological record. The directness with which they can be recovered archaeologically varies greatly. Some of them are, at least potentially, directly recoverable from from the results of excavations of agricultural settlements; others may be less directly inferred from the results of fieldwork or excavation, while others demand a wider range of social and economic evidence. The eight elements were listed in Chapter 1.1, and in Table 11.1A, where they are grouped according to the way in which they relate to the archaeological record. The different nature of the categories reflects the underlying premises - that an agricultural system is defined by its organisation as much as its practices, and that it can only be described adequately if it is described with reference to its social and economic context.

To an extent the work has followed this framework, and I think that the reasoning behind the approach has been justified. By assessing questions deriving from the needs of agricultural systems rather than constructing summaries based within existing categories of archaeological data, more information about agricultural practice has been drawn from the data available, and it has been possible to break down the somewhat static view of later prehistoric agriculture which prevails in much of the literature. This is summarised below, in section 11.2.

In some of the categories, there has been detailed investigation of the data about agriculture, either because the relevant information has not previously been assembled or assessed, or because previous work was felt to be inadequate, or not to address the questions considered here. The coverage of the various elements has therefore been uneven; this was often a necessity imposed by the nature of the evidence available rather than a reflection of the importance attached to them.

One difference from the original scheme has been in the area of decision models. The initial aim of fitting models of agricultural decision making to the data has been abandoned. There are several reasons for this. The lack of consensus on a wide range of social and economic questions of the period raised questions as to the wisdom of attempting to apply any sophisticated models to a highly insecure base. But the most important reason has been a reassessment of the applicability of models originating chiefly in discussions of peasant societies to the societies of later prehistory. These models tend to emphasise individual decision making, and carry a range of socio-economic assumptions related to the economic context of peasantry as a class. Their relevance to the prehistoric period and probably to at least the earlier part of the Romano-British period must therefore be in question. For much of the prehistoric period, to view each agricultural unit or household as acting independently of its community may be very unrealistic. Models of decision making at a variety of social scales and of their interactions would instead be required. Decision making at the community level may have been far more important than appears in some discussions based on Eastern European and Third World peasant communities.

Nevertheless, the assumption that agricultural systems exist in the context of individuals and groups taking rational decisions within their given parameters remains an underlying theme throughout the discussion. Decision models are seen as a tool for interpreting the data rather than an end product of the discussion. Some models of decision making were reviewed in Chapter 1, and it is suggested that Lipton's 'survival algorithm' concept, based on 'satisficing' models, provides a flexible and useful framework for assessing productive decisions, and also for accounting for variation between individuals sites.

Similarly two other categories have received less attention than their place in the original framework might suggest. These are population and labour, and investment. Population was discussed briefly, and the reasons why it is not regarded as a 'prime mover' in agricultural change were outlined. Population change has been regarded here as a social variable requiring explanation in the same way as any other such factor. In terms of the Iron Age and Romano-British period, the poor data base (due to the lack of a recoverable burial rite for most of the Iron Age and the practice of cremation in some areas in the later Iron Age and most of the Romano-British period) limits the potential of population as a source of information during this period. There has been some discussion of aspects of population, and assessment of some attempts to construct the population models of later prehistoric agrarian communities. But the topic has not been given the attention its importance would have merited if the data base had been adequate. It has kept its position in the revised framework for defining agricultural systems. Investment, particularly in the context of agricultural tools, has been subsumed in the sections on tools and techniques, and on the development of markets and specialisation in manufacture.

The eight part framework proved useful in providing a structure for analysis which allowed the agricultural questions to take priority over the nature of the archaeological evidence. Using the experience gained from this work, a modified framework for describing agricultural systems (Table 11.1B) can be suggested.

The structure and scope of the work resulted in a somewhat circular process, with work on one of the aspects considered inevitably raising questions and problems related to others. This was felt to be an advantage, as it led to increased understanding of the different aspects and their interrelationships, but it also resulted in the work continuing to generate problems and questions throughout. For this reason many of the conclusions outlined below are still very much hypotheses.

11.2. Some inferences about agricultural change in later prehistoric and Roman Britain.

The detailed work on agricultural practice has argued that later prehistoric agriculture shows more change and development than is often assumed, and that it is necessary to move away from the idea of a later prehistoric agriculture whose basic parameters were set as early as the early/middle Bronze Age.

One important conclusion was the distinction drawn between a middle/late Bronze Age agricultural 'package' from a different sort of system which seems to have developed in southern Britain during the earlier part of the Iron Age. The Bronze Age 'package' was based on small field groups clustered around settlements, and fertility

Table 11/1.
The eight part framework for defining agricultural systems

A. The original framework.

1. Technology; tools and the ways in which they are used.
2. Plant and animal species exploited.

3. Fertility maintenance methods, and the organisation of land use.
4. Labour needs and population levels.
5. Level and type of investment.

6. Relationships between subsistence and surplus production.
7. Economic demands or constraints; rents, taxes, and the autonomy of the productive unit.
8. Decision framework.

B. The revised framework.

PRACTICE:	1. Tools and techniques.
	2. Plants and animals.
	3. Fertility maintenance.
ORGANISATION:	4. Land holding and the organisation of land use.
	5. Labour and population.
	6. Provision of social insurance.
CONTEXT:	7. The movement of produce - sales and purchases.
	8. Economic demands - tax and tribute.

maintained by manuring the fields. The evidence for trackways, byres and pens suggests that this was made possible by regular movement of animals into the settlements, perhaps every night.

The new 'package' evolving during the Iron Age involved the layout of linear boundaries and extensive fields groups. The evidence for manuring is limited - although the problems in recognising manuring in this period because of poor pottery survival must be noted. But it may be a true reflection of agricultural practice, as supporting evidence in the form of signs of livestock management allowing manure collection is virtually non-existent for most of the Iron Age. Agriculture in this period may be characterised by separation rather than integration of its arable and livestock components. Manuring could have been replaced by folding animals onto the arable or grazing fallow, but evidence for this will be difficult to acquire. Sheep folding could have been based on temporary hurdle barriers, but a system dependent on grazed fallow would be likely to require effective field boundaries. Bare fallow or ungrazed grass ley may have been the main form of fertility maintenance, especially given the suggestion that soil nitrogen levels declined in the period.

The change seems to involve two key changes in organisation as well as practice. These are the community level regulation of arable land (implied by the arable field systems), and the provision of 'social insurance' (inferred from the evidence for centralised storage). Centralised storage has received much attention; here it is suggested that it should be seen as a reflection of the centralised organisation of production, and competition between elites or communities to attract adherents on the basis of their ability to ensure the livelihood of their members/followers through the allocation of land, or, in need, produce. It seems likely that this control over arable represents an extension from regulation of pasture; the earlier extensive field systems relate to this. The extension to arable appears to occur in the face of demands for increased production, here considered likely to be primarily socially rather than demographically instigated, which resulted in the earlier small-scale agricultural systems reaching their productive limits. The stresses arising in these small-scale systems may have been heightened by worsening climatic conditions.

It was suggested in Chapter 9 that the definition of a structure of agricultural organisation provides a useful way to investigate these questions. This identifies the aspects of the structure of a society which are concerned with the organisation of agriculture; it is not seen as a distinct 'level' within the social structure of the society. It may be a valuable step towards using the evidence for agriculture and land use in considering more general questions about a society. It may be particularly useful in considering differences between different areas or environmental regions in Britain, as different elements in the social structure can be emphasised in agricultural organisation depending on the nature of the landscape and the distribution of agricultural resources.

This work has given little attention to factors such as climate and environment, not because they are felt to be unimportant, but because they are not seen as complete explanations in their own right. Even when these factors are crucial, their effects are mediated through the social and economic organisation of the agrarian communities. It is through understanding this socio-economic context, as well as the limitations and potentials of the agricultural systems themselves, that the effects and importance of these essentially external factors can be understood.

Further developments occurred during the Iron Age. One important one is the increased use of heavier soils, and the development of ploughing and drainage techniques necessary to allow it. These soils are harder to work, but more fertile and robust, and it is probably in the context of a desire to increase production rather than pressure to utilise less favoured soils that this development should be seen.

Major changes seen in some areas towards the end of the Iron Age seem to imply the reintegration of the arable and livestock elements of the economy. The appearance of droveways and livestock enclosures suggest a concern with management of livestock to allow manuring. The short-handled scythes/slashing tools and the indications that fodder crops could have been cultivated also suggest change in this area. The view that manuring was of limited significance during most of the Iron Age implies that with its introduction, the potential for increased productivity would have been considerable. The changes may result from increased opportunities to benefit from increased production. The social context of these changes may be interesting. It was suggested that the new types of sites such as Barton Court Farm and Odell may belong to a low level in the elite hierarchy, reflecting the ability of their owners to assert increased access to land and increase their production. Events after the conquest, when both sites became 'villas', but not until later in the Roman period, may reflect this status. If this interpretation is correct, these sites may also represent the beginnings both of private rights to land and, if the changes involved the ability to exploit directly the labour of others, of agricultural production at a level other than that of the household farm.

It can be argued that the later Iron Age saw a shift in the basis of elite power, from a role based on management of agricultural resources to the ability to manipulate imported goods. The ability to obtain these goods might allow the maintenance of a following without the need to fulfil an administrative and redistributive role in agricultural production, and would provide the incentive and opportunity to divert increasing proportions of produce received as tribute out of the community and into external trade. The evidence for direct involvement in production by those at the higher levels in the elite hierarchy is limited; Colchester is possibly a single exception. As suggested above, lower levels in the hierarchy may have been able to exploit their position to increase their productive involvement.

The Romano-British period saw changes in agricultural practice and organisation. In agricultural practice, new tool types (scythes and the winged ploughshares) were introduced, and longer fields also seem to have been an early introduction. But several introductions appear to have been developments occurring within Britain towards the end of the period (the longer scythes, and two developments in plough technology, bar shares used with coulters and asymmetric winged shares). Field drainage appears to have continued to increase in importance. The evidence suggests a marked increase in the use of manuring; this derives from both sherd scatters and the appearance of droveways, pens and enclosures, especially around villas. The manuring evidence also points to the cultivation of large estates, with increasing signs manure was moved over considerable distances from farmyards to fields. The direct cultivation of large estates of production can be regarded as a major innovation.

The Roman concept of the aristocrat as not only landowner but as working farmer of his estates may have been a declining ideal in Italy, but a powerful new reality in Roman Britain. Estate scale production may have provided the incentive for the development of and investment in new types of large iron tools, and a key factor in the development of a market economy in the later Roman period.

11.3. Some concluding points.

Three general points can be stressed. Firstly, there is more change within both later prehistoric and Romano-British agriculture than the static view widely seen in the literature suggests. Some of the often implicit assumptions made about agriculture and agricultural change during this time have tended to obscure this.

Secondly, agricultural changes should not be viewed in isolation, either from other elements in the agricultural system or from its socio-economic context. Changes can be related to the social and economic context of agriculture and to the dynamics of agricultural systems themselves. Essentially exogenous factors (climate, invasion, population growth seen as an independent variable) act through these media, and if considered in isolation from them can offer only incomplete and inadequate explanations for the changes seen.

This, thirdly, in turn implies that the organisation of agriculture can be seen as an important source of social and economic information about past societies, with the reconstruction of a structure of agricultural organisation seen as an important step in inferring social organisation from the nature and distribution of settlement. The 'structure of agricultural organisation' is defined as a tool for analysis, and not as a distinct element in the organisation structure of a society.

It is argued that the approach taken has increased understanding of both agricultural practice and agricultural organisation, and has enabled the identification of and offered explanations for some patterns of change. Agricultural systems are seen to be defined by all three aspects - their practices, their organisation and their context.

The thesis has also dealt with some questions about how the evidence available is to be interpreted, and has suggested areas where a more rigorous approach to the data is needed. It is argued that a wide ranging and structured approach emphasising the functioning of agricultural systems rather than the nature of the archaeological record does allow more valuable information to be drawn from the data. With the increasing volume of often marginalised information about the various aspects of agriculture, this seems to be an important point. Data are worthless if they cannot be used.

The work has inevitably left numerous questions unresolved, and has raised others it has not been possible to follow up. The emphasis on agriculture in its social and economic context, as the central element in the productive economy, stresses that it is not a fringe area but potentially a very informative source of socio-economic inference. The potential for examining the archaeology of a particular region of Britain in these terms appears to be considerable, integrating detailed information about agriculture and socio-economic factors at the level of individual sites. It is suggested that the work in this thesis would provide a basis for such further investigation of these complex and crucial relationships.

This work has generated some broad hypotheses (the 'conclusions') about the nature of agricultural systems and agricultural societies and change in them through time; it has provided a body of detailed information on agricultural practice, deriving from both the past societies studied and comparative data from other sources; and it has suggested a framework for integrating the varied classes of data and approaching these important aspects of the past.

BIBLIOGRAPHY

Aberg, F.A., and Bowen, H.C., 1960. Ploughing experiments with a reconstructed Donnerupland ard. Antiquity 34, 144-7.

Aitken, R., 1956. Virgil's plough. Journal of Roman Studies 46, 97-106.

