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SOCIO-ECONOMIC ASPECTS
OF THE
EAST GHOR CANAL PROJECT, JORDAN

by

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ABSTRACT

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The Jordan Valley has been characterised by irrigated farming for many years but the East Ghor Canal Project represents the first stage of the most recent development. This study examines some of the changes which have occurred in the project since its initiation over two decades ago. The socio-economic changes are seen partly through the continuing adjustment of cropping patterns which are analysed at both the block and farm levels. These are the result of several influences including a greater and more reliable supply of water, new crop marketing opportunities, a reformed land tenure system and a developing infrastructure of farm co-operatives, a farmers' association and extension services to provide supplies, credits and other assistance to farmers.

The study uses a sample of over 350 farmers in the project to establish their general characteristics and to statistically test farmer-farm relationships in an attempt to better understand farmer behaviour, particularly with regard to their use of elements of the evolving infrastructure. Several spatial variations are found in the socio-economic characteristics of farmers and their farming behaviour. Some of these show that farmers in the earlier developed northern blocks of the project, with its better environment for irrigated farming, tend to behave differently from those in the more recently developed, poorer and more arid south. Many of these spatial variations are, however, complex and not easily explained. The study ends with a nine-fold grouping of the sampled farmers based on a wide range of socio-economic variables.

TO MY PARENTS

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CHAPTER 1 INTRODUCTION

The Hashemite Kingdom of Jordan, a developing Middle Eastern state, is generally hilly and arid or semi-arid with 88 per cent of its total 97,000 km^2 receiving less than 200 mm (8 inches) of precipitation annually. The Kingdom came into being in 1950 on the unification of the West Bank - the part of eastern Palestine which was not occupied by the Israelis in 1948 - and the East Bank, or what was then known as Transjordan. With the bulk of the Palestinian refugees, made homeless by the creation of the State of Israel, taking shelter within the new country of Jordan, much pressure was placed on its slender agricultural resources. It became essential to develop them and the Jordan Valley, where many of the refugees were already settled, offered favourable conditions for irrigated agriculture. The first stage in the realisation of that potential was the establishment of the East Ghor Canal Project, the subject of this study (Fig. 1.1).

1.1 The Aims of the Study

This study has two aims. The first of these is to examine some of the land use, social, economic and technical changes that have gone on in the agriculture of the East Ghor Canal Project since it was started in 1962. Like many major new developments, particularly irrigated agricultural projects, the East Ghor Canal Project attracted a considerable amount of academic attention from geographers and others soon after it was initiated. Both European and Arab geographers used the civil engineering and other feasibility reports, as well as the evidence to be seen on the land, with new farming activities, to examine the progress being made in the project and the problems emerging. Since 1970, however, the project has received little academic attention. Indeed, there have even been few new government or professional studies of its progress in recent years.

The writer's early familiarity with parts of the area, during periods of farmwork there, and later on as an undergraduate at the University of Jordan, suggested to him that even ten or more years after the project's initiation, the farmers were still adjusting their cropping

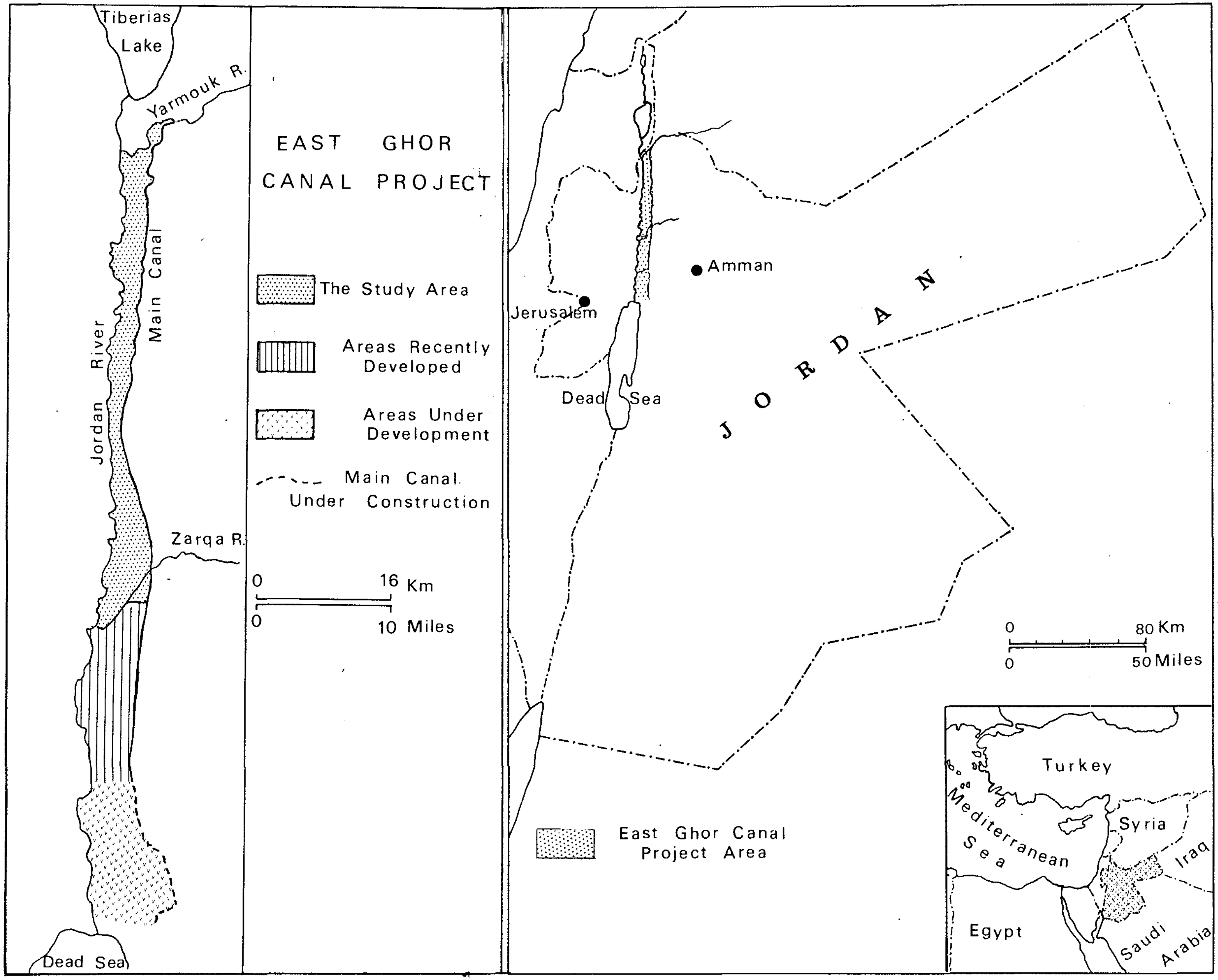

Fig. 1.1 EAST GHOR CANAL PROJECT: LOCATION OF STUDY AREA

and other activities to the new opportunities being offered by the irrigation and other developments. This in itself seemed worth study to see how change over the longer-term was occurring.

As the study developed a second major aim emerged. It soon became clear that any attempt to explain changes in farming would require detailed contact with some of the farmers involved. There are over 3500 farms within the project, most of them small, some of them tenanted, nearly all of them operated on a small capital base by farmers often with limited education and experience of irrigation farming, and of the crops they were growing. Each farmer can therefore be expected to be learning, and improving his farm, over the years from his own experiences of farming as well as from fellow farmers and other information sources. Each would slowly be able to invest more in the land. For this reason, as well as for other reasons, such as the introduction of new farming techniques and new marketing opportunities, one could expect farming patterns to continue to undergo change long after the scheme had been launched.

The writer knew from his own earlier experiences in the valley, however, that farmers seemed to react differently to these various influences on them. Whereas one farmer might change his cropping range in response to an identified opportunity, his neighbour might choose not to. Whereas one might choose to crop his land the whole year round, another might concentrate only on winter crops. While one might join the local co-operative, his neighbour did not. Often such differences from farm to farm seemed to be unrelated to any clear differences in the physical or other conditions on the farms, yet regional differences were known to exist across the project.

It therefore seemed necessary, as the second aim, to examine a range of these farm and farmer variables to seek interrelationships between them in order to see if there were explicable geographical patterns to the land use and other features at the local farm level, or to see if most of them were entirely random patterns. This required the use of long questionnaires to a representative sample of farmers, and as this work progressed it became increasingly clear, in many cases, that there were geographical differences especially between the older-established northern farms and the more recently-settled farms in the much more arid southern part of the project. These differences were seen not only in the crops grown and the seasonal cropping emphasis. The greater amounts of citrus grown in the north within all year cropping programmes, with more vegetables grown in the south within winter cropping programmes, partly reflect different physical conditions, and is a simple example of spatial variety.

Several spatial differences are often more complex, however, than this and the reasons for these are not always clear although it is hoped that this thesis makes these relationships clearer than was previously seen. The use of local markets is clearly related to farm location, for example, but often the relationships are less obvious than this. As an instance of this the role of the commission agents as produce-marketing agents, and suppliers of farm needs and credits, is much more dominant in the south where farm indebtedness seems to result from the strength of this farmer-agent relationship. In the north, on the other hand, the role of these agents is much more limited probably because a wider range of farm supply and credit sources are available there.

In some cases no clear explanation can be offered for the relationships seen, but it is hoped that what has been demonstrated here may form the basis for other more detailed studies to explore these points. In particular the writer hoped to further explore the spatial pattern of diffusion of new agricultural techniques such as drip irrigation and the use of plastic covers to speed crop growth. While some reference is made to this in the study the data base proved insufficient to reach clear conclusions.

1.2 Literature Review

As was stated earlier, the Jordan Valley and its irrigation potential has been the subject of several studies particularly since the 1950s. These studies have varied in their nature and coverage but broadly fall into three main categories. The first include the technical feasibility studies, such as those by Baker-Harza, Dar Al Handaseh and Sir Murdoch MacDonald and Partners, which also reviewed the environmental and other background information to the particular developments being examined. The second category consisted of various more academic studies with foundations in geography, agricultural economics and even politics. Most of these have been Ph.D. theses such as those by Dajani, Manners, Sutcliffe, Sahawneh and Saleh. A third group of studies are various reports on certain aspects of the Jordan Valley. These include a number of surveys made by the Department of Statistics of the Jordanian Government and other bodies mainly on aspects of the agricultural development of the valley.

It is neither possible nor necessary to consider all of these studies here, not least because some of them have little relevance to the present study, but the more important deserve a mention. The first comprehensive study of the resources of the Jordan Valley, on which the East Ghor Canal Project is largely based, was made by co-operation between the two American civil engineering consulting firms of Michael Baker Jr, and the Harza Engineering Company between 1953-55.[1] Commissioned by the Jordan Government, the eight volume Baker-Harza Master Plan Report laid out a plan to develop the valley's land and water resources by means of an irrigation canal along the east ghor of the valley fed from the Yarmouk River, together with ancillary facilities (Fig. 1.1). The report included hydrological, geological, economic, land classification and other studies relevant to the development.

Following on the commencement of the East Ghor Canal Project, based on some of the Baker-Harza proposals, the Jordan Government commissioned a number of other studies in the 1960s to look at further possible developments of the valley's agriculture, sometimes involving modifications to the original Baker-Harza proposals, sometimes simply providing additional information on the valley. These studies included those of the Yugoslav Energoproject Company which looked at the feasibility of constructing storage dams on the Yarmouk River and some of the side wadis to increase the amount of controlled water flow into the project.[2] The British firm of Sir Murdoch MacDonald and Partners conducted a series of studies of the water resources of the Jordan Valley, the most noted of which, East Bank Jordan Water Resources published in 1965, partly dealt with the catchment characteristics of the wadis on the east side of the valley.[3] This led soon after to the construction of dams on several of these wadis.

In 1969 the Dutch Netherlands Engineering Consultants of the Hague and Dar Al Handaseh of Beirut jointly completed a comprehensive study of the agricultural and socio-economic aspects of the valley, including soil and land classification.[4] Material from several of these and other studies has proved of great value in the review of the valley's physical environment presented in the next chapter.

While many of the more academic studies by individual researchers in the valley did not attempt, like these professional reports, to survey the range of basic resources and make plans or recommendations on them, there were a few university-based studies that were of this more "applied" type. A small Durham University Team examined erosion rates from two of the uncontrolled catchments overlooking the ghor in 1967.[5] As early as 1957 Dajani's thesis in agricultural economics on the evaluation of the likely impact of the Baker-Harza development plan, employed cost-benefit analysis to show that the project could give benefits 2½ times as great as the costs.[6]

Two other doctoral theses, completed about a decade later, were amongst the first to look at some of the actual impacts of the project by contacting farmers within the project area. Sutcliffe attempted to assess the social, economic, political and psychological effects five years after the project began on the farmers he interviewed over the period 1961-66.[7] He also considered the policy implications of these impacts and employed hypothesis-testing methods, to seek relationships between various aspects of modernization and their political effects. The study concluded with a model of the processes of change. It might be noted that part of the present thesis follows a similar pattern of hypothesis-testing, but whereas Sutcliffe limited his survey to 278 farmers found in only five villages in the northern project area, the present writer used a larger and much more widely dispersed sample, as well as an earlier, smaller reconnaissance sample.

Manners' study, also completed in 1969, focused on the efficiency of water utilization in the valley.[8] Pointing out that existing estimates of water availability were often crude, he attempted to improve on these to show that these resources were less copious than formerly believed. In particular he noted that current methods of farm irrigation were very wasteful of these scarce water resources, and for this reason called for major support programmes to demonstrate to farmers better methods of irrigated agriculture.

Sahawneh's study in 1970 considered irrigation generally in Jordan and its importance to the nation.[9] Using existing sources of information as well as interviews with agricultural officials, the study reviewed the character and development of the East Ghor Canal Project offering certain criticisms of it. These included aspects of the land reform programme and the need to raise water prices in order to encourage the more economical use of water. He also called for the establishment of an autonomous body to run the project, a development that has since come about.

Lastly one can note Saleh's study which concentrated on the physical environment of the valley and the related land use patterns.[10] While much of the study is essentially descriptive, he appeared to develop his own classification of soil associations and conducted fieldwork in four villages on their land use patterns.