Alexander, M.J., and Roberts, B.K., 1978. The deserted village of Low Buston, Northumberland: a study in soil phosphate analysis. Archaeologia Aeliana, Fifth Series, 6, 107-116.

Allen, D., 1967. Iron currency bars in Britain. Proceedings of the Prehistoric Society 33, 307-335.

Allen, D.F., 1976. Wealth, money and coinage in a celtic society. In J.V.S. Megaw, (ed), To illustrate the monuments, 199-208. London.

Allen, L., 1982. A study of the chronological development of the Bishopstone lynchet by least squares analysis of the distribution of datable artifacts. Sussex Archaeological Collections 120, 207-8.

Allen, M.J., 1988. Archaeological and environmental aspects of colluviation in south-east England. In W. Groenman-van Waateringe and M. Robinson, (eds), Man-made soils, 67-92. British Archaeological Reports International Series 410.

Anstee, J., 1967. Scythe blades of Roman Britain. The Countryman, Winter 1967, 365-9.

Applebaum, S., 1972. Roman Britain. In H.P.R. Finberg (ed), The Agrarian History of England and Wales, Volume I.II A.D. 43-1042, 3-277. Cambridge.

Applebaum, S., 1975. Some observations on the economy of the Roman villa at Bignor, Sussex. Britannia 6, 118-132.

Applebaum, S., 1982. Land tenure and politics in fifth century Britain. In D. Miles, (ed), The Romano-British countryside, 433-449. British Archaeological Reports British Series 103.

Arnold, C.J., 1972. The excavation of a prehistoric ranch boundary at Quarley Hill, Hampshire. Proceedings of the Hampshire Field Club and Archaeological Society 29, 37-40.

Arnold, D.E., 1978. ceramic variability, environment, and culture among the Pokom in the Valley of Guatemala. In I. Hodder, (ed), The spatial organisation of culture, 39-59. London.

Arthur, J.R.B., 1963. Carbonised grain and seeds from the corn-drying oven. In P.A. Rahtz, A Roman villa at Downton, 328. The Wiltshire Magazine 58, 303-.

Arthur, J.R.B., 1977. The plant remains. In M. Bell Excavations at Bishopstone, 273-5. Sussex Archaeological Collections 115.

Ashbee, P., Smith, I.F., and Evans, J.G., 1979. Excavation of three long barrows near Avebury, Wiltshire. Proceedings of the Prehistoric Society 45, 207-300.

Ashdown, R., and Evans,C., 1981. Animal Bones. Part 1. Mammalian Bones. In C. Partridge, Skeleton Green, 205-235. Britannia Monograph Series, 2.

Asingh, P., 1987. Diverhøj. The excavation of a complex burial mound and a Neolithic settlement. Journal of Danish Archaeology 6, 130-155.

Atkinson, D., 1929. The Roman villa of Gayton Thorpe. Norfolk Archaeology 23, 166-209.

Austin, D., 1976. Fieldwork and excavation at Hart, Co. Durham, 1965-1975. Archaeologia Aeliana, Fifth Series, 4, 69-132.

Avery, M., 1968. Excavations at Meare East. Somerset Archaeology and Natural History 112, 21-39.

Bakels, C.C., 1984. Carbonized seeds from northern France. Analecta Praehistorica Leidensia 17, 1-27.

Baker, J.R., 1984. The study of animal diseases with regard to agricultural practices and man's attitude to his animals. In C. Grigson and J. Clutton-Brock, (eds), Animals and archaeology 4. Husbandry in Europe, 253-7.

British Archaeological Reports International Series 227.

Baran, L., 1973. Transport in Czechoslovakia as an ethnographical and social phenomena. In A. Fenton, J. Podolakj and H. Rassmussen, (eds), Land transport in Europe, 57-89. Copenhagen.

Barber, K.E., 1982. Peat-bog stratigraphy as a proxy climate record. In A.F. Harding, (ed), Climatic change in later prehistoric Britain, 102-113. Edinburgh.

Barclay, G.J., and Fairweather, A.D., 1984. Rye and ergot in the Scottish later Bronze Age. Antiquity 58, 126.

Barker, G., and Webley, D., 1977. An integrated economy for Gatcombe. In K. Branigan, Gatcombe Roman villa, 198-200. British Archaeological Reports British Series 44. Oxford.

Barrett, J., 1980. The pottery of the later Bronze Age in lowland England. Proceedings of the Prehistoric Society 46, 297-320.

Barrett, J., and Bradley, R., 1980. Later Bronze Age settlement in south Wessex and Cranbourne Chase. In J. Barrett and R. Bradley, (eds), The British Later Bronze Age, 181-208. British Archaeological Reports British Series 83.

Barrett, J., Bradley, R., Bowden, M., and Mead, M., 1983. South Lodge after Pitt-Rivers. Antiquity 57,193-204.

Barrett, J., Bradley, R, Green, M., and Lewis, B., 1981. The earlier prehistoric settlement of Cranbourne Chase - the first results of current fieldwork. Antiquaries Journal 61, 203-237.

Bateson, J.D., 1973. Roman material from Ireland: a reconsideration. Proceedings of the Royal Irish Academy 73C, 21-97.

Beaven, E.S., 1947. Barley. Edinburgh.

Bedwin, O., 1979. The excavation of a cross-dyke at Old Erringham Farm, Upper Beeding, West Sussex, 1976. Sussex Archaeological Collections 117, 11-19.

Bedwin, O., and Pitts, M.W., 1978. The excavation of an

Iron Age settlement at North Bersted, Bognor Regis, West Sussex 1975-76. Sussex Archaeological Collections 116, 293-347.

Behre, K-E., 1976. Beginn und form der Plaggenwirtschaft in Nordwestdeutschland nach pollenanalytischen Untersuchen in Ostfriesland. Neue Ausgrabungen und Forschungen in Niedersachen Band 10. Hildesheim.

Bell, M., 1976. The excavation of an early Romano-British site and Pleistocene landforms at Newhaven, Sussex. Sussex Archaeological Collections 114, 218-305.

Bell, M., 1977. Excavations at Bishopstone. Sussex Archaeological Collections 115.

Bell, M., 1982. The effects of land use and climate on valley sedimentation. In A.F. Harding, (ed), Climatic change in later prehistory, 127-142. Edinburgh.

Bell, M., 1983. Valley sediments as evidence of prehistoric land-use on the South Downs. Proceedings of the Prehistoric Society 49, 119-150.

Bennett, J., 1983. The examination of Turret 10A and the Wall and Vallum at Throckley, Tyne and Wear, 1980. Archaeologia Aeliana fifth series 11, 27-60.

Bennett, J., and Turner, R., 1983. The vallum at Wallhouses, Northumberland: excavations in 1980 and 1981. Archaeologia Aeliana fifth series 11, 61-78.

Beresford, G., 1975. The medieval clayland village: excavations at Goltho and Barton Blount. Society for Medieval Archaeology Monograph 6.

Berrie, A.M.M., 1977. An introduction to the botany of the major crop plants. London.

Bersu, G., 1940. Excavations at Little Woodbury, Wiltshire. Proceedings of the Prehistoric Society 6, 30-111.

Binchy, D.A., 1963. Secular institutions. In M. Dillon, (ed), Early Irish society, 52-65. Dublin. (Reprint).

Binchy, D.A., (ed), 1970. Crith Gablach. Mediaeval and modern Irish series, Volume XI. Dublin Institute for Advabced Studies. (Reprint).

Binford, L.R., 1983. In pursuit of the past. London.
Bloch, M., 1966. French rural history. Translated by J. Sondheimer. London.
Blockley, K., 1985. Marshfield - Ironmongers Piece; an Iron Age and Romano-British settlement in the south Cotswolds. British Archaeological Reports 141.
Bohannan, P. and Dalton, G., 1962. Introduction. In P. Bohannan and G. Dalton, (eds), Markets in Africa, 1-26. Northwestern University Press.
Bonney, D., 1978. Early fields and land allotment in Wessex. In H.C. Bowen and P.J. Fowler, (eds), Early land allotment in the British Isles, 1-2. British Archaeological Reports British Series 48. Oxford.
Boon, G.C., 1978. A comparative list of plant-remains from Caerwent. In G.C. Boon, (ed), Monographs and Collections I. Roman sites, 113-119. Cambrian Archaeological Association, Cardiff.
Boserup, E., 1965. The conditions of agricultural growth. London.
Boswell, J., 1963. Boswell's Journal of a tour to the Hebrides. Edited by F.A. Pottle and C.H. Bennett. London.
Bowden, M., 1982. Molluscan analysis. In S. Ford, Fieldwork and excavation on the Berkshire Grims Ditch, 32-5. Oxoniensia 47, 13-36.
Bowden, M., and McOmish, D., 1987. The required barrier. Scottish Archaeological Review 4, 76-84.
Bowden, P., 1967. Agricultural prices, farm profits and rents. Statistical Appendix. In J. Thirsk, (ed), The Agrarian History of England and Wales IV, 1500-1640, 593-695 and 814-870. Cambridge.
Bowen, H.C., 1961. Ancient fields. London.
Bowen H.C., 1975. Air photography and the development of the landscape in central parts of southern England. In D.R. Wilson, (ed), Aerial reconnaissance for archaeology, 103-118. Council for British Archaeology Research Report 12.
Bowen, H.C., 1975. Pattern and interpretation: a view of the Wessex landscape. In P.J. Fowler, (ed), Recent work in rural archaeology, 44-56. Bradford-on-Avon.

Bowen, H.C., 1978. 'Celtic' fields and 'ranch' boundaries in Wessex. In S. Limbrey and J.G. Evans, (eds), The effect of man on the landscape: the lowland zone, 115-123. Council for British Archaeology Research Report 21.

Bowen, H.C., 1978. Introduction: 'Ancient Fields' since 1961. In H.C. Bowen and P.J. Fowler, (eds), Early land allotment in the British Isles, 1-2. British Archaeological Reports British Series 48. Oxford.

Bowen, H.C., Evans, J.G., and Race, E., 1978. An investigation of the Wessex linear ditch system. In H.C. Bowen and P.J. Fowler, (eds), Early land allotment, 149-153. British Archaeological Reports British Series 48.

Bowen, H.C., and Fowler, P.J., 1962. The archaeology of Fyfield and Overton Downs, Wiltshire. Wiltshire Archaeological and Natural History Magazine 58, 98-115.

Bowen, H.C., and Fowler, P.J., 1966. Romano-British rural settlements in Dorset and Wiltshire. In C. Thomas, (ed), Rural settlement in Roman Britain, 43-67. Council for British Archaeology Research Report 7.

Bowen, H.C., and Fowler, P.J., (eds), 1978. Early land allotment in the British Isles. British Archaeological Reports British Series 48. Oxford.

Boyd, D.A., Cooke, G.W., Dyke G.V., Moffatt, J.R., and Warren, R.G., 1961. The Rothamsted ley-arable rotation experiment. Report of the Rothamsted Experimental Station for 1961, 173-180. Harpenden.

Boyd, W.E., 1982/3. Botanical remains of edible plants from iron Age broch, Fairy Knowe, Buchlyvie, Stirling. Forth Naturalist and Historian 7, 77-83.

Bradley, R., 1967. Excavations on Portsdown Hill 1963-5. Proceedings of the Hampshire Field Club and Archaeological Society 24, 42-58.

Bradley, R., 1971. Stock raising and the origins of the hillfort on the South Downs. Antiquaries Journal 51, 8-30.

Bradley, R., 1975. Field survey in the Lambourn Valley. In R. Bradley and A. Ellison Rams Hill, 171-189. British Archaeological Reports British Series 19.

Bradley, R., 1975. The landscape in its wider context. In R. Bradley and A. Ellison Rams Hill, 190-203. British Archaeological Reports British Series 19.

Bradley, R., 1978. The prehistoric settlement of Britain. London.

Bradley, R., 1978. Prehistoric field systems in Britain and north-west Europe - a review of some recent work. World Archaeology 9, 265-280.

Bradley, R., and Keith Lucas, M., 1975. Excavation and pollen analysis on a bell barrow at Ascot, Berkshire. Journal of Archaeological Science 2, 95-108.

Bradley, R., Lobb, S., Richards, J., and Robinson, M., 1980. Two late Bronze Age settlements on the Kennett gravels. Proceedings of the Prehistoric Society 46, 217-295.

Bradley, R., and Richards, J.C., 1978. Prehistoric fields and boundaries on the Berkshire Downs. In H.C. Bowen and P.J. Fowler, (eds), Early Land Allotment, 53-60. British Archaeological Reports British Series 48.

Brailsford, J., 1948. Excavations at Little Woodbury. Proceedings of the Prehistoric Society 15, 156-168.

Brandon, P.F., 1971. Agriculture and the effects of floods and weather at Barnhorne, Sussex, during the late Middle Ages. Sussex Archaeological Collections 109, 69-93.

Brandon, P.F., 1972. Cereal yields on the Sussex estates of Battle Abbey during the late Middle Ages. Economic History Review, Second Series, 25, 403-420.

Branigan, K., 1973. Town and country. The archaeology of Verulamium and the Roman Chilterns. Bourne End.

Branigan, K., 1977. Gatcombe Roman villa. British Archaeological Reports British Series 44. Oxford.

Branigan, K., 1982. Celtic farm to Roman villa. In D. Miles, (ed), The Romano-British Countryside, 81-96.

British Archaeological Reports British Series 103.
Breeze, D.J., 1977. Review article. Britannia 8, 451-460.
Breeze, D.J., and Dobson, B., 1978. Hadrian's Wall. Revised edition. Harmondsworth.
Brewster, T.C.M., 1963. The excavation of Staple Howe. East Riding Archaeological Research Committee.
Brigden, R., 1983. Agricultural hand tools. Princes Risborough.
Briggs, D., 1977. Soils. London.
Brongers, J.A., 1976. Air photography and celtic field research in the Netherlands. Rijksdienst voor het Oudheidkundig Bodemonderzoek. Amersfoort.
Bronson, B., 1972. Farm labor and the evolution of food production. In B. Spooner, (ed), Population growth: anthropological implications, 190-218. M.I.T. Press.
Brookfield, H.C., 1972. Intensification and disintensification in Pacific agriculture: atheoretical approach. Pacific Viewpoint 15, 30-48.
Brown, D., 1973. A Roman pewter hoard from Appleford, Berks. Oxoniensia 38, 184-206
Brumfiel, E.M., and Earle, T.K., 1987. Specialization, exchange and complex societies: an introduction. In E.M. Brumfiel and T.K. Earle, (eds), Specialization, exchange and complex societies, 1-9. Cambridge.
Brunskill, R.W., 1971. Illustrated handbook of vernacular architecture. London.
Buckland, P.C., 1978. Cereal production, storage and population: a caveat. In S. Limbrey and J.G. Evans, (eds), The effect of man on the landscape: the lowland zone, 43-5. Council for British Archaeology Research Report 21.
Bulleid, A., and Gray, H.St.G., 1911. The Glastonbury Lake Village. Volume 1. Glastonbury Antiquarians Society.
Bulleid, A., and Gray, H.St.G., 1917. The Glastonbury Lake Village. Volume 2. Glastonbury Antiquarians Society.
Bulleid, A., and Gray, H.St.G., 1948. The Meare Lake Village. Volume 1. Taunton.

Burgess, C., 1984. The prehistoric settlement of Northumberland: a speculative survey. In R. Miket and C.Burgess, (eds), Between and Beyond the walls, 126-175. Edinburgh.

Burstow, G.P., and Holleyman, G.A., 1957. Late Bronze Age settlement on Itford Hill, Sussex. Proceedings of the Prehistoric Society 23, 167-212.

Burton, G., 1987. Government and the provinces. In J. Wacher, (ed), The Roman World, 423-439. London.

Caesar, G.J. The Conquest of Gaul. Translated by S.A. Handford. Penguin Books, 1951.

Caesar, G.J. The Gallic War. Translated by H.J. Edwards. Loeb Classical Library. Reprinted 1952.

Campbell, B.M.S., 1983. Agricultural progress in mediaeval England: some evidence from eastern Norfolk. Economic History Review 36,26-46.

Cancian, F., 1967. Stratification and risk-taking: a theory tested on agricultural innovation. American Sociological Review 32, 912-927.

Caseldine, A.E., 1987. Charcoal patches from Meare Village East 1982. In J.M. Coles, (ed), Somerset Levels Papers 13, 222-6.

Cashdan, E.A., 1985. Coping with risk: reciprocity among the Barsarwa of Northern Botswana. Man, New series, 20, 254-274.

Cato, M.P. De agri cultura In Cato and Varro, De re rustica. Translated by W.D. Hooper and H.B. Ash, 1934. Loeb Classical Library, London.

Caulfield, S., 1978. Neolithic fields: the Irish evidence. In H.C. Bowen and P.J. Fowler, (eds), Early Land Allotment, 137-143. British Archaeological Reports British Series 48.

Chambers, F.M., and Jones, M.K., 1984. Antiquity of rye in Britain. Antiquity 58, 219-224.

Champion, T., 1975. Britain in the European Iron Age. Archaeologia Atlantica 1, 127-135.

Champion, T., Gamble, C., Shennan, S., and Whittle, A., 1984. Prehistoric Europe. London.

Chowne, P., 1978. Billingborough Bronze Age settlement: an interim note. Lincolnshire History and Archaeology 13, 15-21.

Christiansen, S., 1978. Infield-outfield systems - characteristics and development in different climatic environments. Geografisk Tidsskrift 77, 1-5.

Clark, A.J., 1977. Geophysical and chemical assessment of air photographic sites. Archaeological Journal 134, 187-191.

Clark, A.J., 1983. The testimony of the topsoil. In G.S. Maxwell, The impact of aerial reconnaissance on archaeology, 128-135. Council for British Archaeology Research Report 49.

Clark, C., 1970. The economic and social implications of population control. In A. Allison, (ed), Population control, 222-237. Pelican Books.

Clarke, A.F., 1982. An excavation of a lynchet south-west of the Heathy Brow Iron Age settlement. In P. Drewett, The archaeology of Bullock Down, Eastbourne, East Sussex: the development of a landscape, 16-21. Sussex Archaeological Society.

Clarke, D.L., 1972. A provisional model of an Iron Age society and its settlement system. In D.L. Clarke, (ed), Models in archaeology, 801-869. London.

Clay, R.C.C, 1927. Some prehistoric ways. Antiquity 1, 54-65.

Close, R.S., Hayes, R.H., and Spratt, D.A., 1975. Romano-British settlements at Crag Bank and Lounsdale, near Kildale, North Riding. Yorkshire Archaeological Journal 47, 61-8.

Colbourne, G.J.N., and Staines, S.J., 1985. Soil erosion in south Somerset. Journal of Agricultural Science Cambridge 104, 107-112.

Coles, B.J., Rouillard, S.E., and Backway, C., 1986. The 1984 excavations at Meare. In J.M. Coles, (ed),

Somerset Levels Papers 12, 30-57.
Coles, J.M., 1987. Meare Village East. The excavations of A. Bulleid and H.St.George Gray, 1932-1956. Somerset Levels Papers 13.
Coles, J.M., 1986. Somerset Levels Papers 12.
Collingwood, R.G., 1931. Roman objects from Stanwix and Thatcham. Antiquaries Journal 11, 37-45.
Collins, E.J.T., 1969. Harvest technology and labour supply in Britain 1790-1870. Economic History Review second series 22, 453-473.
Collis, J.C., 1970. Excavations at Owslebury: a second interim report. Antiquaries Journal 50, 246-261.
Collis, J.C., 1971. Functional and theoretical interpretations of British coinage. World Archaeology 3, 71-84.
Collis, J.C., 1974. A functionalist approach to pre-Roman coinage. In J. Casey and R. Reece, (eds), Coins and the archaeologist, 1-11. British Archaeological Reports British Series 4.
Colson, E., 1979. In good years and in bad: food strategies of self-reliant societies. Journal of Anthropological Research 35, 18-29.
Columella, L.J.M. On Agriculture. Translated by H.B. Ash, E.S. Forster and E.H. Heffner. Three volumes, 1948-55. Loeb Classical Library, London.
Complete Farmer, 1807. The Complete Farmer, or general dictionary of agriculture and husbandry. Fifth edition. London.
Conway, J.S., 1983. An investigation of soil phosphorus distribution within occupation deposits from a Romano-British hut group. Journal of Archaeological Science 10, 117-128.
Cowell, R.W, Fulford, M.G., and Lobb, S., 1978. Excavations of prehistoric and Roman settlement at Aldermaston Wharf 1976-77. Berkshire Archaeological Journal 69 (1977-8), 1-36.
Cowgill, G.L., 1975. On the causes and consequences of

ancient and modern population changes. American Anthropologist 77, 505-525.
Craddock, P.T., Gurney, D., Pryor, F., and Hughes, M.J., 1985. The application of phosphate analysis to the location and interpretation of archaeological sites. Archaeological Journal 142, 361-376.
Craddock, P.T., 1980. The soil phosphate survey at the Newark Road subsite, Fengate. In F. Pryor Excavations at Fengate, Peterborough, England: the third report, 213-5.
Cra'ster, M., 1961. The Aldwick Iron Age settlement, Barley, Hertfordshire. Proceedings of the Cambridge Antiquarian Society 54, 22-46.
Crawford, M., 1970. Money and exchange in the Roman world. Journal of Roman Studies 60, 40-8.
Cribb, R., 1985. The analysis of ancient herding systems: and application of computer simulation in faunal studies. In G. Barker and C. Gamble, (eds), Beyond domestication in prehistoric Europe,. London.
Crummy, P., 1980. Camulodunum. Current Archaeology 7,6-10.
Cunliffe, B., 1971. Some aspects of hillforts and their cultural environments. In M. Jesson and D. Hill, (eds), The Iron Age and its hillforts, 53-69. Southampton.
Cunliffe, B., 1973. The Regni. London.
Cunliffe, B., 1974. Iron Age communities in Britain. London.
Cunliffe, B., 1982. Settlement hierarchy and social change in southern Britain in the Iron Age. Analecta Praehistorica Leidensia 15, 161-181.
Cunliffe, B., 1983. Danebury: Anatomy of an Iron Age hillfort. London.
Cunliffe, B., 1984a. Danebury: an Iron Age hillfort in Hampshire. Council for British Archaeology Research Report 52. London.
Cunliffe, B., 1984b. Iron Age Wessex: continuity and change. In B. Cunliffe and D. Miles, (eds), Aspects of the Iron Age in Central Southern Britain, 12-45.

University of Oxford: Committee for Archaeology Monograph 2. Oxford.

Cunliffe, B., 1988. Greeks, Romans and Barbarians. Spheres of interaction. London.

Curle, A.O., 1935. An account of the excavation on behalf of H.M. Office of Works, of another prehistoric dwelling (No. V) at Jarlshof, Sumburgh, Shetland in the summer of 1934. Proceeding of the Society of Antiquaries of Scotland 69, 85-107.

Curwen, E.C., 1934. A late Bronze Age farm and and a Neolithic pit-dwelling on New Barn Down, Clapham, nr. Worthing. Sussex Archaeological Collections 75, 136-170.

Curwen, E.C., 1938. Early agriculture in Denmark. Antiquity 12, 135-153.

Curwen, E.C., 1941. More about querns. Antiquity 15,15-32.

Curwen, E., and Curwen, E.C., 1918. Covered ways on the Sussex Downs. Sussex Archaeological Collections 59, 35-75.

Dalton, G., 1967. Traditional production in primitive African economies. In G. Dalton, (ed), Tribal and Peasant Economies, 61-80. New York.

Dalton, G., 1977. Aboriginal economies in stateless societies. In T.K. Earle and J.E. Ericson, (eds), Exchange systems in prehistory, 191-212. London.

Davies, W., 1978. An early Welsh microcosm. Royal Historical Society.

Davies, W., 1979. Roman settlements and post-Roman estates in south-east Wales. In P.J. Casey, (ed), The end of Roman Britain, 153-173. British Archaeological Reports British Series 71.

Dennell, R.W., 1974. Botanical evidence for prehistoric crop processing activities. Journal of Archaeological Science 1, 275-284

Dennell, R.W., 1976. Prehistoric crop cultivation in southern England: a reconsideration. Antiquaries

Journal 56, 11-23.

Dent, J.S., 1982. Cemeteries and settlement patterns of the Iron Age on the Yorkshire Wolds. Proceedings of the Prehistoric Society 48, 437-457.

de Paor, M. amd L., 1958. Early Christian Ireland. London

Dickson, R.W., 1805. Practical Agriculture. London.

Dilke, O.A.W., 1971. The Roman land surveyors. An introduction to the agrimensores. Newton Abbot.

Dimbleby, G.W., and Evans, J.G., 1974. Pollen and land-snail analyses of calcareous soils. Journal of Archaeological Science 1, 117-133.

Diodorus of Sicily. Library of History. Translated C.H. Oldfather, 1933. Loeb Classical Library.

Dix, B., 1979. Odell. Current Archaeology 66, 215-6.

Dix, B., 1981. The Romano-British farmstead at Odell and its setting. Landscape History 3, 17-26.

Dixon, P., 1988. Crickley Hill 1969-1987. Current Archaeology 110, 73-78.

Downs, J.F., 1972. The Navajo. New York.

Drew, C.D., 1935. A LBA hoard at Lulworth, Dorset. Antiquaries Journal 15, 449-451.

Drewett, P.L., 1978. Field systems and land allotment in Sussex, 3rd millennium BC to 4th century AD. In H.C. Bowen and P.J. Fowler, (eds), Early land allotment in the British Isles, 67-80. British Archaeological Reports British Series 48.

Drewett, P.L., 1970. The excavation of two round barrows and associated fieldwork on Ashley Down, Isle of Wight, 1969. Proceedings of the Hampshire Field Club and Archaeological Society 27, 33-5.

Drewett, P., 1982. The archaeology of Bullock Down, Eastbourne, East Sussex: the development of a landscape. Sussex Archaeological Society Monograph 1. Lewes.

Drewett, P., 1982. Later Bronze Age downland economy and excavations at Black Patch, East Sussex. Proceedings of the Prehistoric Society 48, 320-400.