The third category of these studies included some reports and specific studies, related directly to the development of agriculture in the Jordan Valley in general and the East Ghor Canal Project in particular. Awwad who was working for the US-AID in Jordan examined the change in production and income in the project area for the 1965/66 crop year for comparison with years just before and after the project commenced.[11] A forecast of agricultural trends to 1971 in the project was attempted using a sample of 120 farm units. Awwad recommended improvements in the agricultural extension services and encouragement for the private sector to provide the facilities the agricultural developments would need.

Hezleton of the Royal Scientific Society of Jordan in 1974 examined and evaluated the impact of the project's land reform laws upon land tenure, consolidation and distribution.[12] The study concluded that the land reform laws were implemented "with some leniency". However, the study acknowledged the success of the laws in reducing the concentration of land ownership in few hands but also its failure to regulate the relationship between the landlords and their tenants.

Sharab, also of the Royal Scientific Society, examined the agro-economic aspects of tenancy in the East Jordan Valley.[13] The study was based on the selection of two samples during the crop season 1973/74. The first sample included 209 tenants and 166 corresponding landlords, in order to collect socio-economic data, while the second sample involved 143 farmers. Data was collected on farm costs and incomes. The study aimed to pinpoint the features of the tenants and their landlords as well as examining relationships between the two parties. It also attempted to study the costs and incomes in relation to land tenure status. One of the main findings of the study was a criticism of the enforcement of the land reform laws of the project. A large number of absentee landlords were found. Some holdings exceeded the working capacity of the family labour. It also noted that tenants were deprived of credit facilities and there was a lack of contact with the extension services.

Apart from these major studies of the valley's agricultural development, a number of geographers and others have written more briefly about the topic. These have included Davies who visited Jordan in 1956 and wrote of irrigation in Jordan and its possible development.[14] He concluded that irrigation development could help the country's economy and believed that better utilization of the waters of both the Jordan and Yarmouk Rivers was required. The implementation of plans such as that by Bunger or Baker-Harza would be "unrealistic" without removing the political tension with Israel and also a project based only on the Yarmouk River would be "wasteful".

1.3 Sources of Data

The data used in this study has been derived from three main sources. First, many of the studies already referred to, whether technical reports or theses, contain much useful background and detailed material. In addition a number of government publications and statistical reports have been used.

A second major source of data has been the records of the East Ghor Canal Project. The crop data used in Chapters 6 and 7, as well as some other information on the water income of the main canal and the farming character of sampled farm units come from this source. The third major source of data has come by fieldwork for information unavailable by any other means.

The Fieldwork

Two main types of fieldwork were carried out during the various field seasons involved in preparing this thesis: interviews with officials of the project authority and other related agencies, and interviews with many farmers conducted in the two main field seasons of 1978/9 and 1979/80.

Four field visits were made to the valley, the first two of which were mainly of a reconnaissance nature. The first of these was made in December 1976 - January 1977 when the study area was selected. On the second visit for 6 weeks in August - September 1977 the writer toured the whole eastern valley and made preliminary contact with officials of the project for data sources. His first extended (24 weeks) field season took place in the autumn of 1978 when he interviewed 160 farmers. This work was planned for the summer of 1978 but the unusually hot conditions meant that many farmers left the valley and caused the postponement of the work until mid-September. Library work replaced this during the summer. From the end of November until early January 1979 work continued in the headquarters of the East Ghor Canal Project extracting crop data.

Four of the 160 farmers used in this first sample survey produced weak and incomplete questionnaires, reducing the sample to 156. These were distributed as below, giving approximately a 3 per cent sample of the farmers in the east part of the Jordan Valley. As no

East Ghor Canal Project	(116) farmers
Section I	34
Section II (Wadi Yabis)	35
Section III (Kriymeh)	29
Section IV (Deir Alla)	18
Southern Valley	(40) farmers
Extension Area (Ghor Damya)	11
Karameh - S. Shuneh - Kafrain	29
Total sample	156

list of farmers existed at this time, by which the writer could choose his sample, he attempted to create his own stratified random sampling. He did this by taking some farmers from each area of the valley, these areas being subdivided into strips. He then selected a number of farmers in each strip. In this way each section of the project area as well as the two areas south of the project were covered in order to find out basic information about the farmers and farm services across the whole ghor. The writer himself interviewed each farmer in the sample. A long and elaborate questionnaire was devised for this purpose, not all of which was later used for this study. These questions are detailed in Appendix 1.

The second and the main farmer survey was conducted in the fourth field season which lasted 10 weeks in the spring of 1980. Using the findings of the 1978 questionnaire, the author on this occasion decided to restrict his sample to farmers in the four sections of the project area only, that is in the area south from Adasiyeh to the Zarqa River, covered by the 24 blocks which form the East Ghor Canal Project as it has been defined in this study. It was decided to limit the survey to this area since crop data for the previous 15 years could only be obtained for this area and because the project headquarters had a master list of all farms in this area to assist in the writer's establishment of a better sampling framework than was possible in 1978.

To establish the needed sample size the 116 farms in the project area sampled in 1978 were examined to see what number of yes/no responses was obtained to a specific question.[15] The standard deviation (S) was then calculated using the formula:[16]

$$S = \sqrt{\frac{p \times q \times n_1}{n_1 - 1}}$$

where

S = the standard deviation of the pilot survey

p = proportion of "Noes" in the pilot survey of a specific variable (0.621)

q = proportion of "Yes's" in the pilot survey of the same variable (0.379)

n_1 = the total pilot survey (116)

By substituting for p, q and n_1 in the above mentioned formula the value of S is obtained:

$$S = \sqrt{\frac{0.621 \times 0.379 \times 116}{116 - 1}} = \sqrt{0.2374056}$$

$$= 0.4872428$$

the value of S then is used in the following formula to obtain the required sample size.

$$n = \left(\frac{zs}{d}\right)^2$$

where:

- n = the required size of sample
- S = the standard deviation of the pilot sample
- d = the tolerable margin of error at a specified level of confidence
- z = is taken from the z-table corresponding to the same level of confidence

The selected z was 1.96 at a level of confidence 0.05, therefore d was selected at the same level of confidence (0.05). By substituting these values in the above formula the required sample size was determined as:

$$n = \left(\frac{1.96 \times .4872428}{0.05}\right)^2 = 364.8$$

So the sample size required was 365 farms or approximately 10 per cent of the farms.

The master list held by the authority for the project farms included 3674 farm units. This was accepted as a suitable sampling frame from which the 365 farm units could be derived. Before the selection of the individual farms took place, the project area was divided into four sections:

Section I covering the blocks 1 to 10 (except block 3 which is still excluded from the project) located between the Yarmouk River in the north and Wadi Ziqlab in the south; Section II (Blocks 11-18) extending from Wadi Ziqlab in the north to Wadi Abu Kharroub in the south; Section III (Blocks 19-22) located between Wadi Abu Kharroub in the north and Wadi El Khor in the south, and Section IV which included the largest Block 23 and also Block 24 just south of Zarqa River (Fig. 1.2).

For each one of the four sections all the farms were listed and numbered from north to south. One was selected at random from the first ten and every next tenth was taken until the end of the list. In this way a widely scattered, stratified, systematic random sample was obtained. But when the questionnaires were tabulated, 12 of them were