Drury, P.A., 1982. An interpretation of the structures. In D.A., Jackson, Great Oakley and other Iron Age sites in the Corby area, 10-13. Northamptonshire Archaeology 17, 3-23.

Dunnett, R., 1975. The Trinovantes. London.

Dyke, G.V., 1964. Why leys? Experimental husbandry 10, 101-111.

Earle, T.K., 1977. A reappraisal of redistribution: complex Hawaiian chiefdoms. In T.K. Earle and J.E. Ericson, (eds), Exchange systems in prehistory, 213-229. New York.

Ehrenreich, R.M., 1985. Trade, technology and the ironworking community in the Iron Age of southern Britain. British Archaeological Reports British Series 144.

Ellison, A., and Rahtz, P., 1987. Excavations at Hog Cliff Hill, Maiden Newton, Dorset. Proceedings of the Prehistoric Society 53, 223- 269.

Ellison, A., and Harriss, J., 1972. Settlement and land use in the prehistory and early history of southern England: a study based on locational models. In D.L. Clarke, (ed), Models in archaeology, 911-962. London.

Evans, A.M., and Jones, M.K., 1979. The plant remains. In G.J. Wainwright, Gussage All Saints: an Iron Age site in Dorset, 172-5. Department of the Environment Archaeological Reports 10.

Evans, E.E., 1970. Introduction. In A. Gailey and A. Fenton, (eds), The spade in Northern and Atlantic Europe, 1-9. Belfast.

Evans, J.G., 1972. Land snails in archaeology. London

Evans, J.G., 1975. The environment of early man in the British Isles. London.

Evans, J.G., 1980. Appendix 3. Land Mollusca. In M.E. Robertson-Mackay, A 'head and hooves' burial beneath a round barrow with other Neolithic and Bronze Age sites, on Hemp Knoll, near Avebury, Wiltshire, 171-4.

Proceedings of the Prehistoric Society 46, 123-176.
Evans, J.G., and Vaughan, M.P., 1985. An investigation into the environment and archaeology of the Wessex linear ditch system. Antiquaries Journal 65, 11-38.
Evans, R.T., and Tylecote, R.F., 1967. Some vitrified products of non-metallurgical significance. Bulletin of the Historical Metallurgy Group 1/9, 22-3.
Everitt, A., 1967. Farm labourers. In J. Thirsk, (ed), The Agrarian History of England and Wales IV, 1500-1640, 396-465. Cambridge.
Everton, A., and Fowler, P., 1978. Pre-Roman ard-marks at Lodge Farm, Falfield, Avon: a method of analysis. In H.C. Bowen and P.J.Fowler, (eds), Early land allotment in the British Isles, 179-185. British Archaeological Reports British Series 48. Oxford.

Fasham, P.J., 1980. Excavations on Bridgets and Burntwood Farms, Itchen Valley Parish, Hampshire 1974. Proceedings of the Hampshire Field Club and Archaeological Society 36, 37-86.
Fasham, P.J., 1985. The prehistoric settlement at Winnall Down, Winchester. Hampshire Field Club Monograph 2.
Fasham, P., and Hanworth, R., 1978. Ploughmarks, Roman roads and motorways. In H.C. Bowen and P.J. Fowler, (eds), Early land allotment in the British Isles, 175-8. British Archaeological Reports British Series 48. Oxford.
Fenton, A., 1973. Transport with pack-horse and slide car in Scotland. In A. Fenton, J. Podolakj and H. Rassmussen, (eds), Land transport in Europe, 121-171. Copenhagen.
Fenton, A., 1978. The Northern Isles. Edinburgh.
Fenton, A., 1981. Early manuring techniques. In R. Mercer, (ed), Farming practice in British prehistory, 210-217. Edinburgh.
Fenton, A., 1983. Grain storage in pits: experiment and fact. In A. O'Connor and D.V. Clarke (eds), From the

Stone Age to the 'Forty-five, 567-588. Edinburgh.
Field, N.H., 1965. Romano-British settlement at Studland, Dorset. Proceedings of the Dorset Natural History and Archaeological Society 87, 142-207.
Field, N.H., Matthews, C.L., and Smith, I.F., 1964. New Neolithic sites in Dorset and Bedfordshire. Proceedings of the Prehistoric Society 30, 352-381.
Fleming, A., 1982. Social boundaries and land boundaries. In C. Renfrew and S. Shennan, (eds), Ranking resource and exchange, 52-55. Cambridge.
Fleming, A., 1984. The prehistoric landscape of Dartmoor: wider implications. Landscape History 6, 5-19.
Fleming, A., 1985. Land tenure, productivity and field systems. In G. Barker and C. Gamble (eds), Beyond domestication in prehistoric Europe, 129-146. London.
Fleming, A., 1987. Coaxial field systems: some questions of time and space. Antiquity 61, 188-202.
Fleming, A., 1988. The Dartmoor reaves. London.
Ford, S., 1982. Fieldwork and excavation on the Berkshire Grims Ditch. Oxoniensia 47, 13-36.
Ford, S., 1985. Linear earthworks on the Berkshire Downs. Berkshire Archaeological Journal 71 (1981/2), 1-20.
Ford, S., Bowden, M., Mees, G., and Gaffney, V., 1988. The date of the 'Celtic' field systems on the Berkshire Downs. Britannia 19, 401-4.
Forde, C.D., 1934(1964). Habitat, Economy and Society. 1964 reprint. London.
Foreman, M., and Rahtz, S., 1984. Excavationa at Faccenda Chicken Farm, nr. Alcester, 1983. Oxoniensia 49, 23-46.
Found, W.C., 1971. A theoretical approach to rural landuse patterns. London.
Fowler, P.J., 1965. The cross-dyke on Buxbury Hill, Sutton Mandeville. Wiltshire Archaeological and Natural History Magazine 60, 47-51.
Fowler, P.J., 1967. The archaeology of Fyfield and Overton Downs, Wiltshire. Third interim report. Wiltshire Archaeological and Natural History Magazine 62, 16-33.

Fowler, P.J., 1971. Early prehistoric agriculture in western Europe: some archaeological evidence. In D.D.A. Simpson, (ed), Economy and settlement in Neolithic and Early Bronze Age Britain and Europe, 153-182. Leicester.

Fowler, P.J., 1976. Farms and fields in the Roman west country. In K. Branigan and P.J. Fowler, (eds), The Roman West Country, 162-182. Newton Abbot.

Fowler, P.J., 1978. The Abingdon ard share. In M. Parrington, 1978, The excavation of an Iron Age settlement, Bronze Age ring ditches and Roman features at Ashville Trading Estate, Abingdon (Oxfordshire),1974-1976, 83-88. Council for British Archaeology Research Report 28. London.

Fowler, P.J., 1981. Later Prehistory. In S. Piggott, (ed), The Agrarian History of England and Wales Volume I.I, Prehistory, 63-298. Cambridge.

Fowler, P.J., 1983. The farming of prehistoric Britain. Cambridge.

Fowler, P.J., and Evans, J.G., 1967. Ploughmarks, lynchets and early fields. Antiquity 41, 289-301.

Fowler, P.J., Musty, J.W.G., and Taylor, C.C., 1965. Some earthwork enclosures in Wiltshire. Wiltshire Archaeological and Natural History Magazine 60, 52-74.

Fox, A., and Britton, D., 1969. A continental palstave from the ancient field system on Horridge Common, Dartmoor, England. Proceedings of the Prehistoric Society 35, 220-8.

Frayn, J., 1984. Sheep-rearing and the wool trade in Italy during the Roman period. ARCA 15. Liverpool.

Frere, S.S. Britannia. Second edition. London.

Gaffney, V., and Tingle, M., 1985. The Maddle Farm (Berks.) project and marcoregional analysis. In S. Macready and F.H. Thompson, (eds), Archaeological field survey in Britain and abroad, 67-73. Society of Antiquaries Occasional Paper (New series) VI. London.

Gailey, A., and Fenton, A., (eds). The spade in northern and Atlantic Europe. Belfast.

Geertz, C., 1963. Agricultural involution; the processes of ecological change in Indonesia. Monograph of the Association for Asian Studies XI.

Gent, H., 1983. Centralized storage in later prehistoric Britain. Proceedings of the Prehistoric Society 49,243-267.

Gent, H., 1987. Little Woodbury and north-west Europe: aspects of agrarian economy and settlement in the first millennium BC. M.Phil. thesis, University of Reading.

George, S., 1976. How the other half dies. Harmondsworth.

Gillam, J.P., Harrison, R.M., and Newman, T.G., 1973. Interim report on excavations at the Roman fort of Rudchester, 1972. Archaeologia Aeliana fifth series 1, 81-6.

Gingell, C., 1980. The Marlborough Downs in the Bronze Age: the first results of current research. In J. Barrett and R. Bradley, (eds), The British Later Bronze Age, 209-222. British Archaeological Reports British Series 83.

Glob, P.V., 1951. Ard og Plov i Nordens Oldtid. Aarhus.

Godwin, E.W., 1856. Account of a Roman villa at Colerne in the County of Wilts. Archaeological Journal 13, 328-332.

Godwin, H., 1975. The History of the British Flora. Second edition. Cambridge.

Goodburn, R., 1976. The Roman villa, Chedworth. National Trust.

Goodchild, R.G., and Forbes, R.J., 1956. Roads and land transport. In C. Singer, E.J. Holmyard, A.R. Hall and T.I. Williams, (eds), A History of Technology, Volume II, 493-536. Oxford.

Goody, J., 1976. Production and reproduction. Cambridge studies in social anthropology 17.

Gosden, C., 1985. Gifts and kin in early Iron Age Europe.

Man, new series, 20, 475-493.
Gould, P.R., 1963. Man against his environment: a game theoretical framework. Annals of the Association of American Geographers 53, 290-7.
Gould, R., 1966. The wealth quest among the Tolowa Indians of northwestern California. Proceedings of the American Philosophical Society 110, 67-89.
Grant, A., 1975. The animal bones. In B. Cunliffe Excavations at Portchester Castle. Volume 1. Roman, 378-408. Reports of the Research Committee of the Society of Antiquaries of London 32.
Grant, A., 1984. Animal husbandry. In B. Cunliffe Danebury an Iron Age hillfort in Hampshire, 496-548. Council for British Archaeology Research Report 52.
Gray, H.St.G., 1966. The Meare Lake Village. Volume 3. Taunton.
Gray, H.St.G., and Bulleid, A., 1953. The Meare Lake Village. Volume 2. Taunton.
Green, F.J., 1981. The botanical remains. In S.M. Davies, Excavations at Old Down Farm, Andover. Part II: Prehistoric and Roman, 153-6. Proceedings of the Hampshire Field Club and Archaeological Society 37, 81-163.
Green, F.J., 1981. Iron Age, Roman and Saxon crops: the archaeological evidence from Wessex. In M. Jones and G. Dimbleby (eds), The environment of Man, 129-153. British Archaeological Reports British Series 87.
Green, F.J., 1985. Evidence for domestic cereal use at Maxey. In F. Pryor, C. French, D. Crowther, D.Gurney, G. Simpson and M. Taylor Archaeology and environment in the Lower Welland Valley. Volume 1, 224-232. The Fenland Project No.1. East Anglian Archaeology Report 27. Cambridge.
Greene, K., 1986. The archaeology of the Roman economy. London.
Greig, J.R.A., 1971. Seeds. In B.W. Cunliffe Excavations at Fishbourne 1961-9, Volume 2, 376. Leeds.

Gregory, T., 1976. A hoard of late Roman metalwork from Weeting, Norfolk. Norfolk Archaeology 36, 265-272.

Grundy, J.E., 1970. Notes on the relationship between climate and cattle housing. Vernacular Architecture 1, 2-5.

Haarnagel, W., 1961. Zur Grabung auf der Feddersen Wierde 1955-1959. Germania 39, 42-69.

Hadman, J., 1978. Aisled buildings in Roman Britain. In M. Todd, (ed), Studies in the Romano-British villa. Leicester.

Halliday, S.P., Hill, P.J., and Stevenson, J.B., 1981. Early Agriculture in Scotland. In R. Mercer, (ed), Farmimg practice in prehistoric Britain, 55-65. Edinburgh.

Halstead, P., and O'Shea, J., 1982. A friend in need is a friend indeed: social storage and the origins of social ranking. In C. Renfrew and S.J. Shennan, (eds), Ranking, Resource and Exchange, 92-99. Cambridge.

Hansen, H-O., 1969. Experimental ploughing with a Dostrup ard replica. Tools and Tillage 1, 67-92.

Hanworth, R., 1968. The Roman villa at Rapsley, Ewhurst. Surrey Archaeological Collections 65, 1-70.

Harcourt, R., 1979. The animal bones. In G.J. Wainwright Gussage All Saints, 150-160. Department of the Environment Archaeological Reports 10.

Harding, J.M., 1964. Interim report on the excavation of a late Bronze Age homestead in Weston Wood, Albury, Surrey. Surrey Archaeological Collections 61, 10-17.

Harding, D.W., 1974. The Iron Age in lowland Britain. London.