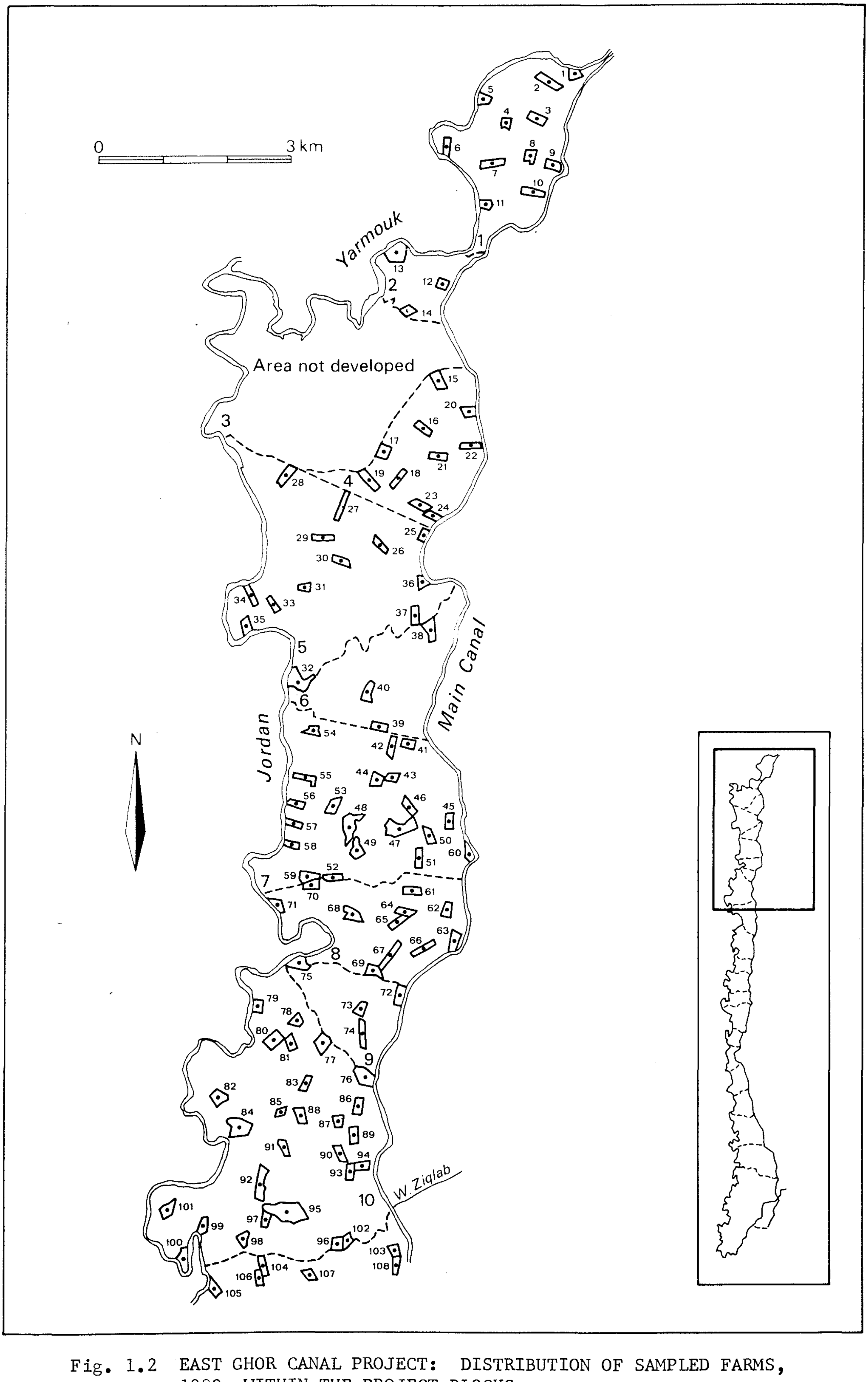

Fig. 1.2 EAST GHOR CANAL PROJECT: DISTRIBUTION OF SAMPLED FARMS, 1980, WITHIN THE PROJECT BLOCKS

East Ghor Canal Project

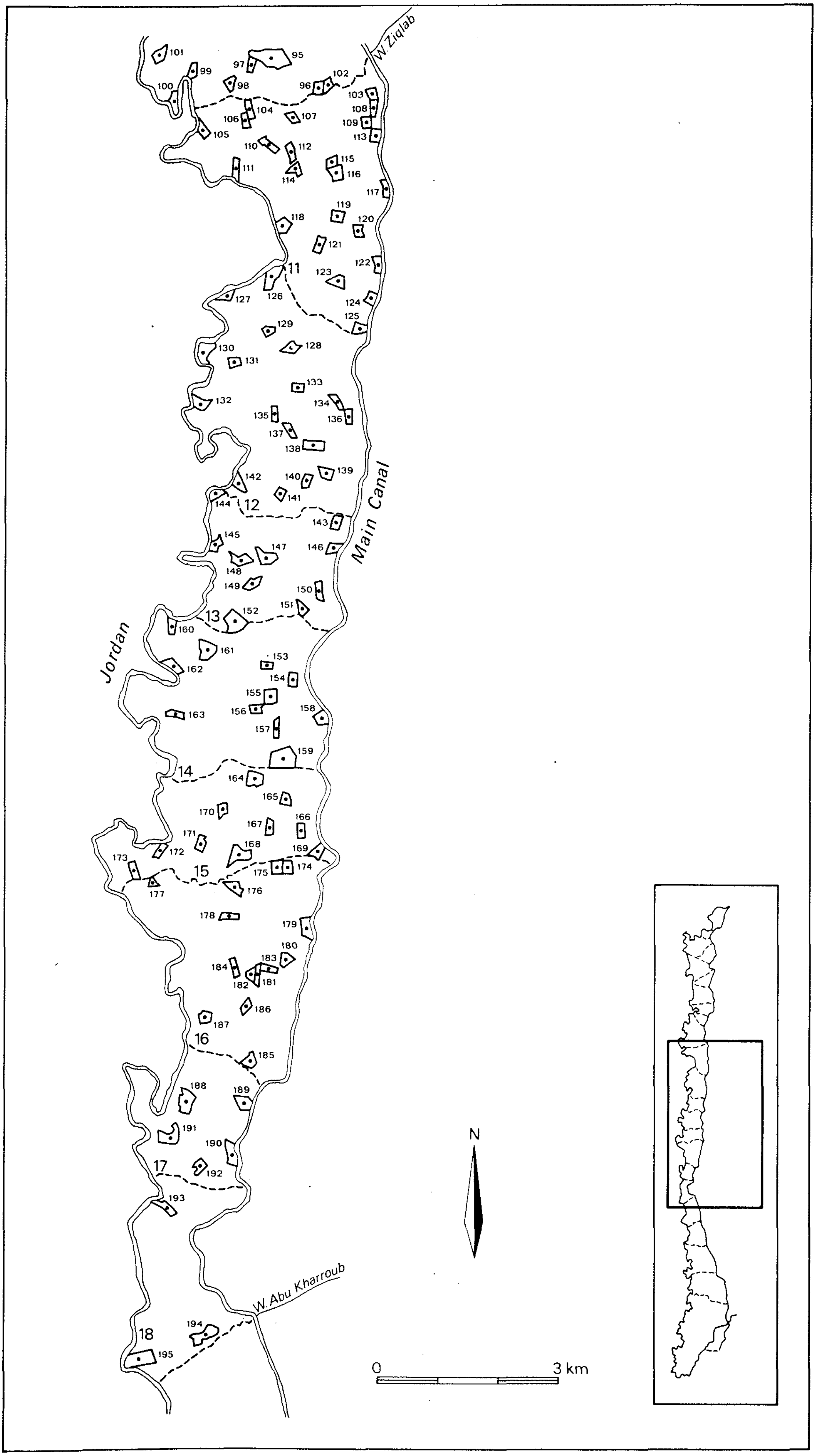

Fig. 1.2 continued

East Ghor Canal Project

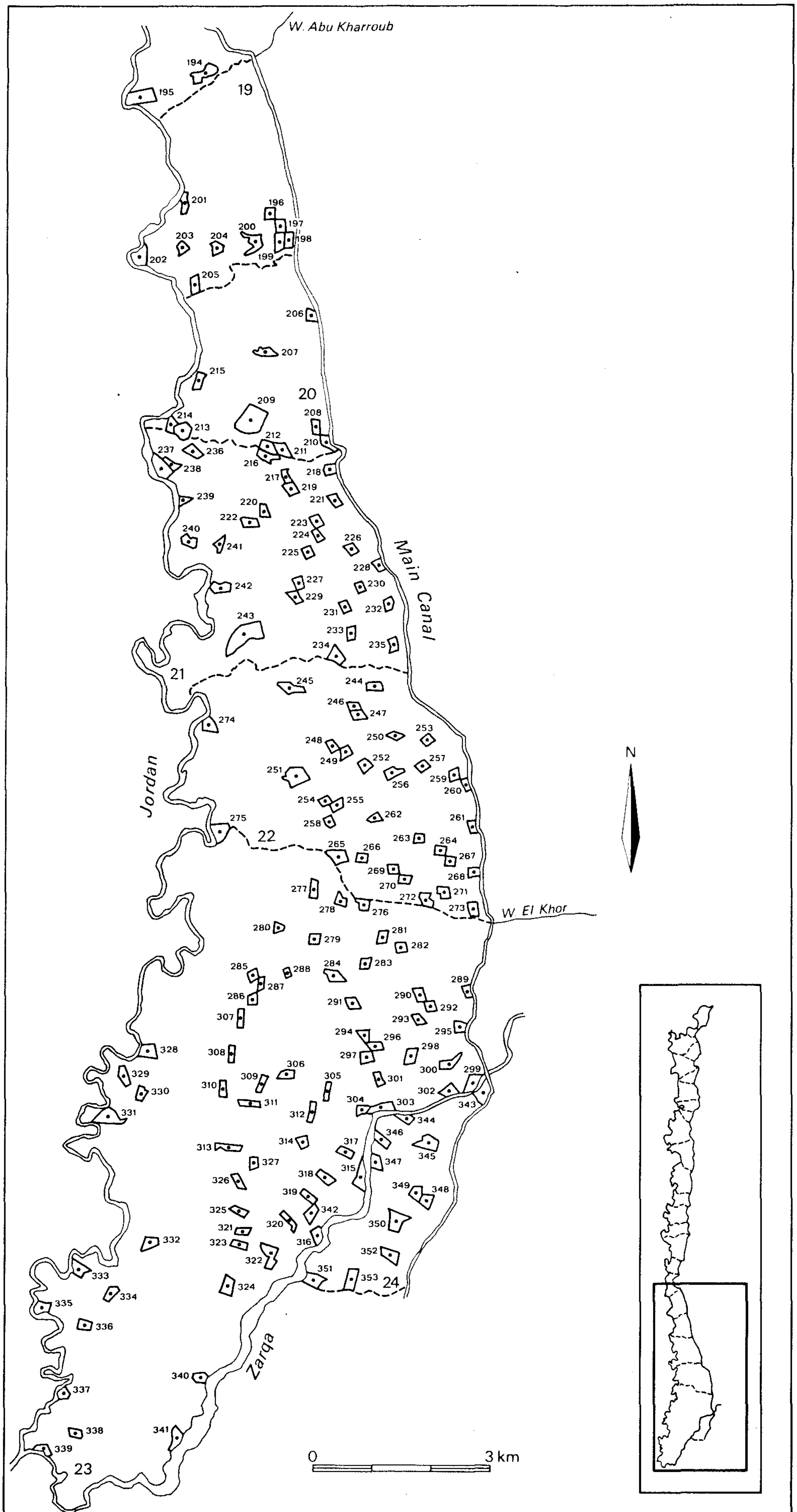

Fig. 1.2 continued

found to be incomplete, therefore they were considered invalid and rejected. However, the remaining 353 valid questionnaires, whose distribution can be seen in Fig. 1.2, were located across the four sections as follows:

Section I	102
Section II	93
Section III	80
Section IV	78

It should be noted that despite the removal of the 12 weak questionnaires, the size of the valid sample remained just over 10 per cent of the total of 3471 active farms, since 59 of those units included in the master list had never been farmed and another 144 farms have not been active recently. The questionnaire used in 1980 was modified from the 1978 one especially to get further information on the use of new farming techniques. It was also arranged to have the questionnaires distributed to farmers by the East Ghor Canal Authority water distributors. The 1980 questionnaire is laid out in Appendix 2.

1.4 Methods of Analysis

The study reflects the influence of the growth of quantitative methods in human geographical research in recent years, firstly by seeking to test relationships between a wide range of variables derived from the sample of farmers. The nature of these variables suggested the application of a non-parametric test and since most of them were of a simple categorized (yes/no) type, the chi-square test, frequently used by geographers, seemed the most appropriate. In those cases where the data was insufficient for the needs of the test, this has been noted in the study. Many of the results given in Chapters 5, 8, 9 and 10 and, to a lesser extent, in Chapter 4, are based on chi-square tests of variables.

In the analysis of crop patterns and trends within the project area for the 15 year period 1965-79, reported in Chapters 6 and 7, a fairly simple quantitative technique was applied. Crop combination analysis, used by several geographers elsewhere, has been employed here to determine the length and nature of crop combinations both at the block and individual farm level. To classify the 353 farms sampled in 1980 into broad enterprise types related to the crop combinations, a rather more complex cluster analysis was used which also served as a preparation for the use of the same technique in a rather more elaborate way in later parts of the study. Cluster analysis is a multivariate method of analysis based on the calculation of the coefficient of similarity between the features of the observed population. In this study it has been used at three points. First, as already noted, it was applied at a simple level to classify the 353 farms into enterprise types. In Chapter 10, part of a set of chapters on farmers' use of services, it was again applied to the same 353 farms, this time employing 11 variables connected with farm services. A four fold classification of the sampled farms was derived which clearly distinguished a main northern and a large southern group of farms. On each occasion when cluster analysis was used, discriminant analysis was also employed to check on the validity of the clustering process.

Finally, the same technique was applied again to the sampled farms, this time employing 31 variables covering a wide range of farm and farmer characteristics to see if a more general classification and regionalization of the sample could be derived. The 353 farms were at this final stage put into 9 groups by the classification procedure suggesting that one can see a main southern and a main northern farm type in the project together with a number of subtypes of these two, and others which are more widely dispersed. All of this quantitative analysis involved much use of the University of Southampton PDP and 2970 Computer Services.

1.5 The Layout of the Study

Eleven chapters follow this introduction. Chapter 2 outlines the physical environment and natural resources of the Jordan Valley notably its soils, climatic conditions and water resources which are all vital to irrigated agriculture. Chapter 3 describes the development of irrigation in the valley, particularly the East Ghor Canal Project and its related water management and irrigation techniques.

Chapter 4 examines the land tenure systems in the valley with particular reference to the impact of the land reform programme which formed an essential part of the irrigation project. To this point in the study the main sources of information were the various reports, technical studies and statistical sources, some of which are referred to in the literature review in an earlier part of this chapter.

From Chapter 5 onwards the study is almost entirely based on the author's two sample surveys, especially the 1980 one, farm crop data obtained from the headquarters of the East Ghor Canal Project, and smaller amounts of data from various other agencies in the valley. Because little published census data was available on the farm population in the project area, much of Chapter 5 examines various characteristics of the sampled farmers - their age, experience, education, farm expenditure, use of more advanced farming techniques, and use of family labour. Because of the limitations of the sample size much of the data examining these and other farmer variables used here and in other chapters are subdivided into the four sections of the project area. This also provides a useful basis for discussing the spatial variations in these results from north to south across the project area.

Chapter 6 examines by crop combination analysis the changing patterns of land use across the project area during 1965-79 for different seasons to show the marked geographical variations that occurred across the area at different seasons and years. Changing patterns of land use intensity, as well as crops, are also examined. Whereas Chapter 6 analyses these patterns for the whole project area at the level of its individual blocks within the four sections of the project, Chapter 7 looks at some of these patterns at the individual farm level for four selected blocks. This chapter also makes the first attempt at classifying and regionalizing the 353 sampled farms on the basis of their crop data using cluster analysis as well as crop combination analysis.

Chapters 8, 9 and 10 are concerned with farm services and farmers' use of them. Chapter 8 focuses on farm supplies, including their sources and farmers' methods of payment for them; and marketing channels including the relationships between how farmers market their crops and their other characteristics. Again it becomes clear in this chapter that there are strong geographical variations in the use of these services by the sampled farmers. Chapter 9 looks, in a similar way, at the provision and use of farm credits and loans, while Chapter 10 examines the role of agricultural co-operatives, and the local farmers' association, in the provision of various farm services. A clear distinction often emerges between the farm behaviour of members and non-members of these bodies. Because membership of these organizations within the sample was not equally spread geographically this also has some interesting spatial consequences. Lastly the role of the agricultural extension services, and the use made of them by the sampled farmers, is also examined. As has already been pointed out the chapter ends with an attempt to group and locate the farms on the basis of their varying use of these farm services.

The penultimate chapter (Chapter 11) presents an attempt to classify and regionalize the sampled farms by cluster analysis using the widest possible range of variables. Inevitably with every farm being a unique combination of social, economic and physical conditions one cannot expect any classification to clearly separate all farms into a few discrete groups. Overlaps are bound to occur, but it is hoped that the nine-fold grouping produced here, which shows clear spatial features, is a worthwhile contribution to a better understanding of the geographical variety within the project farms. The main conclusions of the study are laid out in Chapter 12.

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CHAPTER 2 THE PHYSICAL ENVIRONMENT

2.1 Topographic Background

The Jordan Valley is part of the rift system which extends over 50 degrees of latitude from the northern borders of Syria and the Beqa'a Valley of Lebanon, and continues south of the Dead Sea through the Red Sea into east Africa.[1] Throughout its 6000 km. (3700 miles) length, the rift's lowest land point (-396 metres), and the deepest point on the earth's surface, is reached in the Jordan Valley just north of the Dead Sea.[2] Located at 32 degrees north, and with its whole surface well below sea level, the Jordan Valley is one of the hottest places on earth and is therefore conducive, in some ways, to intensive irrigated agriculture.

The valley between Lake Tiberias in the north and the Dead Sea in the south (Fig. 2.1) is about 105 km. long, but its floor varies in width from about 20 km. in the south to about 10 km. in the north with a minimum of 4 to 5 km. in the central part. One can note two major slope directions to the valley floor. First, there is an overall drop of 180 metres from north to south between Tiberias and the Dead Sea giving an average gradient of .18 per cent. Second, the floor is largely composed of two terraces (el ghor) lying below the eastern and western escarpments of the rift valley. The eastern terrace which is never more than a few kilometres wide, slopes gently down towards the Jordan River and forms the main cultivable area of the East Ghor Canal Project. Below this terrace and separated from it by a narrow zone of dissected and uncultivable badland (el katar) is the present river flood plain (el zor) which is also cultivable.

The main faulting which created the valley probably took place at the start of the Miocene period, although Bentor believes that major north-south faults, which influenced later land-forming processes, occurred as early as Jurassic-Triassic times.[3] It also appears that the rifting was not simply a splitting away of the Arabian block from the African by a shift of the Trans-Jordanian plateau eastwards and Quennell has suggested, on the basis of identical rock structures on both sides of the valley, that there was a northward movement of about 107 km. on the eastern side of the rift.[4]

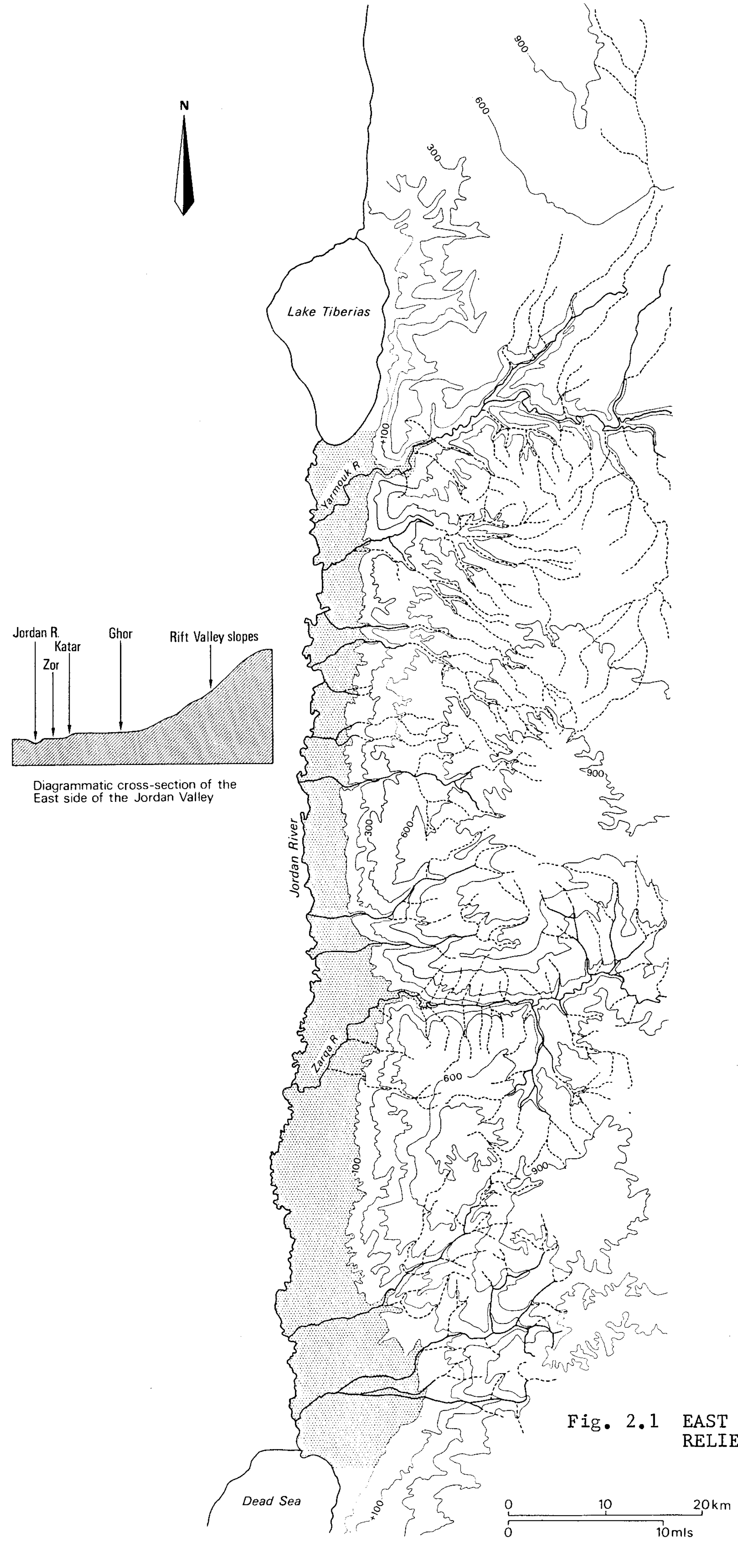

Fig. 2.1 EAST JORDAN VALLEY: RELIEF AND LOCATION

Sufficient valley development had occurred by the Pliocene for a series of lakes to form. At least two lakes occupied this area during the upper Pliocene with most of the present area of Lake Tiberias included in the northern one, and a southern lake extending well south of the present Dead Sea, with the two separated in the Zarqa River area. With climatic fluctuations the extent of these lakes varied and their freshwater character changed to brackish and even into playa marsh until wetter climatic conditions extended their areas again.[5] By the middle Pleistocene one vast lake, known as the Lisan Sea covered the whole valley from Tiberias in the north to 30 km. south of the present shore of the Dead Sea.[6] But radical changes occurred in the middle and upper Pleistocene which saw the splitting up and lowering of the level of the Lisan Sea leading to the creation of the present two water bodies, Tiberias and the Dead Sea, with a covering of Lisan marls on much of the valley floor between. With Lake Tiberias at a considerably higher level than the Dead Sea, drainage, which later developed into the Jordan River, cut across and into this valley floor eventually creating the ghor and zor surfaces to help develop the range of soil conditions to be considered in the next section. What also contributed to the variety in those soils was the effect of downwashing of material from the escarpment slopes above by wadi flows and other means so that most soils now in the valley are formed of colluvial or alluvial material overlying the Lisan marl, rather than simply being lacustrine-derived. While little more need be said of the topography of the valley, and the eastern ghor in particular, on which the irrigation project is largely based, it is necessary to give more attention to the soils.

2.2 Soils and Land Classification

2.2.1 Introduction

The characteristics and qualities of the soils of the valley are an essential element of the physical environment not only in terms of their influence on crop nutrition, because certain soils can grow a wider range of crops or give higher yields, but also in terms of the water demand of crops on different soils. A heavier soil, for example, may retain more water so that less, or less frequent, irrigation is required, although its less perfect drainage may create other problems. Previous studies of the soils of the valley, summarized here, have tended to emphasize such soil cropping qualities rather than their profile characteristics because of their irrigation potential. As a result soil maps were largely drawn up in the form of land classification, rather than soil series, maps.

Several studies have been made of the soils of sections of, or the whole of, the East Ghor Canal Project area as part of the evaluation of the area for irrigation development. The first and most comprehensive survey was carried out by the American Baker and Harza consultancy firms in 1953-4.[7] Their maps of land classes, reproduced in Fig. 2.2 were drawn up according to the land categories established by the US Bureau of Reclamation. Their eight volume Master Plan Report for the development of the physical resources of the valley was based on 7800 soil profile pits and some 11,580 soil samples analysed for salinity and alkalinity. Other tests were carried out on infiltration, total soluble salts, conductivity, cation exchange capacity and nutrient status.

Other studies have included that by Moorman who briefly examined the valley soils, as part of his general study of Jordan's soils in 1959,[8] but his study lacked sufficient detail for most agricultural purposes. The German Geological Mission to Jordan in 1965 carried out a survey of 80 sq. km. in the valley around Deir Alla.[9] This was to establish a representative soil map of a block of the valley stretching from the eastern scarp to the River Jordan and to fill in the detail not obtainable in the Baker-Harza survey. This German survey, based on some 36 soil pits, helped determine the range of soil types now recognized in the valley. At about the same time the Institute of Pedology of Zagreb made a survey of salinity and alkalinity problems in the valley. Another study of the valley's soils was carried out by the Dar Al Handaseh consulting firm as part of their agro-economic study of the valley in 1969.[10] Shortly after, Saleh summarized the main features of soil conditions in his study of the valley.[11] Like the Baker-Harza survey, the Dar Al Handaseh and Saleh's studies were

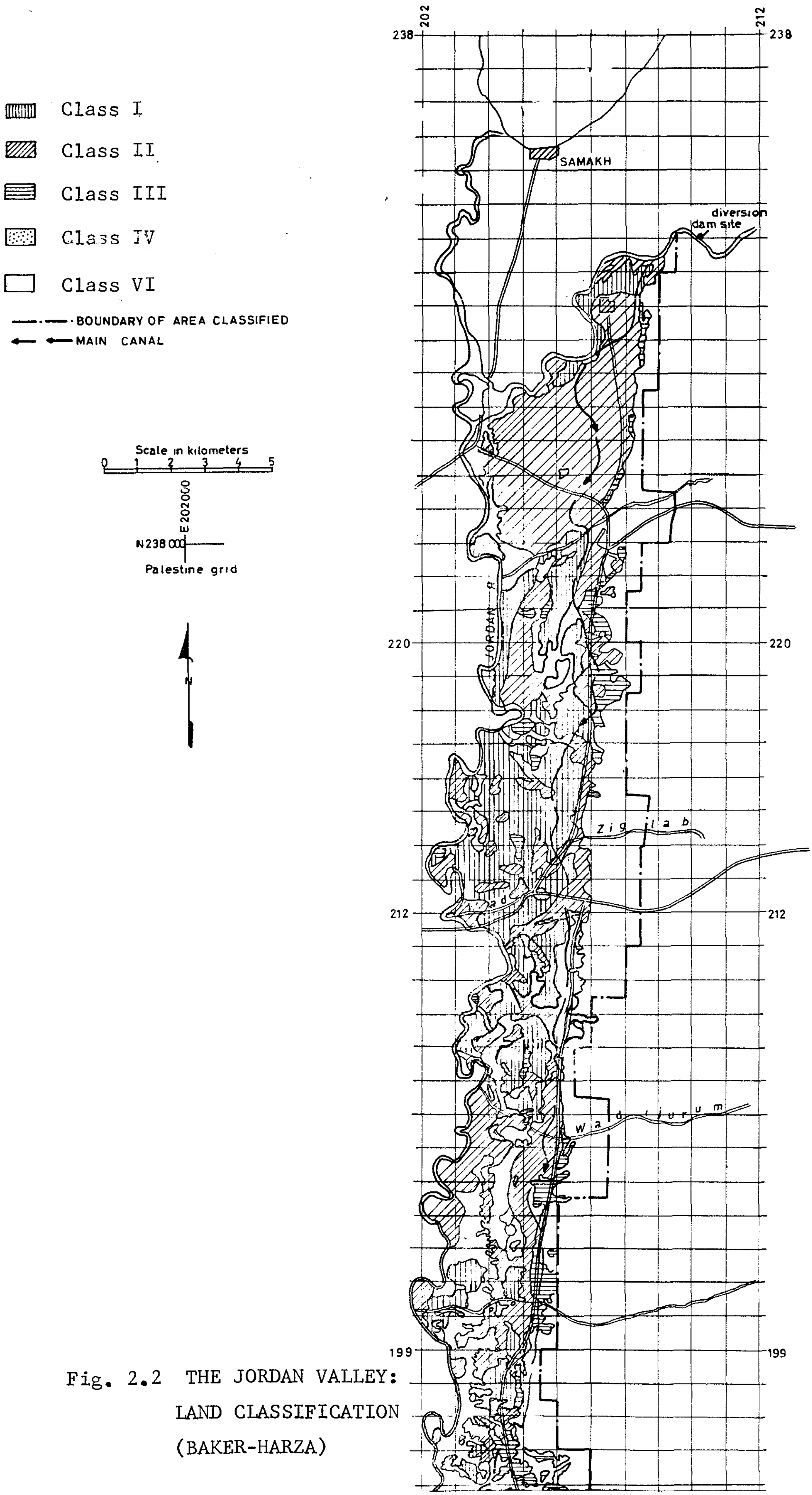

Fig. 2.2 THE JORDAN VALLEY: LAND CLASSIFICATION (BAKER-HARZA)