Harris, R., (ed), 1987. Weald and Downland Open Air Museum Guidebook. Singleton.

Harrison, C.J., 1971. Grain price analyses and harvest qualities, 1465-1634. Agricultural History Review 19, 135-155.

Hartridge, R., 1978. Excavations at the prehistoric and

Romano-British site on Slonk Hill, Shoreham, Sussex. Sussex Archaeological Collections 116, 69-141.
Harvey, P.D.A., 1965. A medieval Oxfordshire village. Cuxham 1240-1400. Oxford.
Haselgrove, C., 1979. The significance of coinage in pre-conquest Britain. In B.C. Burnham and H.B. Johnson, (eds), Invasion and Response, 197-209. British Archaeological Reports British Series 73.
Haselgrove, C., 1982. Wealth, prestige and power: the dynamics of late Iron Age political centralisation in south-east England. In C. Renfrew and S.Shennan, (eds), Ranking, resource and exchange,79-88. Cambridge.
Haselgrove, C., 1987a. Iron Age coinage in southeast England: the archaeological context. British Archaeological Reports British Series 174. Oxford.
Haselgrove, C., 1987b. Culture process on the periphery: Belgic Gaul and Rome during the late Republic and early Empire. In M. Rowlands, M. Larsen and K. Kristiansen, (eds), Centre and periphery in the ancient world, 104-124. Cambridge.
Haselgrove, C.C., and Allon, V.L., 1982. An Iron Age settlement at West House, Coxhoe, County Durham. Archaeologia Aeliana fifth series 10, 25-51.
Hassan, F.A., 1981. Demographic archaeology. New York.
Hawkes, C., 1932. The Towednack gold hoard. Man 32, 177-186.
Hawkes, C.F.C, 1940. The excavations at Quarley Hill 1938. Proceedings of the Hampshire Field Club and Archaeological Society 14, 136-192.
Hawkes, C.F.C., 1947. Britons, Romans and Saxons round Salisbury and in Cranbourne Chase. Archaeological Journal 104, 27-81.
Helbaek, H., 1952. Early crops in southern Britain. Proceedings of the Prehistoric Society 18, 194-233.
Helbaek, H., 1964. The Isca grain, a Roman plant introduction in Britain. New Phytologist 63, 158-164.
Helbaek, H., 1971. The origin and migration of rye. In

P.H. Davis, P.C. Harper and I.C. Hedge, (eds), Plant life in south-west Asia, 265-280. Edinburgh.

Henneberg, M., and Osteja- Zagorski, J., 1984. Use of a general ecological model for the reconstructuring of prehistoric economy: the Hallstatt period culture of northwestern Poland. Journal of Anthropological Archaeology 3, 41-78.

Herskovits, M.J., 1962. Preface. In P. Bohannan and G. Dalton, (eds), Markets in Africa. Northwestern University Press.

Heslop, D.H., 1987. The excavation of an Iron Age settlement at Thorpe Thewles, Cleveland, 1980-1982. Council for British Archaeology Research Report 65.

Higham, N.J., and Jones, G.D.B., 1983. The excavation of two Romano-British farm sites in northern Cumbria. Britannia 14, 45-72.

Hill, A.F., 1952. Economic Botany. New York.

Hill, P.S., 1982. Settlement and chronology. In D.W. Harding, (ed), Later prehistoric settlement in southeast Scotland, 4- . Edinburgh.

Hillman, G., 1973. Agricultural resources and settlement in the Asvan region. Anatolian Studies 23, 217-224.

Hillman, G., 1978. Remains of crops and other plants from Carmarthen (Church Street). In G.C. Boon, (ed), Monographs and Collections I. Roman sites, 107-112. Cambrian Archaeological Association, Cardiff.

Hillman, G., 1978. On the origins of domestic rye - Secale cereale: the finds from aceramic Can Hassan III in Turkey. Anatolian Studies 28, 157-174.

Hillman, G., 1981a. Reconstructing crop husbandry practices from charred remains of crops. In R. Mercer, (ed), Farming practice in British prehistory, 123-162. Edinburgh.

Hillman, G., 1981b. Crop husbandry: evidence from macroscopic remains. In I. Simmons and M. Tooley, (eds), The environment in British prehistory, 183,191. London.

Hillman, G., 1982. Evidence for spelting malt (sic). In R. Leech Excavations at Catsgore 1970-1972, 137-141. Bristol.

Hinchliffe, J., and Thomas, R., 1980. Archaeological investigations at Appleford. Oxoniensia 45, 9-111.

Hingley, R., 1983. Iron Age and Romano-British society in the Upper Thames Valey: an analysis of settlement data in terms of modes of production. Ph.D. thesis, University of Southampton.

Hingley, R., 1984. Towards social analysis in archaeology: Celtic society in the Iron Age of the Upper Thames Valley. In B. Cunliffe and D. Miles, (eds), Aspects of the Iron Age in central southern Britain, 72-88. University of Oxford: Committee for Archaeology. Monograph No. 2.

Hingley, R., 1984. The archaeology of settlement and the social significance of space. Scottish Archaeological Review 3, 22-7.

Hingley, R., and Miles, D., 1984. Aspects of Iron Age settlement in the Upper Thames Valley. In B. Cunliffe and D. Miles, (eds), Aspects of the Iron Age in Central Southern Britain, 52-71. University of Oxford: Committee for Archaeology. Monograph No. 2.

Hinton, P., 1982. Carbonised seeds. In P. Drewett Later Bronze Age downland economy and excavation at Black Patch, East Sussex, 382-390. Proceedings of the Prehistoric Society 48, 321-400.

Hodder, I., 1979. Pre-Roman and Romano-British tribal economies. In B.C. Burnham and H.B. Johnson, (eds), Invasion and Response, 189-193. British Archaeological Reports British Series 73.

Hodder, I., 1982. The Present Past. London.

Hogg, A.H.A., 1975. Hillforts of Britain. St. Albans.

Holden, E.W., 1972. A Bronze Age cemetery-barrow on Itford Hill, Beddingham, Sussex. Sussex Archaeological Collections 110, 70-117.

Holleyman, G.A., and Curwen, E.C., 1935. Late Bronze Age lynchet-settlements on Plumpton Plain, Sussex. Proceedings of the Prehistoric Society 1, 16-38.

Hodges, R.D., and Arden-Clarke, C.,1986. Soil erosion in Britain. The Soil Association, Bristol.

Hopkins, K., 1978. Conquerors and slaves. Sociological Studies in Roman History 1. Cambridge.

Hopkins, K., 1980. Taxes and trade in the Roman Empire (200 BC - AD 400). Journal of Roman Studies 70, 101-125.

Hopkins, K., 1983. Death and Renewal. Sociological Studies in Roman History 2. Cambridge.

Hoskins, W.G., 1964. Harvest fluctuations and English economic history, 1480-1619. Agricultural History Review 12, 28-46.

Houseley, R.A., 1984. The carbonised plant remains from Meare 1984. In J.M. Coles, (ed), Somerset Levels Papers 13.

Hubbard, R.N.L.B., 1980. Development of agriculture in Europe and the Near East: evidence from quantitative studies. Economic Botany 34, 51-67.

Jackson, D.A., 1982. An Iron Age and Roman settlement at Islip. Northamptonshire Archaeology 17, 91-3.

Jackson, D.A., and Ambrose, T.M., 1978. Excavations at Wakerley, Northants, 1972-75. Britannia 9, 115-242.

Jessen, K., and Helbaek, H., 1944. Cereals in Great Britain and Ireland in prehistoric and early historic times. Copenhagen.

Jobey, G., 1960. Some rectilinear settlements of the Roman period in Northumberland. Archaeologia Aeliania, Fourth Series, 38, 1-38.

Jobey, G., 1973. A Romano-British settlement at Tower Knowe. Archaeologia Aeliana fifth series, 1, 55-79.

Jobey, G., 1977. Iron Age and later farmsteads on Belling Law, Northumberland. Archaeologia Aeliana, fifth series, 5, 1-38.

Jobey, G., 1978. Iron Age and Romano-British settlements on Kennel Hall Knowe, North Tynedale, Northumberland. Archaeologia Aeliana fifth series, 6, 1-28.

Jobey, G., 1983. A note on some northern palisaded settlements. In A. O'Connor and D.V. Clarke, (eds), From the Stone Age to the 'Forty Five, 197-205. Edinburgh.

Jobey, G., and Tait, J., 1966. Excavations on palisaded settlements and cairnfields at Alnham, Northumberland. Archaeologia Aeliana fourth series, 44, 5-48.

Johnsen, S.J., Dansgaard, W., and Clausen, H.B., 1970. Climatic oscillations 1200-2000 AD. Nature 227, 482-3.

Johnson, P., 1987. Romano-British mosaics. Princes Risborough.

Johnston, D.E., 1974. The Roman settlement at Sandy, Bedfordshire. Bedfordshire Archaeological Journal 9, 35-54.

Jones, A.H.M., 1964. The later Roman Empire. Oxford

Jones, A.H.M., 1974. Capitatio and iugatio. In A.H.M. Jones, edited by P.A. Blunt, The Roman Economy, 280-292. Oxford.

Jones, G., 1981. The carbonised plant remains. In J.M. Coles, (ed), Somerset Levels Papers 7, 33-5.

Jones, G., 1986. The carbonised plant remains from Meare West 1979:2. In J.M.Coles, (ed), Somerset Levels Papers 12, 57-69.

Jones, G.R.J., 1972. Post-Roman Wales. In H.P.R. Finberg, (ed), The Agrarian History of England and Wales, I.II. AD 43 - 1042. Cambridge.

Jones, M., 1978. The plant remains. In Parrington, M., The excavation of an Iron Age settlement, Bronze Age ring ditches and Roman features at Ashville Trading Estate, Abingdon (Oxfordshire), 1974-1976, 93-110. Council for British Archaeology Research Report 28.

Jones, M., 1981. The development of crop husbandry. In M. Jones and G. Dimbleby, (eds), The environment of man: the Iron Age to the Anglo-Saxon period, 95-127. British Archaeological Reports British Series 87.

Jones, M., 1984. The plant remains. In B. Cunliffe Danebury: an Iron Age hillfort in Hampshire, Volume 2, 483-495.

Jones, M., 1984. Regional patterns in crop production. In B. Cunliffe and D. Miles, (eds), Aspects of the Iron Age in central southern Britain, 120-5. University of Oxford: Committee for archaeology Monograph 2.

Jones, M., 1986. England before Domesday. London.

Jones, M.U., 1985. Cereals at Mucking. Panorama 27, 13-21.

Jones, M.U., and Bond, D., 1980. Later Bronze Age settlement at Mucking, Essex. In J. Barrett and R. Bradley, (eds), The British Later Bronze Age, 471-482. British Archaeological Reports British Series 83.

Kenward, H.K., Hall, A.R., and Jones, A.K.G., 1986. Environmental evidence from a Roman well and Anglian pits in the legionary fortress. The Archaeology of York 14/5.

Kenward, H.K., and Williams, D., 1979. Biological evidence from the Roman warehouses in Coney Street. The Archaeology of York 14/2.

Kerblay, B., 1971. Chayanov and the theory of peasantry as a specific type of economy. In T. Shanin, (ed), Peasants and peasant societies, 150-160. Penguin Books..

King, A., 1978. A comparative survey of bone assemblages from Roman sites in Britain. Bulletin of the Institute of Archaeology 15, 207-232.

King, F.H., 1927. Farmers of forty centuries. London.

Korber-Grohne, U., 1967. Geobotanische Untersuchungen auf der Feddersen Wierde. Wiesbaden.

Korber-Grohne, U., and Piening, U., 1980. Microstructure of the surfaces of carbonized and non-carbonized grains of cereals as observed in scanning electron and light microscopes as an additional aid in determining prehistoric findings. Flora 170, 189-228.

Kunstadter, P., 1972. Demography, ecology, social structure and settlement patterns. In G.A. Harrison and A.J. Boyce, (eds), The structure of human populations, 313-351.

Lamb, H.H., 1966. The changing climate: selected papers. London.

Lamb, H.H., 1981. Climate from 1000 BC to 1000 AD. In M. Jones and G. Dimbleby, (eds), The environment of man, 53-65. British Archaeological Reports British Series 87.

Lamb, R.C., and Rees, S.E., 1981. Ard cultivation at Sumburgh, Shetland. Tools and Tillage 4, 119-121.

Lambrick, G., 1978. iron Age settlements in the Upper Thames Valley. In B. Cunliffe and T. Rowley, (eds), Lowland Iron Age communities in Europe, 103-119. British Archaeological Reports International Series 48.

Lambrick, G., and Robinson, M., 1979. Iron Age and Roman settlements at Farmoor, Oxfordshire. Council for British Archaeology Research Report 32.

Laegdsmand, K., 1968. The ard-head from Mors. Tools and Tillage 1, 60-1.

Leech, R., 1981. The excavation of a Romano-British farmstead and cemetery at Bradley Hill, Somerton, Somerset. Britannia 12, 177-252.

Leech, R., 1982. Excavations at Catsgore 1970-1973. Western Archaeological Trust, Bristol.