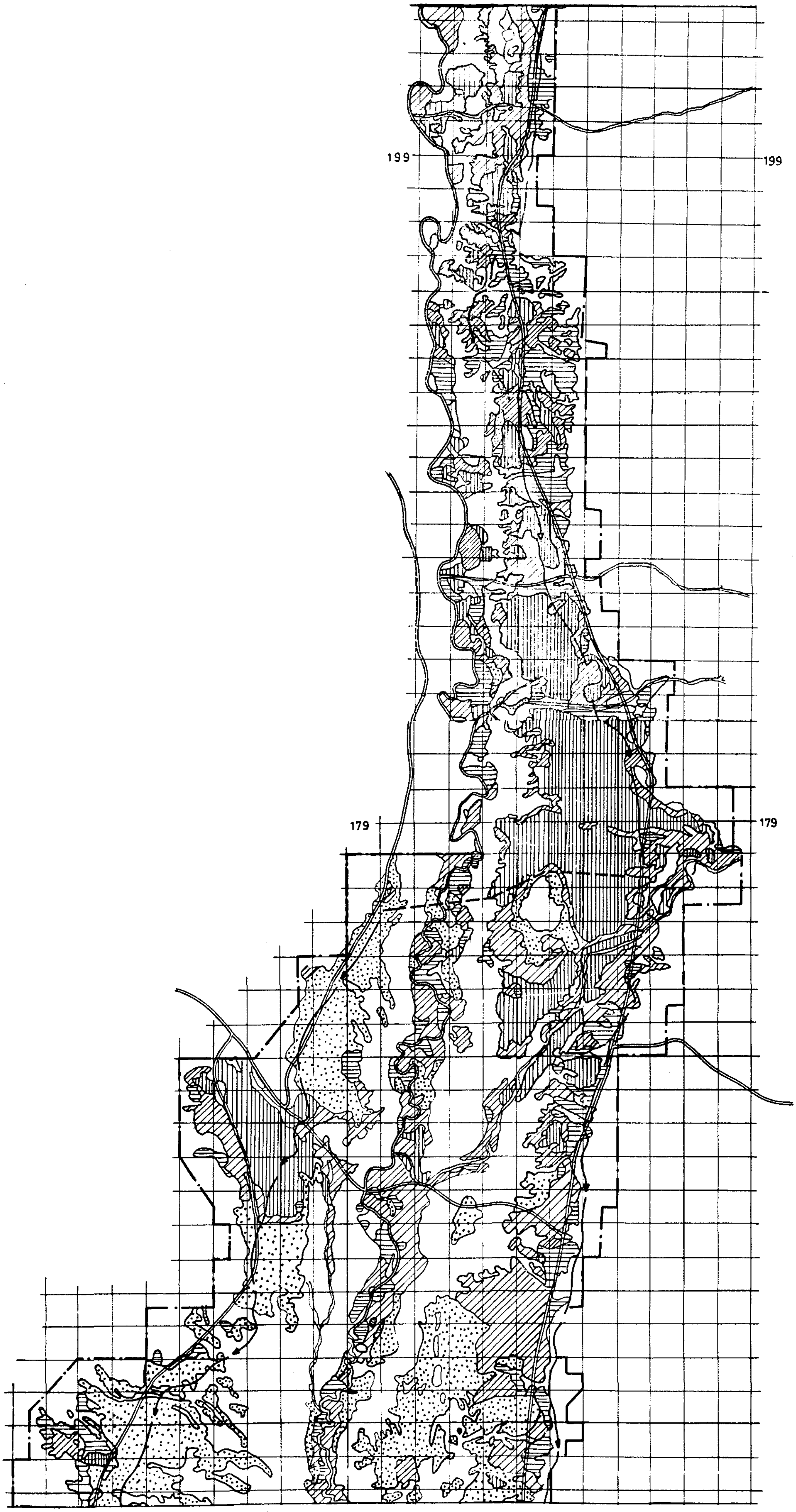

Fig. 2.2 continued

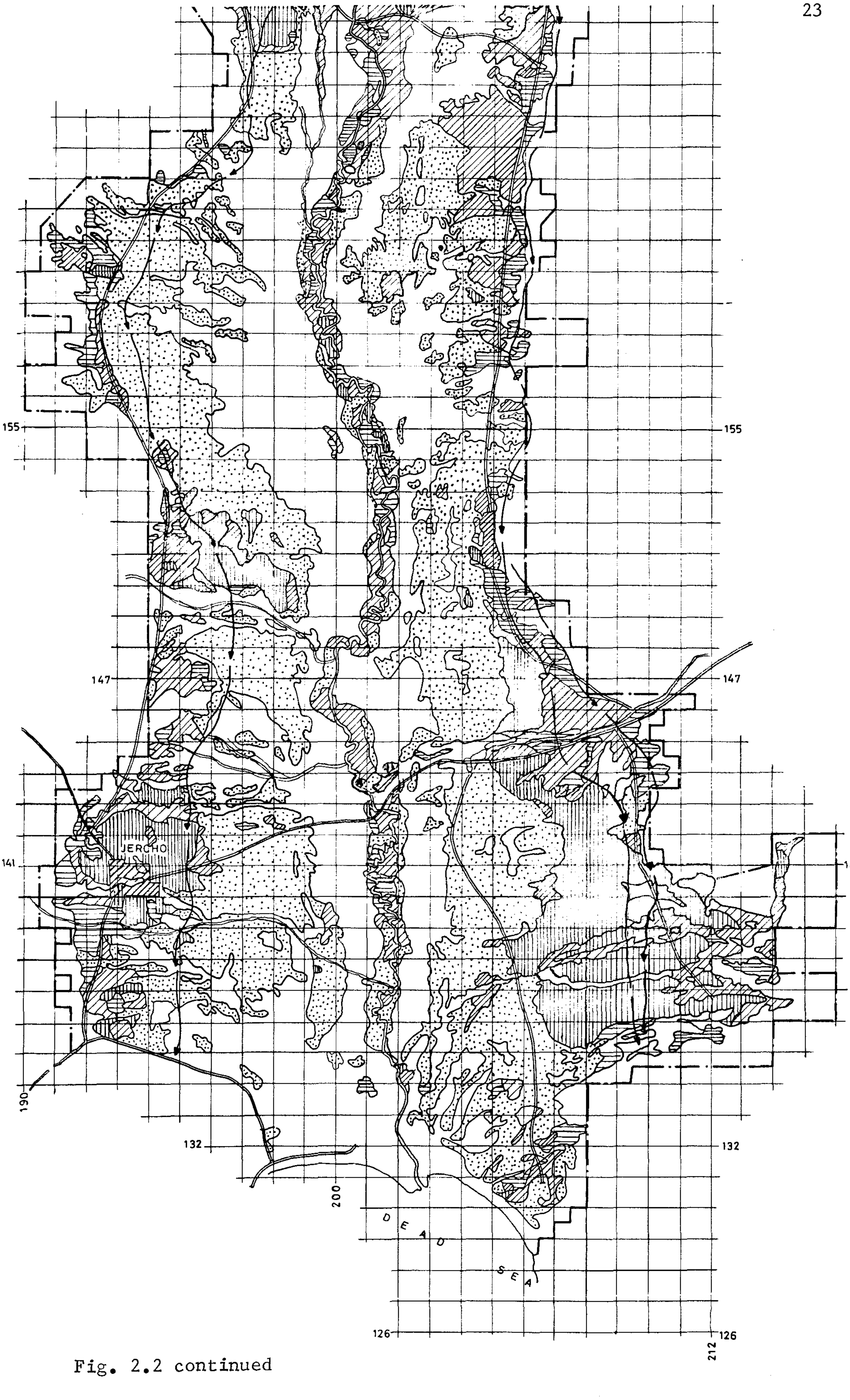

Fig. 2.2 continued

comprehensive enough to establish some of the detail of the soil series and features of the valley. It is convenient, therefore, to briefly refer to all three sources, beginning with the Dar Al Handaseh work since this provides the best analysis of the distribution of the main textural types of soils.

2.2.2 Types of Soils

Dar Al Handaseh in their study of the soils of both the east and west sides of the Jordan Valley divided them into 27 mapping units, or series, only the more important of which will be considered here. Table 2.1 summarizes the extent of each mapping unit in various parts of the eastern valley. The units were first divided according to their original mode of formation into the lacustrine, fluviatile and colluvial-derived soils and the alluvial soils. The most important and extensive of these are the ones derived from fluviatile-colluvial sediments which give rise to a number of useful soil series including the subtypes of the widespread Ghor 1 and Ghor 2 series shown in Table 2.1. Much less important, because they are rather less extensive or far less useful, are the soils derived from the lacustrine sediments. These include only two mapping units in the east part of the valley, the small areas of Lisan series and the much more extensive badland soil areas where older valley deposits have been exposed. 70 per cent of these badland soils are in the southern part of the valley and occupy the zone of broken topography (el katar) between the ghor and the zor. These badly eroded soils were considered non-arable under both the Dar al Handaseh and the Baker-Harza classification and need no further consideration here.

The fluviatile-colluvially derived soils should therefore claim most of our attention. They subdivide, as Table 2.1 indicates, into the Ghor 1 series containing four main textural types each containing several phases. The Ghor 2 series are made up of twelve mapping units several of which include a number of phases. The Ghor 1 series are twice as extensive as the Ghor 2 series. More of both of the series are found in the north of the valley but the Ghor 2 series is much more common than the Ghor 1 series in the south.

TABLE (2.1) EAST JORDAN VALLEY:

AREAS OF SOIL MAPPING UNITS (DAR AL-HANDASEH)

	NORTHERN VALLEY			SOUTHERN VALLEY		
	total area	below main canal	above main canal	total area	below main canal	above main canal
A) LACUSTRINE SEDIMENTS						
1. Lisan series	-	-	-	-	-	-
Moderately eroded phase	-	-	-	500	500	-
Hilly phase	-	-	-	700	700	-
2. Hugim series	-	-	-	-	-	-
Moderately eroded phase	-	-	-	-	-	-
severely eroded phase	-	-	-	-	-	-
hilly phase	-	-	-	-	-	-
3. Badland (miscellaneous land type)	32,150	22,150	100	70,350	61,850	8,500
B) FLUVIATILE - COLLUVIAL SEDIMENTS						
Ghor - 1 series						
4. Fine textured type	14,150	9,800	4,350	-	-	-
stony/very stony phase	550	-	550	-	-	-
sloping phase	500	400	100	-	-	-
poorly drained phase	1,650	1,550	100	-	-	-
5. Moderately fine textured type	77,350	65,350	12,000	56,490	48,150	8,340
Slightly eroded phase	100	-	100	3,400	3,400	-
Moderately eroded phase	-	-	-	1,800	1,800	-
Stony/very stony phase	6,700	2,500	4,200	2,330	1,650	680
Slightly eroded, stony/ very stony phase	-	-	-	1,310	-	1,310
Moderately eroded, stony/ very stony phase	-	-	-	500	-	500
Sloping phase, moderately eroded phase	13,100	9,550	3,550	50	50	-
Sloping phase, stony/ very stony phase	4,100	850	3,250	-	-	-
Rolling phase	-	-	-	200	200	-
Poorly drained phase	2,800	2,800	-	-	-	-
6. Medium textured type	3,000	2,500	500	23,150	17,600	5,550
Slightly eroded phase	-	-	-	4,380	4,250	130
Stony/very stony phase	800	-	800	2,390	1,250	1,140
Slightly eroded, stony/ very stony phase	-	-	-	2,400	1,050	1,350
Sloping phase	700	550	150	-	-	-
Rolling phase	-	-	-	100	100	-
Poorly drained phase	-	-	-	1,330	1,200	130
7. Moderately coarse textured type	550	250	300	9,350	8.750	600
Slightly eroded phase	-	-	-	950	600	350
Moderately eroded phase	-	-	-	550	550	-
Stony/very stony phase	-	-	-	2,930	2,100	830
Slightly eroded, stony/very stony phase	-	-	-	-	-	-
Moderately eroded, stony/ very stony phase	-	-	-	250	250	-
Sloping phase	300	150	150	-	-	-
Rolling phase	-	-	-	1,350	1,350	-
Ghor - 2 series						
8. Moderately fine textured type	1,750	1,300	450	5,775	3,750	2,025
Slightly eroded phase	-	-	-	800	800	-
Moderately eroded phase	100	100	-	200	200	-
Sloping phase	400	400	-	-	-	-
Rolling phase	-	-	-	550)	550)	-
	-	-	-	2,000)	2,000)	-
Hilly phase	8.850	8.150	700	-	-	-
9. Medium textured type	-	-	-	3,290	2,550	740
Slightly eroded phase	-	-	-	1,990	1,550	440
Sloping, moderately eroded phase	100	100	-	-	-	-
Rolling phase	-	-	-	750	750	-
10. Nukheil series,						
Slightly eroded phase	-	-	-	8,050	8,050	-
Moderately eroded phase	-	-	-	400	400	-
Poorly drained phase	2,250	2,250	-	-	-	-

TABLE (2.1) continued..

		NORTHERN VALLEY			SOUTHERN VALLEY		
		total area	below main canal	above main canal	total area	below main canal	above main canal
11.	Bassat series	800	800	-	150	150	-
12.	Ghor - Lisan - 1 series	800	800	-	1,450	1.450	-
	Slightly eroded phase	-	-	-	2,700	2,700	-
	Stony/very stony phase	-	-	-	200	200	-
	Sloping phase	200	200	-	-	-	-
	Rolling phase	-	-	-	150	150	-
13.	Ghor - Lisan - 2 series	1,200	1,200	-	650	650	-
	Sloping phase	350	350	-	-	-	-
	Rolling phase	-	-	-	150	150	-
14.	Ghor - Lisan complex	-	-	-	600	600	-
	Moderately eroded phase	-	-	-	200	200	-
	Rolling phase	-	-	-	-	-	-
	Poorly drained phase	-	-	-	500	500	-
15.	Lisan marl outcrop complex	200	200	-	890	-	890
	Slightly eroded phase	-	-	-	-	-	-
	Moderately eroded phase	-	-	-	1,550	1,550	-
	Severely eroded phase	1.450	1,300	150	5,400	5,400	-
	Rolling phase	650	600	50	9.250	5.250	4,000
	Hilly phase	-	-	-	350	-	350
	Rolling, poorly drained phase	1,500	1,500	-	-	-	-
16.	Wadi Fringe association	8.600	4.450	4,150	11,550	5.000	6,550
17.	Foothill association	15.500	1,500	4.000	18.450	6,600	11,850
18.	Stony land (miscellaneous land type)	-	-	-	1,050	400	650
19.	Gullied land (miscellaneous land type)	-	-	-	-	-	-
C)	ALLUVIAL SEDIMENTS						
20.	Zor series moderately fine textured type	650	-		-	-	
21.	Zor series medium textured type	21,300	(10,400)*		14,800	(14,800)	
	moderately eroded phase	150	(150)		-	-	
	stony/very stony phase	-	-		-	-	
	poorly drained phase	2,800	-		350	(350)	
22.	Zor series moderately coarse textured type	5,850	(4,250)		3,950	(2,900)	
	poorly drained phase	550	(550)		-	-	
23.	Zor - Lisan series	1,450	(700)		2,800	(2,800)	
24.	Alluvial land (miscellaneous land type)	4,050	(3,850)		2,600	(2,600)	
D)	OTHER MISCELLANEOUS LAND TYPES						
25.	Playas	-	-	-	-	-	-
26.	Rock land	650	-	650	1,600	1,500	100
27.	River wash						
	Beaches	500	500	-	2,350	2,350	-
	Urban areas	1,850	550	1,300	2,650	1,400	1,250
	Tells	900	800	100	150	100	50

* (10400) = of which 10,400 dunums low bottom phase

Source: Dar Al Handaseh et al (1969) <u>Jordan Valley Project: Agro and Socio Economic Study, Final Report,</u> Annex C1, pp. 10-12.

Type differentiation was largely made by Dar Al-Handaseh on a combination of textural conditions and other profile features. Although it is the texture of the plough layer which was applied as a major criterion, differences between the texture of the top soil and the lower root zone were small so that in practice the texture of the entire root zone of the soil was taken together.

The most notable features of the Ghor 1 series were the extensive areas in all parts of the valley of medium or moderately-fine textured soils (clay loams, silty clay loams and loams) and the much more limited extent of both the finest and coarser textured types. The finer textured series - generally a dark coloured soil with slow internal and external drainage - only occurs in the north while the coarser textured types occur much more in the south.

Most of the soils in the Ghor 1 grouping have few limitations on their cultivation although it can be seen in Table 2.1 that some were classed as stony, eroded or occurring on sloping land. Among the soils in the Ghor 2 series, however, there are a number with more serious limitations, in some cases because of their sloping or eroded condition, in other cases because of their profile characteristics. The Nukheil series, for example, has been mapped where there is fossil salt in the root zone giving an indurated, sometimes gypsum-rich, horizon. The Ghor-Lisan soils are also of limited irrigation value because they only have a shallow colluvial or fluviatial layer overlying the Lisan marl. This gives a moderately fine-textured soil of weak structure and moderate compaction at depth. Fortunately these are not as widespread on the east ghor as on the west. Both the Nukheil and Lisan series also tend to be less common in the northern part of the eastern valley than in the south.

Alluvium-derived soils form the third main group mapped by Dar Al-Handaseh in the eastern valley. Essentially forming the main soils of the zor developed on the recent deposits of the Jordan flood plain, they were classed into five mapping units. All have youthful profiles so that differentiation is again largely on the basis of texture. Medium to coarse-textured types are most common, helping to give them good drainage in spite of a naturally high water table near the river.

Because the further detail of the Dar Al Handaseh survey exceeds the needs of this study - beyond showing that most valley soils are of medium textures while some suffer various physical or chemical restrictions on their use - it is convenient to group the main valley soils into five major associations largely on the basis of their mode of formation as outlined by Saleh.[11] These associations are:

1 Thick alluvium over marl

2 Thin alluvium over marl

3 Soils formed on residual Lisan marl material

4 Soils formed on residual limestone material

5 Recent alluvium on the zor (flood plain)

1. <u>Thick alluvium over marl</u>

This association, roughly equivalent to the main fluviatile-colluvial soils mapped by Dar Al Handaseh, is one of the most important in the valley since it is widely distributed in the Ghor from the Yarmouk River in the north to the Dead Sea in the south. The soils in this group have well developed profiles as a result of the depth of the alluvium over the marl and are especially common on the alluvial fans which have washed down from the eastern hills. They can be divided into two main types: reddish-brown soils and greyish-brown soils.

The reddish-brown soils are characterised by deep, uniform profiles rich in silt or clay, giving their generally high moisture-holding capacities and infiltration rates ranging between 0.5 and 68 mm per hour. They are therefore particulary useful for summer as well as winter cropping since they require less irrigation, especially as they are mainly found north of the Zarqa River where rainfall amounts range between 250 and 450 mm per year. The German Geological Mission divided these soils into two main phases of which one, a silty loam can be found mostly to the south around Wadi Rajib, while a more clay rich phase - a silty clay loam - occurs north of Wadi Rajib. Both have similar chemical status and a freedom from salinity.

The greyish-brown soils in this association largely occur south of River Zarqa where rainfall amounts range from 100 to 250 mm a year. Like their reddish-brown counterparts in the north, the profiles of these soils are deep and well-developed but vary widely in texture, ranging from the heavier clays and clay-loams in the vicinity of the Zarqa River, to much lighter loams and sandy loams in the south. In some cases both heavy and light-textured horizons can be found in the same profile as a result of the layering of the alluvial sediments. Moisture-holding capacities in these soils are generally moderate to high. Their grey colour results from their lower organic matter content which also reduces their nutrient status although their fertility characteristics seem to depend more on their physical than their chemical conditions. Two main sub-types of this soil group - the saline-alkali and the non-alkali types - can occur in association with all texture types.

2. Thin alluvium over marl

The profiles of these soils, also equivalent to Dar Al Handaseh's fluviatile-colluvial group, are thinner than those of the previously-discussed association because of the limited depth of the alluvial cover they largely form in. They can be divided into two main groups according to parent material conditions and climate. These are grey-brown alluvial soils and grey solonchaks.

Grey-brown alluvial soils: Apart from their shallowness and more friable profiles, these soils are similar to those in the previously-discussed association in terms of texture, fertility, moisture-holding conditions and infiltration rates (5-61 mm per hour). They can be subdivided into three textural types: loams ranging from friable to compacted; silt loams that show a higher moisture content and redder and more friable profiles; and silty clays which tend to edge the broken badland (el Katar) zone. Most of the soils in this group occur north of the Zarqa River.

The grey solonchaks, in contrast, are mainly located south of the Zarqa River in the areas between the thicker grey-brown soils on the alluvial fans and the whitish-grey soils on the badland. The profiles range from friable to compacted and their textures are generally clay loams although some are more silty. Infiltration rates are therefore generally low, ranging from 1 to 18 mm per hour so that in this dry southern location salts tend to concentrate in the root zone while some variants of this soil also have a rich gypsum content.

3. Residual Soils formed from Lisan Marl

This soil association, roughly equivalent to Dar Al Handaseh's Ghor-Lisan group, is formed from the heavy Lisan marls and other saline water deposits. As they are especially found in the drier south of the project area, south of the Zarqa River, they largely form saline rich soils, particularly as they occupy flatter areas between the lower edges of the alluvial fans (where the grey brown soils are common) and the broken katar. Some concentrations of this soil association also occur, however, on the katar. Soils in this association can be divided into two phases: katar (badland) solonchaks and sebkha (mud flat) solonchaks.

Katar solonchaks are mainly found in the badland zone between the ghor and the zor. Textures are dominated by loams and clay loams so that infiltration rates are low (10 mm per hour). Heavy salt deposits are common throughout the whole profile and are heaviest at the lower limit of the zone of evaporation. The percentage of total soluble salt varies from 1 to 3 per cent. Plant nutrient status is poor. The Baker-Harza land classification maps show several phases to these soils: eroded soils on Lisan marl in the badland zone where the A horizon is completely or partly eroded away; loam soils on the edge of the katar which are less saline or alkaline than all of the other phases; silt loam and clay loam soils which occur on other parts of the katar.

Sebkha solonchaks occur in two main areas, in a salt pan area south-west of Deir Alla and on the northern edges of the Dead Sea. The soluble salt content in some of these soils can reach 18 per cent of total dry matter. The German Geological Mission subdivided these soils on the basis of texture and salinity into four main types: highly saline silty clays where the highly soluble salt content induces a granular structure to a depth of about 60 cm; clay soils with high salinity in the A horizon but less saline below; moderately saline silty clay loams which are more saline in their subsoils, mainly occurring on the southern and eastern fringes of the salt pan; and moderately saline silty loams where salinity increases gradually with depth, probably as a result of stagnant water in the wet period of the year.

4. Soils formed on Residual Limestone Materials

These soils are generally located at the edge of the valley at the junction with the foothills where the limestone outcrops. The only representatives of this association are the rendzina soils whose main component is limestone but with a generally rich organic content. Their profiles are, however, not well developed and consist of no more than an A horizon resting directly on a C horizon of broken parent material. Two phases - a hilly phase and a soil on the gravel fans - have been recognized. These soils are probably roughly equivalent to the foothill association mapped by Dar Al Handaseh.

5. Recent Alluvium Soils on the Zor

Unlike all the previous soils which occur on the ghor or the katar, there are a number of alluvial soils restricted to the present flood plain (el zor) of the Jordan River, and its tributaries. There are two main series: the alluvial complex and the saline-alluvial complex. The alluvial complex soils are mainly found in the northern flood plain of the river and its tributaries. These soils are formed of sandy, loamy and clay rich sediments of Holocene fluviatile origins. According to the Baker-Harza classification the soils in this complex can be subdivided into different textural phases - impeded clays, clay loams, loams and loamy sand soils. As a result most of these soils have a high moisture holding capacity and a low infiltration rate, but are generally free of alkalinity.

In contrast the saline-alluvial complex soils occur in the southern flood plain, and are of much lighter texture giving much higher infiltration rates (about 125 mm per hour). Total soluble salt contents are not excessive but the sodium content can be high so that the soils tend towards alkalinity although a high gypsum content can reduce this. These soils are basically fertile except for deficiencies in nitrogen and phosphorus. Four phases of these soils have been recognized based on textural differences: sandy loams, sandy clay loams, clay loams and clays.

2.2.3 Land Classification and Capabilities

Much of the information derived from the soil surveys made on the distribution of soil types and conditions in the valley was collected for the purpose of classifying the lands in terms of their suitability for irrigational development. In such a system of land evaluation all lands placed in one class should have similarities in those characteristics which might influence their suitability for irrigation. The two soil studies already referred to here - the original Baker-Harza survey in 1954 and that by Dar Al Handaseh in 1969 - were both directed at land classification for irrigation and can be used here to summarize the main features of land quality in the valley. Since each used specific criteria for land evaluation they need to be treated separately. The Baker-Harza survey largely used the U.S. Bureau of Reclamation classification whereas the Dar Al Handaseh work was based on an evaluation mainly of limitations on land use imposed by the scale and nature of costs to the farmer of land development.

2.2.3.1 Baker-Harza Land Classification

The Baker-Harza classification estimated that 279,070 dunums (46.1 per cent) of the land in the east part of the valley was suitable for arable use.* 61 per cent of this arable land (170,088 dununs) was in the northern part of the valley. Five of the six standard classes of land were mapped in the area and their areas are shown in Table 2.2 and their distribution in Fig. 2.2. The main features of these class areas can be outlined here.

Class 1 land is suitable for substained high levels of production of any climatically suited crop with minimum costs of management. That is, this land needs no prior reclamation before use. As Fig. 2.2 shows this best quality land occurs at several points throughout the valley but more commonly in the northern part where there are 73,165 dunums. In the southern part of the valley there are only 42,761 dunums of this land class. The main areas occur where the flood plains of the perennial side wadis cross the ghor terraces as on the Ziqlab in the north, the Zarqa River in the middle valley and on the Kafrain-Hisban Wadis in the south. Some very small areas of class 1 land also occur on the zor. In the north the soils of this class of land are mainly the deeper profiled alluvial soils of heavier textures but with good permeability. Rather lighter textures are found with

* 1 dunum equals 0.25 acre, or 0.10 hectare.

TABLE (2.2) EAST JORDAN VALLEY: LAND CLASSIFICATION (BAKER-HARZA)

	Northern Valley		Southern Valley		Total Valley	
	dunums	%	dunums	%	dunums	%
Arable Land:-	170 088	62.7	108 982	32.6	279 070	46.1
Class I	73 165	27.0	42 761	12.8	115 926	19.2
Class II	71 053	26.2	43 456	13.0	114 509	18.9
Class III	25 870	9.5	22 765	6.8	48 635	8.0
Non-Arable:-	101 338	37.3	224 892	67.4	326 230	53.9
Class IV	4 206	1.5	80 268	24.0	84 474	14.0
Class VI	97 132	35.8	144 624	43.3	241 756	39.9
Total	271 426	100.0	333 874	100.0	605 300	100.0

N.B. Zarqa River is the dividing line between the Northern and Southern Valley

Source:- Compiled from Barker-Harza (1955) Master Plan Report, Vol. III, Part I.

this class of land in the south. These are soils with good infiltration rates, so that only normal drainage is required. They also have good inherent fertility, and an even topography so that no levelling is needed. Amounts of soluble salts are also low. Some of this land in the south has probably deteriorated with use, however, to class II as a result of intensive irrigation with saline well water increasing the soil's salinity.

Class II land is slightly less productive and able to take a slightly narrower range of crops. It would give normal yields but is more difficult and costly to manage because of slight to moderate limitations of soil, topography or drainage. There are few very extensive areas of this class of land in the project area except in the north, but it occurs as a discontinuous zone largely along the edge of the foothill zone. As with Class I land, more Class II land occurs in the north of the valley (71,053 du.) than in the south (43,456 du.). Soils associated with this land class are generally deep, alluvial profiles over marl often of heavier textures, particularly in the extensive northern area where this class of land is found around Adasiyeh. Most soils in this class are not only deep but reasonably permeable with fair infiltration rates and fairly low soluble salt contents, but the land surface is often in need of moderate levelling and grading. The Baker-Harza surveys suggested that land reclamation could greatly expand the area of land placed in this class.

Class III land offers more restricted productivity because of moderate to severe limitations of soil, topography or drainage. It occurs much less extensively than either Class I or II land, there being only 25,870 dunums in the north of the valley and 22,765 dunums in the south. There are no really extensive areas of this land in the valley. Most of it occurs as small patches on the upper edges of the ghor and adjacent to some of the better class lands on the alluvial fans. Amongst the limitations of this class of land are coarser textures with some soils being stony; rough topography requiring levelling and grading, and even needing stone clearance in some cases before use; drainage deficiencies in some small depressions; and a tendency to alkalinity (with pH figures of 9.6 in the subsoil) and subsoil salinity. Although normal yields are possible from a restricted range of crops, this land is generally less suitable for fruit trees and salt-sensitive vegetables.

Class IV land is that which is presently too saline or alkaline to be included in a higher class but which might be reclaimed and then placed in one of those higher classes. This class of land was shown by Baker-Harza to be widespread in the southern part of the valley, mainly on the ghor, where it covered over 80,000 dunums. It is uncommon in the northern valley where less than 5 per cent of all Class IV land in the valley was found. This class of land commonly occurs with solonchak soils. Most of the land has flat to undulating surfaces, in some cases in need of little levelling, but in other cases its slope would prevent it being reclaimed beyond Class III land. But Baker-Harza suggested that much of this class of land could, because of its favourable topography, be reclaimed into Class I, II or III on the removal of the salinity in the soil. Table 2.3 outlines the amounts of Class IV land that Baker-Harza believed to be reclaimable to higher classes, particularly in the southern valley area.

Class VI land is unsuitable for irrigated cropping because of extreme limitations of soil, topography or drainage. The katar areas of badland between the ghor and the zor forms most of the land in this class, forming a broad zone, which is particularly extensive in the centre and south, throughout the project area. Not only is the land topographically broken and stony but the soils are generally shallow and eroded and often strongly saline. Areas of equally poor land also lie alongside the wadi and stream channels. Class VI land forms the single largest land class in both the northern and southern valley areas.

2.2.3.2 The Dar Al-Handaseh Land Classification

A second land classification was made of the Jordan valley soils by Dar Al-Handaseh on the basis of their survey of the soil series. In this they evaluated the soils' potential for irrigated agriculture by noting their limitations which would impose extra costs or restrictions on the farmer. Deficiencies of drainage, topography, salinity and alkalinity, however, where they could be corrected by proposed land improvements were not taken into account.

TABLE (2.3) EAST JORDAN VALLEY: CLASS IV LAND AND ITS POTENTIAL CLASSES

	Class IV			
	Class I du.	Class II du.	Class III du.	Total Class IV
Northern Valley				
Ghor above Canal	-	-	-	-
Ghor below Canal	1,060	2,063	315	3,438
Zor below Canal	200	314	254	768
Total Ghor & Zor below Canal	1,260	2,377	569	4,206
Total Northern Valley	1,260	2,377	569	4,206
Southern Valley				
Ghor above Canal	298	317	470	1,085
Ghor below Canal	33,808	27,554	13,677	75,039
Zor below Canal	1,732	2,212	200	4,144
Total Ghor & Zor below Canal	35,540	29,766	13,877	79,183
Total Southern Valley	35,838	30,083	14,347	80,268
Total All Valley	37,098	32,460	14,916	84,474

Source: Baker-Harza (1955) Master Plan Report, Vol. III, Part I.

Soil limitations on irrigated farm cropping were grouped under three headings: those affecting the yield potential of the soils; those affecting the cropping range of the soils; and those affecting the farm management. In terms of cropping range, for example, the fine textured soils of the Ghor 1 series (Table 2.1), where poor internal and external drainage conditions and weather soil structure created some restrictions, were considered unsuitable for fruit trees and vegetable production, but most other soils offered no limitations on crop range.

Two classes of soil were differentiated on the basis of their effects on yield potential. All the soils on the ghor areas were judged to have normal yield potentials but those on the zor were considered to have above average potentail. Four classes of soils were also distinguished in terms of the limitations they imposed on farm management in terms of causing the farmer to accept either higher costs or lower yields. All soils in areas of hilly relief, for example, were considered to put a severe limitation on farm management. These lands occur mainly north of Wadi Yabis in the katar zone between the ghor and the zor. In these areas surface irrigation is not feasible so that sprinkler methods would become necessary. All sloping and rolling phases of soils were placed in a category where farm management was considered moderately restricted since levelling for surface irrigation is often not feasible. Sprinkler irrigation is generally the only alternative particularly on the rolling land. All stony phases of soils were placed in a category of land with slight management limitations where the farmer must either exclude those crops not compatible with stoniness or accept the extra cost of stone removal.

On this basis the Dar Al Handaseh survey then identified those soils that were unsuitable for irrigated cropping if they had one very severe limitation on use in any one grouping of restrictions, or a combination of certain other limitations. As a result the following soil areas were considered not suitable for irrigation: the hilly phase of the Lisan marl (group 15 in Table 2.1); the rolling and poorly drained phases of the Ghor Lisan complex (group 14); the severely eroded, rolling, and hilly phases of the Lisan marl series (group 15); and the poorly drained phases when combined with the rolling phase; the strongly sloping and very strong phases of the Ghor 1 series when moderately eroded in the wadi fringe or foothill association (group 16 and 17); the severely eroded and hilly phases of the Hugim series (group 2); the Bassat series (group 1); a number of miscellaneous soil types with limitations in general severer than those listed above.