Legge, A.J., 1981. Carbonised seeds. In R.J. Mercer Grimes Graves, Norfolk Volume 1, 90-3. Department of the Environment Archaeological Reports No. 11.

Lerche, G., 1968. Observations on harvesting with sickles in Iran. Tools and Tillage 1, 33-49.

Lerche, G., 1970. Cutting of sod and heather-turf in Denmark. In A. Gailey and A. Fenton, (eds), The Spade in Northern and Atlantic Europe, 148-154. Ulster Folk Museum, Belfast.

Lerche, G., and Steensberg, A., 1980. Agricultural tools and field shapes. National Museum of Denmark.

Copenhagen.

Liebeschaetz, J.H.W.G., 1987. Government and administration in the late Empire. In J. Wacher, (ed), The Roman World, 455-469. London.

Lindquist, S-O., 1974. The development of the landscape on Gotland during the Early Iron Age. Norwegian Archaeological Review 7, 6-32.

Lipton, M., 1968a. A game against Nature: Theories of peasant decision making. The Listener 28 March 1968, 401-3.

Lipton, M., 1968b. A game against nature: strategies of security. The Listener 4 April 1968, 437-9.

Lipton, M., 1968. The theory of the optimising peasant. Journal of Development Studies 4, 327-351.

Lo Cascio, E., 1981. State and coinage in the late Republic and early Empire. Journal of Roman Studies 71, 76-86.

Long, W.H., 1979. The low yields of corn in medieval England. Economic History Review 32, 459-469.

Loudon, J.C., 1825. An encyclopaedia of agriculture. London.

Low, D., 1838. Elements of practical agriculture. Second edition. London.

Lucas, A.T., 1977. Sea sand and shells as manure. In J.G. Jenkins, (ed), Studies in folk life. New York. (Reprint).

Mackreth, D., and O'Neill, F., 1980. Werrington: an Iron Age and Roman site. Durobrivae 8,23-7.

Macinnes, L., 1982. Pattern and Purpose: the settlement evidence. In D.W. Harding, (ed), Later prehistoric settlement in south-east Scotland, 57-73. Edinburgh.

MacNiocaill, G., 1972. Ireland before the Vikings. The Gill History of Ireland 1. Dublin.

Maltby, M., 1981. Iron Age, Romano-British and Anglo-Saxon animal husbandry: a review of the faunal evidence. In M. Jones and G. Dimbleby, (eds), The environment of man: the Iron Age to the Anglo-Saxon period, 155-203. British Archaeological Reports British Series 87.

Maltby, J.M., 1981. Animal bone. In S.M. Davies, Excavations at Old Down Farm, Andover. Part II: Prehistoric and Roman, 147-153. Proceedings of the Hampshire Field Club and Archaeological Society 37, In S.M. Davies, 81-163

Maltby, J.M., 1985. The animal bones. In P.J. Fasham, The prehistoric settlement of Winnall Down, Winchester. Hampshire Field Club Monograph 2.

Mamdani, M., 1973. The myth of population control: family, caste and class in an Indian village. New York.

Mann, J., 1975. The Romans in the North (exhibition catalogue). Universities of Lancaster and Durham.

Mann, J.C., 1985. Two 'Topoi' in the Agricola. Britannia 16, 21-24.

Mann, M., 1986. The sources of social power. Cambridge.

Manning, W.H., 1964. The plough in Roman Britain. Journal of Roman Studies 54,54-65.

Manning, W.H., 1966. A hoard of Romano-British metalwork from Brampton Tilery, Cumberland. Transactions of the Cumberland and Westmorland Antiquarian and Archaeological Society, 1-36

Manning, W.H., 1972. Iron-work hoards in Iron Age and Roman Britain. Britannia 3, 224-250.

Manning, W.H., 1975. Economic inluences on land-use in the military areas of the highland zone during the Roman period. In J.G. Evans, S. Limbrey and H. Cleere, (eds), The effect of man on the landscape: the highland zone, 112-116. Council for British Archaeology Research Report 11.

Marshall, A.J., 1978. Environment and agriculture during the Iron Age: statistical analysis of changing settlement ecology. World Archaeology 9, 347-356.

Mate, M., 1985. Mediaeval agrarian practices: the determining factors? Agricultural History Review 33, 22-31.

Mattingly, H., 1970. Introduction to Tacitus: The Agricola and the Germania. Penguin books.

McConnell, P., 1883. Note-book of agricultural facts and figures for farmers and farm students, first edition. London.

McConnell, P., 1896. The elements of farming, second edition. London.

McConnell, P., 1904. Note-book of agricultural facts and figures for farmers and farm students, seventh edition. London.

McGavin, N., 1980. A Roamn cemetery and trackway at Stanton Harcourt. Oxoniensia 45, 112-123.

Megaw, J.V.S., and Thomas, A.C., and Wailes, B., 1961. The Bronze Age settlement at Gwithian, Cornwall. Proceedings of the West Cornwall Field Club 2, 200-215.

Meillassoux, C., 1962. Social and economic factors affecting markets in Guro Land. In P. Bohannan and G. Dalton, (eds), Markets in Africa. Northwestern University Press.

Mercer, R., 1978. The linking of prehistoric settlement to its farming landscape in south western Britain. In H.C. Bowen and P.J. Fowler, (eds), Early Land Allotment in the British Isles, 163-169. British Archaeological Reports British Series 48

Mercer, R., 1980. Hambledon Hill: a neolithic landscape. Edinburgh.

Mercer, R. (ed),1981. Farming practice in British prehistory. Edinburgh.

Mercer, R., 1981. Appendix. In R. Mercer, (ed), Farming practice in British prehistory. Edinburgh.

Miles, D., 1978. The Upper Thames Valley. In H.C. Bowen and P.J. Fowler, (eds), Early land allotment in the British Isles, 81-88. British Archaeological Reports British Series 48.

Miles, D., (ed), 1986. Archaeology at the Barton Court Farm, Abingdon, Oxon. Council for British Archaeology Research Report 50.

Miles, H., and Miles, T., 1973. Trethurgy. Current Archaeology 4, 142-7.

Millar, F., 1981. The world of the Golden Ass. Journal of Roman Studies 71, 63-75.

Millett, M., and Russell, D., 1984. An Iron Age and Romano-British site at Viables Farm, Basingstoke. Proceedings of the Hampshire Field Club and Archaeological Society 40,49-60.

Mills, A., 1948. A section of 'celtic' field terraces at Streatley Warren, Berkshire. Berkshire Archaeological Journal (1948-9) 51,51-2.

Mills, J., 1762. A new and complete system of practical husbandry. Volume 1. London.

Mitchell, F., 1986. The Shell Guide to reading the Irish landscape. Dublin.

Monk, M.A., and Fasham, P.J., 1980. Carbonised plant remains from two Iron Age sites in Hampshire. Proceedings of the Prehistoric Society 46, 321-344.

Moray-Williams, A., 1909. The Romano-British establishment at Stroud, near Petersfield, Hants. Archaeological Journal 66, 33-52.

Morris, P., 1979. Agricultural buildings in Roman Britain. British Archaeological Reports British Series 70.

Morton, J.C., (ed), 1855. A cyclopedia of agriculture, practical and scientific. Glasgow.

Murphy, P.L., 1977. Early Agriculture and environment on the Hampshire chalklands: circa 800 BC - 400 AD. M.Phil Thesis, University of Southampton.

Murphy, P.L., 1983. Studies of the environment and economy of a Bronze age fen-edge site at West Row, Mildenhall, Suffolk: a preliminary report. Circaea 1, 49-60.

Mytum, H.C., 1986. An early iron Age site at Wytham Hill, near Cumnor, Oxon. Oxoniensia 51, 15-24.

Naismith, J., 1795. On horses and oxen. Annals of Agriculture XXIII, 69-70.

Nash, D., 1976. Reconstructing Poseidonios's Celtic

ethnography: some considerations. Britannia 7, 111-126.
Nash, D., 1984. The basis of contact between Britain and Gaul in the late pre-Roman Iron Age. In S. Macready and F.H. Thompson, (eds), Cross-Channel trade between Gaul and Britain in the pre-Roman Iron Age, 92-107. Society of Antiquaries Occasional Papers (New Series) IV.
Nash, D., 1987. Coinage in the Celtic World. London.
Nasman, U., 1983. Review. Norwegian Archaeological Review 16, 62-7.
Neal, D.S., 1974. The excavation of the Roman villa in Gadebridge Park, Hemel Hempstead 1963-8. Reports of the Research Committee of the Society of Antiquaries of London 31.
Neal, D.S., 1978. The growth and decline of villas in the Verulamium area. In M. Todd, (ed), Studies in the Romano-British villa, 33-58. Leicester.
Neel, J.V., and Chagnon, N.A., 1968. The demography of two tribes of primitive, relatively unacculturated American Indians. Proceedings of the National Academy of Sciences of the United States of America 59, 680-9.
Netting, R.McC., 1965. Household organisation and intensive agriculture: the Kofyar case. Africa 35, 422-9.
Nielsen, V., 1970. Iron Age plough-marks in Store Vildmose, North Jutland. Tools and Tillage 1, 151-165.
Nielsen, V., 1984. Prehistoric field boundaries in eastern Denmark. Journal of Danish Archaeology 4, 135-163.
Nielsen, V., 1986. Ploughing in the Iron Age. Plough marks in Store Vildmose, North Jutland. Journal of Danish Archaeology 5, 189-208.
Noddle, B., 1983. The animal bones. In G. Webster, P. Fowler, B. Noddle and L. Smith, The excavation of a Romano- British establishment at Barnsley Park, Gloucestershire, 1961-1979: Part III. Transactions of the Bristol and Gloucester Archaeological Society 103, 73-100.
Northover, J.P., 1982. The exploration of the long

distance movement of bronze in Bronze and early Iron Age Europe. Bulletin of the Institute of Archaeology 19, 45-72.

O'Connor, B., 1980. Cross-Channel relations in the later Bronze Age. British Archaeological Reports International Series 91.

O'Connor, T.P., 1976. The excavation of a round barrow and cross-ridge dyke at Alfriston, East Sussex, 1975. Sussex Archaeological collections 114, 151-163.

Oliver, M., and Applin, B., 1978. Excavation of an Iron Age and Romano-British settlement at Ructstalls Hill, Basingstoke, Hampshire, 1972-5. Proceedings of the Hampshire Field Club and Archaeological Society 35, 41-92.

Orme, B.J., Coles, J.M., Caseldine, A.E., and Bailey, G.N., 1981. Meare Village West 1979. In J.M. Coles, (ed), Somerset Levels Papers 7, 12-69.

Orme, B.J., Coles, J.M., and Silvester, R.J., 1983. Meare Village East 1982. In J.M. Coles, (ed), Somerset Levels Papers 9, 49-74.

Osbourne, P.J., 1978. Insect evidence for the effect of man on the lowland landscape. In S. Limbrey and J.G. Evans, (eds), The effect of man on the landscape: the lowland zone, 32-4.Council for British Archaeology Research Report 21.

Palmer, R., 1984. Danebury: an Iron Age hillfort in Hampshire. An aerial photographic interpretation of its environs. RCHM(E) Supplementary Series 6.

Parrington, M., 1978. The excavation of an Iron Age settlement, Bronze Age ring ditches and Roman features at Ashville Trading Estate, Abingdon (Oxfordshire), 1974-1976. Council for British Archaeology Research Report 28. London.

Payne, F.G., 1947. The plough in ancient Britain. Archaeological Journal 104, 82-110.

Peacock, D.P.S., 1968. A petrological study of certain Iron age pottery from western England. Proceedings of the Prehistoric Society 34, 414-427.

Peacock, D.P.S., 1969. A contribution to the study of Glastonbury ware from south-western Britain. Antiquaries Journal 49, 41-61.

Peacock, D.P.S., 1982. Pottery in the Roman world: an ethnoarchaeological approach. London.

Peal, C.A., 1967. Romano-British pewter plates and dishes. Proceedings of the Cambridge Antiquarian Society 60, 19-37

Pedersen, J.A., 1986. A new Early Bronze Age house-site under a barrow at Hyllerup, Western Zealand. Journal of Danish Archaeology 5,168-176.

Percival, J., 1900. Agricultural Botany. London.

Percival, J., 1943. Wheat in Great Britain. Second edition. London.

Percival, J., 1976. The Roman Villa. London.

Perkins,J.A., 1977. Harvest technology and labour supply in Lincolnshire and the East Riding of Yorkshire 1750-1850. Tools and Tillage 3, 47-58 and 125-135.

Perry, B.T., 1967. Early settlement and agriculture on the Hampshire chalklands. PhD. thesis, University of Reading.

Perry, B.T., 1972. Excavations at Bramdean, Hampshire, 1965 and 1966, and a discussion of similar sites in southern England. Proceedings of the Hampshire Field Club and Archaeological Society 29, 41-77.

Piggott, C.M., 1942. Five Late Bronze Age enclosures in north Wiltshire. Proceedings of the Prehistoric Society 8, 48-61.

Piggott, S., 1981. Early prehistory. In S. Piggott, (ed), The Agrarian History of England and Wales I.I: Prehistory, 1-59. Cambridge.