2.3 Climate

2.3.1 Introduction

It is appropriate at this point to outline the other two factors of the physical environment important to irrigation development, namely the climatic conditions and, in the next section, the water resources of the valley. The climatological data for this section has been compiled from two main sources: First, raw data has been taken from official records published by the Jordan Department of Meteorology. These include the Jordan Climatological Data Handbook; the Summary of Climatological Data for the period, 1966-1975; and the data bank of the climatological records in Jordan published by the Arab Organization for Agricultural Development (1977).[12] These data are largely based on records derived from the ten weather stations established in the Jordan Valley. Table 2.4 lists the name, location and date of establishment of each of these stations.

Secondly, various climatological analyses have been used. These include the work of Manners who discussed the climate of Jordan as a whole in detail, and that of the Arab Organization for Agricultural Development whose agroclimiatological study of Jordan formed part of their programme on the agroclimatology of the Arab countries.[13]

2.3.2 Local Factors Affecting the Climate

A number of factors influence the general features of the valley's dry Mediterranean climate. With most of the valley floor at more than 200 metres below sea level and the southern end at nearly 400 metres below, air temperatures in the valley are often raised well above

TABLE (2.4) THE JORDAN VALLEY: CLIMATOLOGICAL STATIONS

Stations	Co-ordinate Latitude °	′	Longitude °	′	Altitude (in metres)	Date of establishment
North Shuneh	32	37	35	35	- 190	1955
Wadi Ziqlab	32	31	35	36	- 150	1955
Wadi Jurum	32	27	35	36	- 145	1955
Wadi Yabis	32	24	35	35	- 200	1960
Deir Alla	32	12	35	37	- 224	1952
Wadi Fari'a	32	08	35	30	- 198	1955
South Shuneh	31	54	35	37	- 230	1955
Jericho Airport	31	52	35	30	- 276	1960
Wadi Hisban	31	49	35	39	- 185	1958
Dead Sea North	31	47	35	31	- 387	1960

Source:- Jordan, Meteorological Department (1968), Jordan Climatological Data Handbook, p. 5.

what would be normal for the region by the katabatic effects of air sweeping down from the surrounding highlands. At the same time, the height of the surrounding hills, rising more than 1000 metres above sea level, except at the southern end of Lake Tiberias, insulate much of the valley floor from certain outside weather influences such as some of the depressional rainfall that is received on the hills to the west. The Esdraelon-Beison corridor to the north-west of the valley, however, does allow some humid air from the west to penetrate the northern part of the valley. This further emphasises the greater moistness of the northern valley than the south. Cold air can also sometimes enter this northern part of the valley and it is noticeable that frost, which is a rare occurrence, does occasionally occur.

2.3.3 Climatic Features

The Jordan Valley's predominantly dry Mediterranean climate gives it hot, dry summers and cool, moister winters. The general pattern of this climate is varied both spatially and temporally, however, by influences such as the valley's topography already referred to and the occurrence of continental air masses. Thus the whole valley is dry partly because it lies in the rain shadow of the hills to the west, but the dryness strengthens markedly southwards because rainfall amounts decrease as temperatures and rates of evaporation increase. Weather conditions throughout the valley can also differ markedly from what is normal for the season particularly in terms of amounts of rainfall received when continental air masses prevail. These differences in climate both within the extent of the valley and between years clearly reflect on its agricultural capabilities especially with regard to the greater scarcity of water resources for irrigation in the southern districts and during the drier years.

2.3.3.1 Rainfall

The precipitation received in the valley all comes in the form of rain and most in the form of fairly sharp showers. Although the valley's climate is dry, most of it would receive enough rain to support some form of rather erratic dry farming so that irrigation can be thought of as a process of rainfall supplementation to greatly intensity and make secure the agricultural output so that it is necessary to know something of rainfall receipts. Furthermore, although much of the irrigation water used in the valley comes from the Yarmouk River and other sources, fed by rain which has fallen on areas east of and outside of the valley, some of the water is derived quite locally from the side wadis, springs and pumped wells which are, at least, partly fed from rain that falls in the valley. For this reason, the rainfall element of the climate, together with the water balance, will be given some prominence here over other aspects of the climate.

Mean Annual Rainfall and its Seasonal Distribution: Table 2.5 shows the mean annual and monthly rainfall for the seven stations in the valley for which a reasonable run of data is available. As can be seen the annual mean varies spatially from about 390 mm. at Wadi Ziqlab, the wettest station in the north of the valley, to about 150 mm. at Jericho Airport, the driest station, with clear evidence from the data for the intervening stations that there is a marked gradient in rainfall receipt down the length of the valley, with increasing aridity towards the south. These records show that, on average, the wettest station in the north receives about 2½ times as much rain per year as the driest southern station. The data also shows that each station experiences a markedly dry season, generally with no recorded rainfall receipt, lasting about four months and that the bulk of the rainfall received comes in the five months from November to March. Fig. 2.3 puts in diagrammatic form the mean monthly rainfall for the wettest and the driest stations listed in Table 2.5 to show their essentially similar pattern of rainfall receipt in spite of the differences in the totals.

As is the general case with Mediterranean climates, the Jordan Valley experiences most of its rainfall in the winter months. Table 2.6 shows, for the same seven stations, between 61 and 70 per cent of the rainfall, for the recorded years, occurred in the three winter months (December-February) with another 30 to 32 per cent coming in the immediately preceding month of November or the months immediately

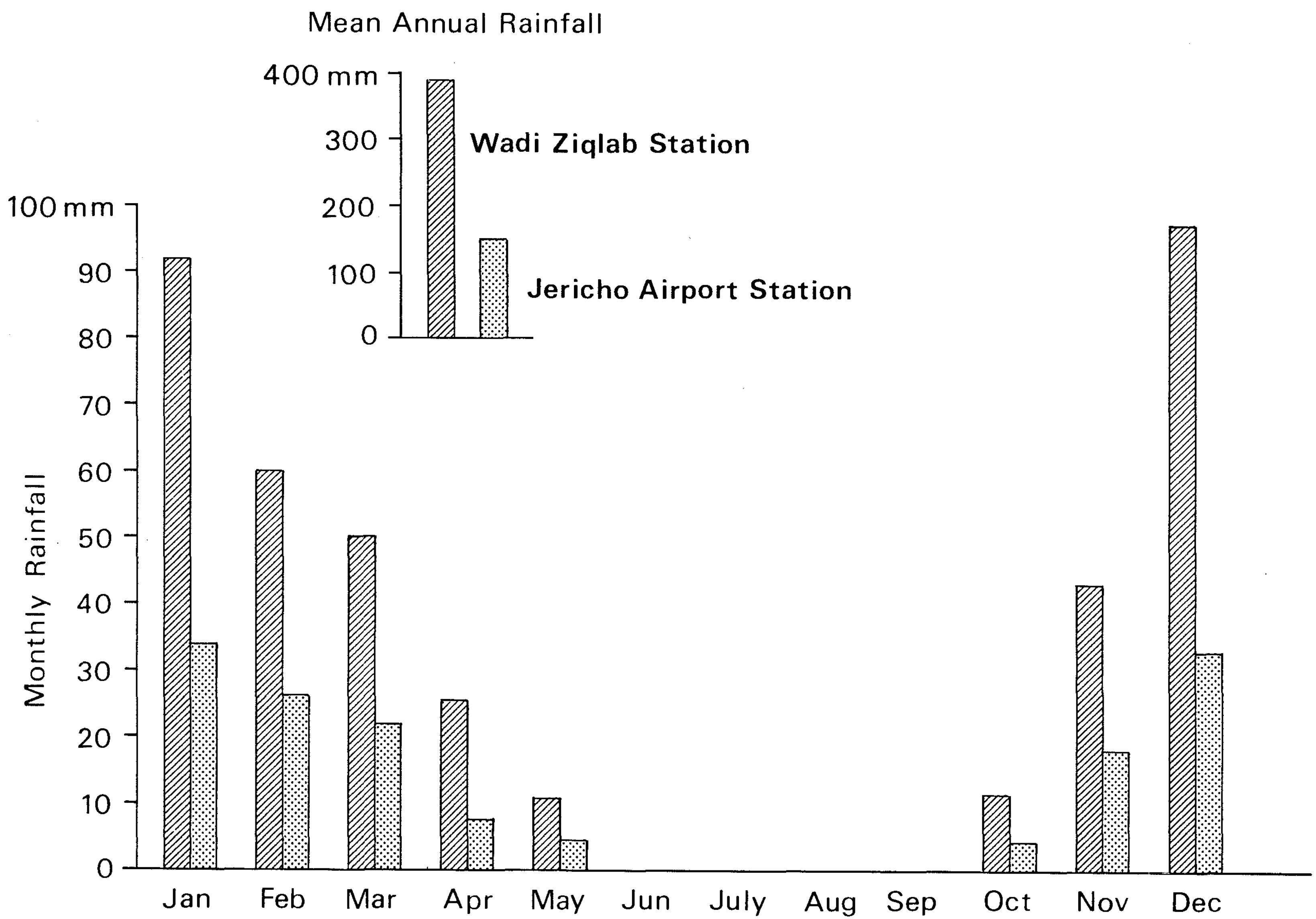

Fig. 2.3 THE JORDAN VALLEY: RAINFALL PATTERN OF TWO EXTREME STATIONS

TABLE (2.5) THE JORDAN VALLEY: MEAN ANNUAL AND MONTHLY RAINFALL (mm)

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total
North Shuneh	86.9	57.1	49.8	24.1	11.9	0	0	0	0	13.9	49.5	91.7	385.0
Wadi Ziqlab	92.6	59.9	49.6	25.6	10.6	0	0	0	0	11.4	43.3	97.1	389.9
Wadi Jurum	79.7	53.8	41.6	21.6	6.7	0	0	0	0.3	14.5	37.7	80.4	336.2
Deir Alla	63.4	59.4	37.5	19.0	5.9	0	0	0	0.4	5.2	38.4	62.2	291.5
Wadi Fari'a	65.5	44.0	26.2	14.0	4.0	0	0	0	0	2.9	35.0	48.1	239.7
South Shuneh	48.3	27.2	22.6	8.0	3.4	0	0	0	0	3.1	13.4	41.6	167.5
Jericho Airport	34.2	26.4	22.0	7.7	4.8	0	0	0	0	4.1	18.1	32.5	149.9

N.B. All data was processed within the period 1923-1965.

Source:- Jordan, Meteorological Department (1968), Jordan Climatological Data Handbook, p. 51

TABLE (2.6) THE JORDAN VALLEY: MONTHLY AND SEASONAL DISTRIBUTION OF RAINFALL (%)

	Autumn			Winter			Spring			Summer				
	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Nov-April	Dec-Feb
North Shuneh	0	3.6	12.9	23.8	22.6	14.8	12.9	6.3	3.1	0	0	0	93.3	61.2
Wadi Ziqlab	0	2.9	11.1	24.9	23.7	15.3	12.7	6.6	2.7	0	0	0	94.3	63.9
Wadi Jurum	0.1	4.3	11.2	23.9	23.7	16.0	12.4	6.4	2.0	0	0	0	93.6	63.6
Deir Alla	0.1	1.8	13.2	21.3	21.7	20.4	12.9	6.5	2.0	0	0	0	96.0	63.4
Wadi Fari'a	0	1.2	14.6	20.1	27.3	18.4	10.9	5.8	1.7	0	0	0	97.1	65.8
South Shuneh	0	1.9	8.0	24.8	28.8	16.2	13.5	4.8	2.0	0	0	0	96.1	69.8
Jericho Airport	0	2.7	12.1	21.7	22.8	17.6	14.7	5.1	3.2	0	0	0	94.0	62.1

Source:- Jordan, Meteorological Department (1968), Jordan Climatological Data Handbook, P 51. (Compiled) following the winter, March and April. That is, at all seven stations more than 93 per cent of the rain comes in that half of the year extending from November to April. This can be considered a favourable precipitation regime for irrigated agriculture, based mainly on winter crops, since these months are also the period of more moderate but not cold temperatures most suited to crop growth and cultivation activities. These are also the months of generally lower water loss by evaporation so that a higher proportion of the rainfall can penetrate the soil and recharge aquifers and springs.

Virtually all of the rest of an average year's rainfall comes in October and May, that is at either end of the summer period. This amount, however, on average has never exceeded 7 per cent of the annual total at any of the stations and is often considerably less than this, leaving the summer months of June, July and August as well as September generally without any rain.

On the basis of these average monthly figures, the greater aridity of the southern part of the valley does not appear to result from much lengthening of the dry summer season so much as from lower rates of rainfall receipt in the winter months. There is some evidence, however, that the overall reduction in monthly rainfall receipts in southern parts of the valley does, in effect, mean a slight lengthening of the dry season which starts earlier in the spring and lasts longer into the autumn in the south than it does in the north. As part of its study of the agroclimatology of the valley, the Arab Organization for Agricultural Development used data from five stations in different parts of the northern and central valley and classed their monthly rainfall receipts into five groups ranging from humid to very dry. Fig. 2.4 shows the seasonal distribution of these monthly patterns for these stations and shows that for the three northern stations (Baqura to Wadi Jurum) the dry season might be considered to last from June to September whereas it might include May at the two southern stations.