Pitt-Rivers, A.L.F., 1898. Excavations in Cranbourne Chase Volume VI.

Pitts, L.F., and St.Joseph, J.K., 1985. Inchtuthil. The

Roman legionary fortress. Britannia Monograph Series 6. London.
Platt, C., 1978. Medieval England. London.
Pliny. Natural History. Translated by H. Rackham and W.H.S. Jones. 10 volumes, 1938-1963. Loeb Classical Library, London.
Pohanka, R., 1986. Die eisern Agrargerate der Romischen Kaiserzeit in Osterreich. British Archaeological Reports International Series 298.
Poole, C., 1984. Rectangular post-built structures. In B. Cunliffe Danebury: an Iron Age hillfort in Hampshire, 87-110. Council for British Archaeology Research Report 52.
Porter, E., 1977. Fenland peat. In J.G. Jenkins, (ed), Studies in folk life, 157-182. New York. (Reprint).
Potts, T., 1807. The British farmer's cyclopaedia. London.
Pritchard, A., 1985. Molluscan analysis. In S. Ford, Linear earthworks on the Berkshire Downs, 11-15. Berkshire Archhaeological Journal 71 (1981-2), 1-20.
Pryor, F., 1980. Excavations at Fengate, Peterborough, England: the third report. Northants Archaeological Society and Royal Ontario Museum.
Pryor, F., 1984. Excavations at Fengate, Peterborough, England: the fourth report. Northants Archaeological Society and Royal Ontario Museum.
Pryor, F., and Cranstone, D.,1978. An interim report on excavations at Fengate, Peterborough, 1975-77. Northamptonshire Archaeology 13, 9-27.
Pryor, F., French, C., Crowther, D., Gurney, D., Simpson, G., Taylor, M., 1985. Archaeology and environment in the lower Welland Valley. The Fenland Project, No.1. East Anglian Archaeology Report 27. Cambridge.
Pusey, P., 1843. On the agricultural improvements of Lincolnshire. Journal of the Royal Agricultural Society of England 4, 287-316.

Rackham, D.J., 1987. The animal bones. In D.H. Heslop, 1987. The excavation of an Iron Age settlement at Thorpe Thewles, Cleveland, 1980-1982, 99-109. Council for British Archaeology Research Report 65.

Rahtz, P., 1962. Excavations at Shearplace Hill, Sydling St. Nicholas, Dorset, England. Proceedings of the Prehistoric Society 28, 289-328.

Rahtz, P.A., and Greenfield, E., 1977. Excavations at Chew Valley Lake, Somerset. Department of the Environment Archaeological Reports 8.

Raistrick, A., 1938. Prehistoric cultivations at Grassington, W. Yorkshire. Yorkshire Archaeological Journal 33, 166-174.

Rankin, H.D., 1987. Celts and the classical world. London.

Rasmussen, K., 1979. A mathematical description of an infield-outfield system. Geografisk Tidsskrift 78/9. 5-9.

Rausing, G., 1981. Ecology, Economy, and Man. Lund.

Redknap, M., and Millett, M., 1980. Excavations on a RB farmstead at Elsted, W. Sussex. Sussex Archaeological Collections 118, 197-229.

Reid, C., 1917. Plants, wild and cultivated. In A. Bulleid and H.St.G. Gray The Glastonbury Lake Village Volume 2, 625-630.

Reece, R., 1973. Roman coinage in the western Empire. Britannia 4, 227-251.

Reece, R., 1979. Roman monetary impact. In B.C. Burnham and H.B. Johnson, (eds), Invasion and Response, 211-7. British Archaeological Reports British Series 73.

Reece, R., 1980. Town and country: the end of Roman Britain. World Archaeology 12, 77-92.

Rees, S.E., 1978. Tools available for cultivation in prehistoric Britain. In S. Limbrey and J.G. Evans, (eds), The effect of man on the landscape: the lowland zone. Council for British Archaeology Research Report 21, 103-114.

Rees, S.E., 1979. Agricultural implements in prehistoric and Roman Britain. British Archaeological Reports, British Series, 69. Oxford.

Rees, S.E., 1979. The Roman scythe blade. In C. Lambrick and M. Robinson, Iron Age and Roman settlements at Farmoor, Oxfordshire, 61-4. Council for British Archaeology Research Report 32.

Rees, S.E., 1981. Ancient agricultural implements. Princes Risborough.

Rees, S.E., 1981. Agricultural tools: function and use. In R. Mercer, (ed), Farming practice in British prehistory, 66-84. Edinburgh.

Rees, S., 1987. Agriculture and horticulture. In J. Wacher, (ed), The Roman World. London.

Reining, C.C., 1962. Zande markets and commerce. In P. Bohannan and G. Dalton, (eds), Markets in Africa. Northwestern University Press.

Renfrew, C., 1974. British Prehistory. London.

Renfrew, J.M., 1973. Palaeoethnobotany. London.

Reynolds, D.M., 1982. Aspects of later timber construction in south-east Scotland. In D.W. Harding, (ed), Later prehistoric settlement in south-east Scotland, 44-56. Edinburgh.

Reynolds, P.J., 1967. Experiment in Iron Age agriculture. Transactions of the Bristol and Gloucestershire Archaeological Society 86, 60-73.

Reynolds, P.J., 1974. Experimental Iron age pits: an interim report. Proceedings of the Prehistoric Society 40,118-131.

Reynolds, P.J., 1978. An ard tip from Slonk Hill. In R. Hartridge, Excavations at the prehistoric and Romano-British site on Slonk Hill, Shoreham, 99. Sussex Archaeological Collections 116, 69-141.

Reynolds, P.J., 1979a. Iron Age Farm. The Butser experiment. London.

Reynolds, P.J., 1979b. The Butser Ancient Farm Demonstration Area. Hampshire County Council, Winchester.

Reynolds, P.J., 1980. The working agroscape of the Iron Age. Landscape History 2, 1-18.

Reynolds, P.J., 1981. Deadstock and livestock. In R. Mercer (ed), Farming practice in British prehistory, 97-122. Edinburgh.

Reynolds, P.J., 1982. The Donnerupland ard. In S. McGrail, (ed), Woodworking techniques before AD 1500, 129-151. British Archaeological Reports International Series 129.

Reynolds, P.J., 1987. Butser Ancient Farm Yearbook 1986. Horndean.

Reynolds, P.J., 1988. Butser Ancient Farm Yearbook 1987. Horndean.

Rhodes, P., 1950. The celtic field systems on the Berkshire Downs. Oxoniensia 15, 1-28.

Richards, J.C., 1978. The archaeology of the Berkshire Downs: an introductory survey. Berkshire Archaeological Committee Publication 3. Reading.

Richards, J.C., 1984. The excavation of a late Bronze Age settlement and ditch at Beedon Manor Farm, Berkshire. In P.D. Catherall, M. Barnett, and H. McClean, (eds), The southern feeder - the archaeology of a gas pipe line, 56-68. London.

Richmond, I.A., 1968. Hod Hill, Volume 2. London.

Rivet, A.L.F., 1969. Social and economic aspects. In A.L.F. Rivet, (ed), The Roman Villa in Britain, 173-216. London

Robertson-Mackay, M.E., 1980. A 'head and hoofs' burial beneath a round barrow, with other Neolithic and Bronze Age sites, on Hemp Knoll, near Avebury, Wiltshire. Proceedings of the Prehistoric Society 46,123-176.

Robinson, D.H., 1947. Leguminous forage plants. Second edition. London.

Robinson, D.H., (ed), 1977. Fream's Elements of Agriculture. Fifteenth edition. London.

Robinson, M., 1981. The Iron Age to early Saxon environment of the Upper Thames terraces. In M. Jones and G. Dimbleby, _The environment of man_, 251-286. British Archaeological Reports British Series 87.

Rodwell, W., 1976. Coinage, oppida and the rise of Belgic power in south-eastern Britain. In B. Cunliffe and T, Rowley, (eds), _Oppida: the beginnings of urbanisation in Barbarian Europe_, 181-366. British Archaeological Reports International Series 11.

Rodwell, W., 1978. Rivenhall and the emergence of first century villas in northern Essex. In M. Todd, (ed), _Studies in the Romano-British villa_, 11-32. Leicester.

Rothamsted Experimental Station, 1968. The Broadbalk wheat experiment. _Rothamsted Experimental Station Report for 1968_, Part 2. Harpenden.

Rothamsted Experimental Station, 1970. _Details of the classical and long-term experiments up to 1967_. Harpenden.

Royal Commission on Historical Monuments. _Inventory of the Historical Monuments in the County of Dorset_. Volume 2(3), 1970. Volume 5, 1976.

Rowlands, M.J., 1976. _The organisation of Middle Bronze Age metalworking_. British Archaeological Reports British Series 31.

Rowlands, M.J., 1980. Kinship, alliance and exchange in the European Bronze Age. In J. Barrett and R. Bradley, (eds), _The British Later Bronze Age_, 15-55. British Archaeological Reports British Series 83(i). (Oxford).

Rowley-Conwy, P., 1981. Slash and burn in the temperate European neolithic. In R. Mercer, (ed), _Farming practice in British prehistory_, 85-96. Edinburgh.

Rowley-Conwy, P., 1987. The interpretation of ard-marks. _Antiquity_ 61, 263-6.

Royal Commission on Historical Monuments, 1976. _County of Gloucester Volume 1. Iron Age and Romano-British monuments in the Gloucestershire Cotswolds_.

Russell, E.J., and Voelcker, J.A., 1936. _Fifty years of field experiments at the Woburn Experimental Station_.

London.
Russell, Dr., 1981. Discussion. In R. Mercer, (ed), Farming practice in British prehistory, 163-5. Edinburgh.
Ryder, M.L., 1983. Sheep and man. London.

Sahlins, M., 1957. Land use and the extended family in Moala, Fiji. American Anthropologist 59, 449-462.
Sahlins, M.D., 1968. Tribesmen. Englewood Cliffs, New Jersey.
Sahlins, M., 1974. Stone Age Economics. (London).
Salisbury, E.J., 1961. Weeds and aliens.
Salisbury, R.F., 1973. Economic anthropology. Annual Review of Anthropology 2, 85-94.
Salway, P., 1967. Excavations at Hockwold-cum-Wilton, Norfolk. Proceedings of the Cambridge Antiquarian Society 60, 39-80.
Salway, P., 1981. Roman Britain. Oxford.
Sanders, W.T., 1974. Chiefdom to state: political evolution at Kaminaljuyu, Guatemala. In C.B. Moore, (ed), Reconstructing complex societies, 97-113. Supplement to the Bulletin of the American Schools of Oriental Research No.20.
Sansom, B., 1974a. Traditional economic systems. In W.D. Hammond-Tooke, (ed), The Bantu-speaking Peoples of Southern Africa, 135-176. Second Edition. London.
Sansom, B., 1974b. Traditional rulers and their realms. In W.D. Hammond-Tooke, (ed), The Bantu-speaking Peoples of Southern Africa, 246-283. Second Edition. (London).
Schultz, T.W., 1964. Transforming traditional agriculture. Yale University Press.
Scott, E., 1983. Romano-British wheat yields. In J.C. Chapman and H.C. Mytum (eds), Settlement in North Britain 1000 BC - AD 1000, 221-2. British Archaeological Reports British Series, 118.
Scott, L., 1948. Gallo-British colonies. The aisled roundhouse culture in the north. Proceedings of the

Prehistoric Society 14, 46-145.
Scott, L., 1951. Corn drying kilns. Antiquity 25,196, 208.
Seeberg, P., and Kristensen, H.H., 1964. Mange striber pa kryds og Tvaers. KUML, 7-14.
Sellwood, L., 1984. Objects of iron. In B. Cunliffe, Danebury, 357-361. Council for British Archaeology Research Report 52.
Shennan, S.J., 1981. Settlement history in East Hampshire. In S.J. Shennan and R.T. Schadla Hall The archaeology of Hampshire, 106-121. Hampshire Field Club and Archaeological Society Monograph No. 1.
Shepherd, I.A.G., and Tuckwell, A.N., 1977/8. Traces of Beaker period cultivation at Rosinish, Benbecula. Proceedings of the Society of Antiquaries of Scotland 108, 108-113.
Sherratt, A.G., 1976. Resources, technology and trade: an essay in early European metallurgy. In G.deG. Sieveking, I.H. Longworth and K.E. Wilson (eds), Problems in economic and social archaeology, 557-581. London.
Sherratt, A., 1981. Plough and pastoralism: aspects of the secondary products revolution. In I. Hodder, G. Isaac, and N. Hammond, (eds), Pattern of the Past. Cambridge.
Shortt, H. de S., 1949. A hoard of bangles from Ebbesbourne Wake, Wilts. Wiltshire Archaeological and Natural History Magazine 53, 104-112.
Simon, H.A., 1957. Models of man. New York.
Simon, J.L., 1978. An integration of the Invention-Pull and Population-Push theories of Economic-Demographic History. In J.L. Simon, (ed), Research in Population Economics VI, 165-187. Greenwich, Connecticut.
Slicher van Bath, B.H., 1963. The agrarian history of Western Europe 500-1850. London.
Smith, C., 1979. Fisherwick. British Archaeological Reports, British Series 61. Oxford.
Smith, G.H., 1978. Excavations near Hadrian's Wall at

Tarraby Lane, 1976. Britannia 9, 19-56.
Smith, D.J., 1969. The mosaic pavements. In A.L.F. Rivet, (ed), The Roman Villa in Britain, 71-125. London.
Smith, J.T., 1964. Romano-British aisled houses. Archaeological Journal 120 (1963), 1-30.
Smith, J.T., 1978. Villas as a key to social structure. In M. Todd, (ed), Studies in the Romano-British villa, 149-185. Leicester.
Smith, J.T., 1980. The Roman villa at Rapsley: a reinterpretation. Surrey Archaeological Collections 72, 63-8.
Smith, J.T., 1985. Barnsley Park villa: its interpretation and implications. Oxford Journal of Archaeology 4, 341-351.
Smith, J.T., 1987. The social structure of a Roman villa: Marshfield - Ironmongers Place. Oxford Journal of Archaeology 6, 243-255.
Smith, R.W., 1985. Prehistoric human ecology in the Wessex chalklands with special reference to evidence from valleys. PhD thesis, Southampton University.
Spielmann, K.A., 1986. Interdependence among egalitarian societies. Journal of Anthropological Archaeology 5, 279-312.
Spratt, D., 1982. The analysis of innovation processes. Journal of Archaeological Science 9, 79-94.
Sproule, J., 1844. Elements of practical agriculture. London.
Spruytte, J., 1983. Early harness systems. Experimental studies. Translated by M. Littauer. London.
Stead, I.M., 1971. Beadlam Roman villa: an interim report. Yorkshire Archaeological Journal 43, 178-186.
Stead, I.M., 1976. Excavations at Winterton Roman villa and other Roman sites in north Lincolnshire. London.
Steensberg, A., 1943. Ancient harvesting implements. Copenhagen.
Steensberg, A., 1958. Parallel ploughing with alternately sloping and upright ard in Columella. Folk-liv 1957-8,

157-162. Stockholm.

Steensberg, A., 1983. Review of R. Mercer, (ed) 1981, Farming practice in British prehistory. Agricultural History Review 31, 61-63.

Steensberg, A., 1986. Man the manipulator. National Museum of Denmark, Copenhagen.

Steer, K.A., 1955-6. An early Iron Age homestead at West Plean, Strilingshire. Proceedings of the Society of Antiquaries of Scotland 89, 227-251.

Stevens, C.E., 1947. A possible conflict of laws in Roman Britain. Journal of Roman Studies 37, 132-4.

Stevens, C.E., 1966. The social and economic aspects of rural settlement. In C. Thomas, (ed), Rural settlement in Roman Britain, 108-128. Council for British Archaeology Research Report 7.

Stevenson, W., 1812. General view of the agriculture of the County of Dorset. Board of Agriculture and Internal Improvement, London.

Stone, J.F.S., 1934. Three "Peterborough" dwelling pits and a double-stockaded early Iron Age ditch at Winterbourne Dauntsey. Wiltshire Archaeological and Natural History Magazine 46, 445-453.

Stone, J.F.S., 1937. An enclosure ditch on Boscombe Down East. Wiltshire Archaeological and Natural History Magazine 47, 446-489.

Stopford, J., 1987. Danebury: an alternative view. Scottish Archaeological Review 4, 70-5.

Strabo. The Geography of Strabo. Translated by H.L. Jones, 1917. Loeb Classical Library, London.

Straker, V., 1987. Carbonised cereal grains from first century London. In P. Marsden The Roman Forum Site in London, 151-155. H.M.S.O., London.

Stuart, J.D.M., and Birkbeck, J.M., 1937. A celtic village on Twyford Down. Proceedings of the Hampshire Field Club and Archaeological Society 13, 188-207.

Suttles, W., 1968. Coping with abundance: subsistence on the northwest coast. In R.B. Lee and I. de Vore, (eds), Man the Hunter, 56-68. Chicago.

Swain, H., 1988. Pottery survival in the field: some initial results of experiments in frost shattering. Scottish Archaeological Review 5, 87-9.

Tacitus, P.C. Agricola and Germania. Translated by M. Hutton. Loeb Classical Library. Revised edition 1970. London.

Tacitus, P.C. The Agricola and the Germania. Translated by H. Mattingly. Revised edition 1970. Penguin Books.

Tacitus, P.C. The Histories. translated C.H. Moore. 4 volumes, 1925-1951. Loeb Classical Library.

Taylor, A., and Woodward, P.J., 1983. Excavations at Roxton, Bedfordshire, 1972-4. The post-Bronze Age settlement. Bedfordshire Archaeology 16, 7-28.

Thirsk, J., 1967. Farming techniques. In J. Thirsk, (ed.), The Agrarian History of England and Wales IV, 1500-1640, 161-199. Cambridge.

Thomas, C., 1970. Bronze Age spade marks at Gwithian, Cornwall. In A. Gailey and A. Fenton, (eds), The spade in northern and Atlantic Europe, 10-17. Belfast.

Thomas, J.O., and Davies, L.J., 1938. Common British grasses and legumes. London.

Thomas, K.D., 1977. A preliminary report on the mollusca from the lynchet section. In M. Bell, Excavations at Bishopstone. Sussex Archaeological Collections 115, 258-264.

Thompson, E.A., 1965. The early Germans. Oxford.

Tierney, J.J., 1960. The celtic ethnography of Posidonius. Proceedings of the Royal Irish Academy 60C, 189-275.

Tinsley, H.M., 1981. The Bronze Age. In I. Simmons and M. Tooley, (eds), The environment in British prehistory, 210-249. London.

Titow, J.Z., 1972. Winchester Yields: a study in mediaeval agricultural productivity. Cambridge.

Todd, M., 1969. The Roman settlement at Margidunum: excavations 1966-8. Transactions of the Thoroton Society 73, 7-104.

Todd, M., 1975. The Northern Barbarians, 100BC-AD300.

London.
Todd, M., 1978. Villas and Romano-British society. In M. Todd, (ed), Studies in the Romano-British villa, 187-208. Leicester.
Toms, H., 1925. Bronze Age, or earlier, lynchets. Proceedings of the Dorset Natural History and Archaeological Society 46, 89-100.
Tratman, E.K., 1970. The Glastonbury Lake Village: a reconsideration. Proceedings of the University of Bristol Spelaeological Society 12, 143-167.
Turner, J., 1981. The Iron Age. In I. Simmons and M. Tooley, (eds), The environment in British prehistory, 250-281. London.
Tweddle, D., 1986. Finds from Parliament Street and other sites in the city centre. The Archaeology of York 17/4.
Tylecote, R.F., 1962. Metallurgy in Archaeology. London.

van Ardsell, R.D., 1986. An industrial engineer (but no papyrus) in Celtic Britain. Oxford Journal of Archaeology 5, 205-222.
van der Veen, M., 1987. The plant remains. In D.H. Heslop, The excavation of and Iron Age settlement at Thorpe Thewles, Cleveland, 1980-1982, 93-99. Council for British Archaeology Research Report 65.
van der Veen, M., 1987. Plant remains. In I. Jobey and G. Jobey, Prehistoric, Romano-British and later remains on Murton High Crags, Northumberland, 192-196. Archaeologia Aeliana fifth series 15, 151-198.
van der Veen, M., and Haselgrove, C.C., 1983. Evidence for pre-Roman crops from Coxhoe, Co. Durham. Archaeologia Aeliana fifth series 11, 23-5.
van Zeist, W., 1968 (1970). Prehistoric and early historic food plants in the Netherlands. Palaeohistoria 14, 42-173.
Varro, On agriculture. In Cato and Varro, De re rustica. Translated by W.D. Hooper and H.B. Ash, 1934. Loeb Classical Library, London.

Vasey, D.E., 1979. Population and agricultural intensity in the humid tropics. Human Ecology 7, 269-283.

Vitruvius. On architecture. Translated F. Granger. Loeb Classical Library. 1955 reprint.

Wacher, J., 1978. Roman Britain. London.

Wainwright. G.J., 1968. The excavation of a Durotrigian farmstead near Tollard Royal in Cranbourne Chase, southern England. Proceedings of the Prehistoric Society 34, 102-147.

Wainwright, G., 1971. The excavation of a fortified settlement at Walesland Rath, Pembrokeshire. Britannia 2, 48-108.

Wainwright, G.J., 1979. Gussage All Saints: an Iron Age site in Dorset. Department of the Environment Archaeological Reports 10.

Walthew, C.V., 1975. The town house and the villa house in Roman Britain. Britannia 6, 189-205.

Warner, P., 1987. Greens, commons and clayland colonization. Department of English Local History, University of Leicester: Occasional papers fourth series No. 2.

Warner, R.B., 1976. Some observations on the context and importation of exotic material in Ireland, from the first century BC to the second century AD. Proceedings of the Royal Irish Academy 76C, 267-292.

Waterbolk, H.T., 1975. Evidence of cattle stalling in excavated pre- and protohistoric houses. In A.T. Clason, (ed), Archaeozoological studies, 383-394. Amsterdam.

Webster, G., 1981. The excavation of a Romano-British establishment at Barnsley Park, Gloucestershire, 1961-1979: Part I. Transactions of the Bristol and Gloucestershire Archaeological Society 99, 21-77.

Webster, G., and Smith, L., 1982. The excavation of a Romano-British establishment at Barnsley Park, Gloucestershire, 1961-1979: Part II. Transactions of

the Bristol and Gloucestershire Archaeological Society 100, 65-189.
Webster, G., and Smith, L., 1987. Barnsley Park villa: reply to J.T. Smith. Oxford Journal of Archaeology 6.
Webster, G., Fowler, P., Noddle, B., and Smith, L., The excavation of a Romano-British establishment at Barnsley Park, Gloucestershire, 1961-1979: Part III. Transactions of the Bristol and Gloucestershire Archaeological Society 103, 73-100.
Wiessner, P., 1982. Risk, reciprocity and social influences on !Kung San economics. In E. Leacock and R. Lee, (eds), Politics and history in band societies. Cambridge.
Wells, C.M., 1977. Where did they put the horses? Cavalry stables in the early Empire. In J.Fitz (ed), Limes. Akten des XI Internationalen Limeskongresses, 659-665. Akadememiai Kiado, Budapest.
White, B., 1975. The economic importance of children in a Javanese village. In M. Nag, (ed), Population and social evolution, 127-146. The Hague.
White, D.A., 1970. The excavation of an Iron Age round barrow near Handley, Dorset 1969. Antiquaries Journal 50, 26-36.
White, K.D., 1967. Agricultural implements of the Roman world. Cambridge.
White, K.D., 1970. A bibliography of Roman agriculture. Reading.
White, K.D., 1970. Roman Farming. London.
White, K.D., 1972. The Great Chesterford scythes. Proceedings of the Hungarian Agricultural Museum 1971-2, 77-82.
Widgren, M., 1983. Settlement and farming systems in the early Iron Age. Stockholm Studies in Human Geography 3.
Wightman, E.M., 1985. Gallia Belgica London.
Wild, J.P., 1970. Textile manufacture in the northern Roman provinces. Cambridge.
Wild, J.P., 1982. Wool production in Roman Britain. In D.

Miles, (ed), The Romano-British countryside, 109-122. British Archaeological Reports British Series 103.
Wilkinson, T.J., 1982. The definition of ancient manured zones by means of extensive sherd-sampling techniques. Journal of Field Archaeology 9, 323-333.
Willcox, G.H., 1977. Exotic plants from Roman waterlogged sites in London. Journal of Archaeological Science 4, 269-282.
Williams, D., 1979. Plant remains. In H.K. Kenward and D. Williams Biological evidence from the Roman warehouses in Coney Street. The Archaeology of York 14/2, 52-62.
Williams, D.F., 1977. The Romano-British Black-burnished industry: an essay on characterization by heavy mineral analysis. In D.P.S.Peacock, (ed), Pottery and Early Commerce,163-220. London.
Williamson, T., 1987. Early coaxial field systems on the East Anglian boulder clays. Proceedings of the Prehistoric Society 53,419-432.
Wilson, C.M., 1971. Archaeological notes (Fishtoft). Lincolnshire History and Archaeology 6, 7.
Wilson, G., 1984. Appendix 5. A report on the plant macrofossils from Fengate. In F. Pryor Excavation at Fengate, Peterborough, England: the fourth report, microfiche pages 242-4. Northants Archaeological Society/Royal Ontario Museum.
Wilson, J., 1859. Our farm crops. London.
Windell, 1981. The Upper Nene Valley in the Iron Age and Roman periods. Northamptonshire County Council.
Winterhalder, B., 1986. Diet choice, risk and food sharing in a stochastic environment. Journal of Anthropological Archaeology 5,369-392.
Wolf, E.R., 1966. Peasants. Englewood Cliffs, New Jersey.

Young, A., 1952-3. An aisled farmhouse at the Allasdale, Isle of Barra. Proceedings of the Society of Antiquaries of Scotland 87, 80-105.

Zeepvat, R., 1987. MK 105 Bancroft villa. In D.C. Mynard, (ed), Roman Milton Keynes, 60-79.