Variability of Annual Rainfall: One of the most notable features of the valley climate is, of course, the variability from year to year of total rainfall receipts as the result of occasionally dry winters and extended summer droughts. Even over the short period for which records are

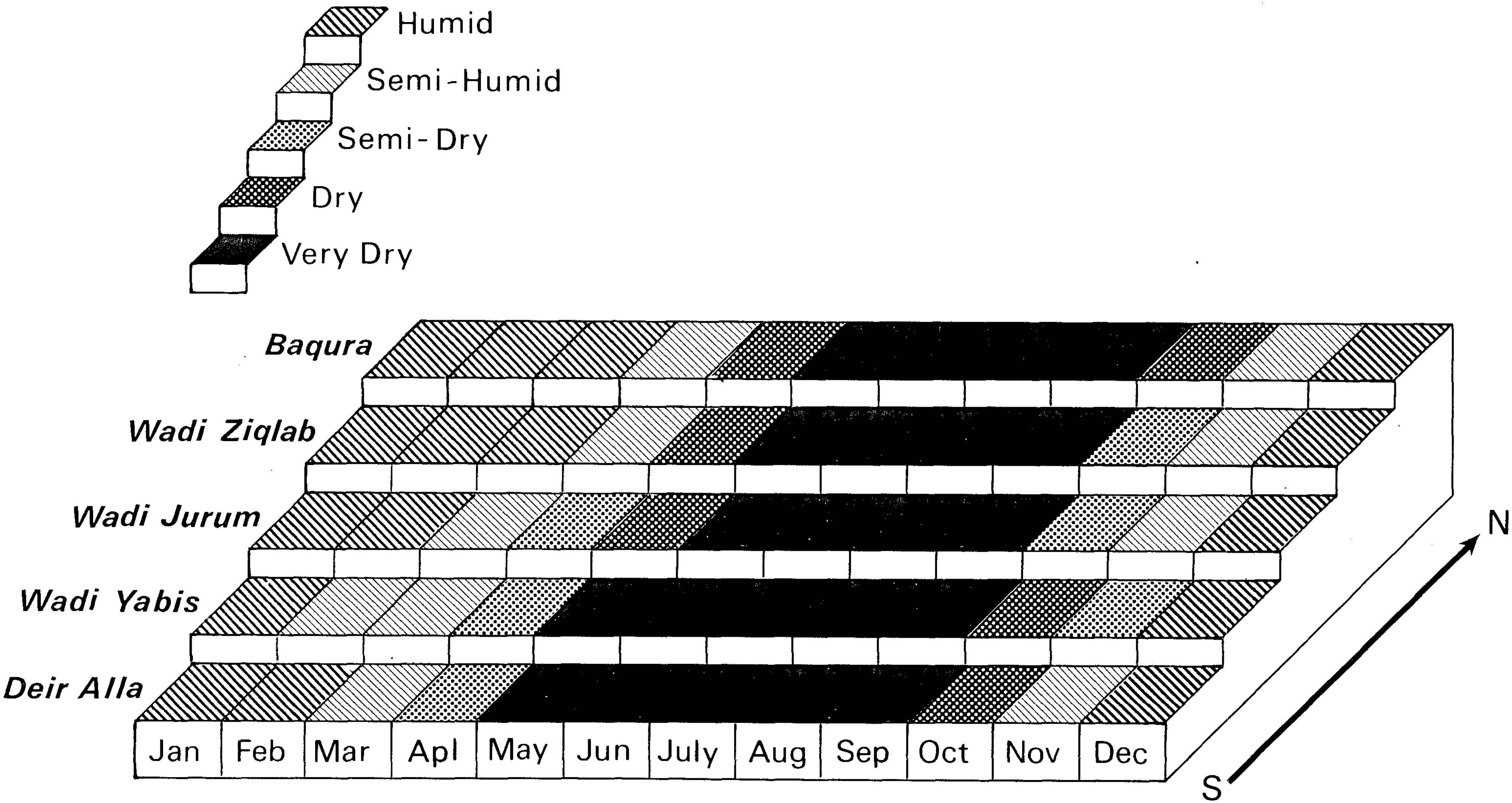

Fig. 2.4 EAST JORDAN VALLEY: SEASONAL PATTERN OF ARIDITY

available this can be clearly seen. It obviously has serious consequences for water planning in connection with irrigation as a result of increased water demand during the drier years as well as the danger that some water sources, like side wadis and springs which feed into the scheme, may not be available every year. The station at Adasiyeh, at the northern end of the valley has, for example, over the period of its rainfall records between 1947 and 1964 recorded annual rainfall totals ranging from 531 mm. to 205 mm. with a mean of 414 mm. At the drier southern end of the valley the station at King Hussein Bridge, just north of the Dead Sea, over the same years had recorded a high rainfall year of 236 mm. and a low year of only 45 mm. with a mean of 128 mm. Because of the local nature of many storm showers not all stations recorded the same driest and wettest years.

Manners has used a coefficient of variation to further examine this variability of rainfall across the whole of Jordan in which he included data for the years 1939-64 for ten stations in the valley. Expressed as a percentage this coefficient indicates the statistical probability of a particular station receiving rainfall amounts below certain chosen limits. The limits he chose were the 200 mm. annual receipt, which might be considered the lower limit for successful dry farming, a 300 and a 400 mm. limit. The results that Manners obtained are summarized in Table 2.7. Along with data for other stations in Jordan, not shown here, Manners demonstrated that not only did rainfall reliability decrease southwards through the valley, in parallel with decreasing rainfall amounts, but that this formed part of a general pattern of declining rainfall reliability and increasing variability across the whole of Jordan from west to east and from north to south.

From Table 2.7 it can be seen that the probability of any of the valley stations receiving less than 200 mm. of rain in a year is much lower than the probability of receiving less than 300. These probabilities are greater for the southern stations in the valley than for the northern stations. So, if one considers a minimum receipt of 200 mm necessary to sustain some form of dry-farming, it would seem that the northern parts of the valley run a small risk of rain failure, but that this risk rises markedly southwards particularly in those areas where average rainfall receipts, as at Jericho, stand at less than this

TABLE (2.7) THE JORDAN VALLEY: PROBABILITY AND MEAN OF ANNUAL RAINFALL

	Probability of receiving less than			25 year Mean Rainfall (mm)
	200 mm %	300 mm %	400 mm %	
Mukheibeh	4.85	20.02	49.60	400.72
Adasiyeh	2.81	15.39	44.83	414.32
North Shuneh	3.84	20.61	55.17	386.04
Wadi Ziqlab	5.05	21.77	53.59	389.52
Deir Alla	18.67	56.75	88.88	284.32
Wadi Fari'a	37.83	80.89	97.98	226.28
South Shuneh	72.57	98.57	100.00	162.60
King Husein Bridge	93.94	100.0	100.00	127.68
Jericho	82.38	94.74	100.00	150.36
Kafrain	63.68	95.54	99.89	174.00

Source: Manners, I (1969) p. 70

level. The chances of not receiving 300 mm. annual totals are particularly high in the southern half of the valley. A 400 mm. receipt is everywhere much more problematic and highly unlikely further south.

On this basis one might view irrigation as providing the opportunity for greatly increasing the intensity and productivity of agriculture in the north of the valley whereas further south irrigation is making agriculture possible where rainfall amounts were often too small and unreliable for any form of permanent land use each year. If one takes a 75 per cent probability of receiving 200 mm. of rain in a year as the limit for fairly safe dry-farming, it means that all of the valley as far south as its centre point around Wadi Zarqa, could have been used for dry farming but much more productively with irrigation. It is this northern area where most of the irrigational development has occurred, its expansion into the drier non-farmed south being a much more recent and less productive development.

Rainfall Intensity: While the volume and seasonality of annual rainfall can be an important factor in the irrigational development and potential of an area, since the more rain that is received at the right time the less water that has to be supplied from exotic sources, the nature of the intensity of the rainfall is also of significance. The rainfall's intensity helps to determine the effectiveness of the rainfall for crop production, in that the rainfall which enters the soil can become available to crops whilst that which runs off, when the soil infiltration capacity has been exceeded, might simply enter drainage channels as flood flow and be wasted. This is more likely to happen in more intensive rainstorms. Furthermore heavy storm rainfall is more likely to cause soil erosion particularly on sloping land or on land when the vegetation cover is thin or absent, as, for example, in the early part of the cropping season.

Unfortunately no data is available on individual events in the valley over an extended period of time to allow a study of the nature of rainfall intensity although some use might be made of the daily record of rain days. A rain day is normally defined as one with a recorded fall of rain greater than ·1 mm. and the weather records of the valley stations divide rain days into those with a fall of less than 0.1 mm., 0.1-0.9 mm., from 1.0 mm. to 9.9 mm. as well as days with falls of over 10 mm. and over 50 mm. (see Table 2.8). Although it should be immediately noted that use of this data could produce misleading results since the records do not show if a particular fall of rain on any one day came in a short sharp storm lasting a few minutes, and possibly causing much runoff and erosion, or was spread out over a much longer period in the day, so allowing all or most of the water to infiltrate into the soil, it is clear from the data that at a range of stations the most frequent rain days produced falls of between 1 mm. and 9.9 mm. Even so heavier and possibly more erosive and less effective falls were relatively common. Rare events can produce much heavier falls producing much runoff. One storm in October 1957 on the West Ghor, for example, produced a recorded 59 mm. of rain in 35 minutes at Maoz Hayim but records were not available at the other valley stations to see how common such falls are. For the most part it does seem that most rain days produce moderate rather than excessive falls which probably allows much of the receipt to infiltrate the soil as a useful addition of water to that available by irrigation supplies.

2.3.3.2 Temperature

Table 2.9 gives average monthly temperatures for the ten stations in the valley. These show that the Jordan Valley is one of the hottest places in the world and just as its southern part is drier than the north, so also the south tends to record the highest temperatures. An absolute maximum temperature of 51.2 ^{0}C (124 ^{0}F) was recorded at Dead Sea North station in June 1942 while all other weather stations in the valley have recorded maxima of over 47 ^{0}C (117 ^{0}F). Although these are extreme conditions, the maxima averaged for the years for which data is available are about 39 ^{0}C (102.2 ^{0}F) while the mean summer temperatures are, as Table 2.9 shows, around 31 ^{0}C (87.8 ^{0}F). August is generally the hottest month although summer maxima have been recorded in other months.

Daytime temperatures in winter are pleasantly warm and seldom cool enough to slow crop growth so that, theoretically, all-year crop production is not prevented by winter temperature considerations. January is the

TABLE (2.8) THE JORDAN VALLEY: AVERAGE ANNUAL NUMBER OF DAYS WITH PRECIPITATION RECEIVED WITHIN RECORDED RANGES

RAINFALL RANGE m.m.

Month	≤0.1	0.1–0.9	1.0–9.9	≧10.0	≧50.0	<0.1	0.1–0.9	1.0–9.9	≧10.0	≧50.0	<0.1	0.1–0.9	1.0–9.9	≧10.0	≧50.0
	North Shuneh (Period 1955–65)					Wadi Ziqlab (Period 1955–65)					Wadi Jurum (Period 1955–65)				
January	0	0.82	5.27	3.63	0.09	0	1.86	4.71	3.71	0	0	1.00	5.45	2.45	0
February	0	1.00	5.18	1.82	0	0	1.17	5.83	2.17	0	0	0.45	5.27	1.55	0
March	0.09	0.82	3.82	1.72	0	0.50	1.20	3.40	0.80	0	0	0.27	3.82	1.45	0
April	0.09	0.27	2.63	0.54	0	0	0.83	1.83	0.60	0	0	0.64	2.27	0.63	0.09
May	0	0.45	1.27	0.27	0	0	0.20	8.00	0.40	0	0	0	0.82	0.18	0
June	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0.27	0
October	0.27	0.27	1.09	0.54	0	0	0.50	1.50	0.13	0	0.09	0.36	1.09	0.27	0
November	0	0.64	2.55	1.54	0.09	0.14	0.71	3.50	1.00	0.09	0	0	2.36	1.36	0
December	0.18	1.00	4.27	2.36	0.36	0	1.38	3.50	3.00	0.37	0	0.56	3.90	2.27	0.09
Year	0.63	5.27	26.08	12.42	0.54	0.64	7.85	32.27	11.81	0.46	0.09	3.28	25.07	14.43	0.18

Month	≤0.1	0.1–0.9	1.0–9.9	≧10.0	≧50.0	<0.1	0.1–0.9	1.0–9.9	≧10.0	≧50.0	<0.1	0.1–0.9	1.0–9.9	≧10.0	≧50.0
	Deir Alla (Period 1952–65)					Wadi Fari'a (Period 1955–65)					South Shuneh (Period 1955–65)				
January	1.54	2.23	4.54	2.15	0.08	0	0.81	5.55	1.72	0.09	0.09	1.18	3.90	1.44	0
February	1.31	1.77	4.62	1.64	0	0	0.72	5.00	1.18	0	0.26	0.80	4.00	0.44	0
March	2.15	2.31	4.31	0.84	0	0	1.18	3.72	0.54	0	0.18	0.80	3.53	0.18	0
April	1.77	0.69	2.08	0.46	0	0	0.36	1.72	0.36	0	0.26	0.44	1.26	0.18	0
May	1.15	0.54	0.61	0.23	0	0	0.18	0.72	0	0	0.09	0.09	0.18	0	0
June	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July	0.22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
September	0.13	0	0.07	0	0	0	0	00	0	0	0	0	0	0	0
October	1.37	0.71	1.07	0.14	0	0	0.45	1.27	0	0	0	0.17	0.62	0	0
November	1.44	1.21	2.86	0.93	0.07	0	1.27	3.18	0.91	0.09	0.26	0.62	1.71	0.09	0
December	1.87	1.30	3.30	1.64	0.07	0	1.27	3.45	1.46	0.09	0	0.71	3.34	0.09	0
Year	12.97	10.76	23.46	8.03	0.22	0	5.42	24.61	6.17	0.27	1.14	4.81	18.54	2.42	0

Source:– Jordan, Meteorological Department (1968), Jordan Climatological Data Handbook, pp. 54–55

TABLE (2.9) THE JORDAN VALLEY: MONTHLY AND ANNUAL TEMPERATURE MEANS(°C)

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual Mean
North Shuneh	14.0	14.7	17.3	21.2	25.8	28.7	30.3	31.0	29.0	26.7	21.6	16.5	23.1
Wadi Ziqlab	13.5	14.2	16.8	20.8	26.0	28.7	30.2	31.0	29.4	26.3	21.1	15.8	22.8
Wadi Jurum	13.5	14.2	17.0	20.9	25.5	28.5	29.8	30.6	29.0	25.6	20.7	15.3	22.6
Wadi Yabis	12.8	13.9	16.3	20.5	26.0	28.1	30.3	30.7	29.2	24.8	20.3	15.1	22.3
Deir Alla	14.6	15.5	17.9	21.8	26.3	29.0	30.5	31.1	29.8	26.6	22.3	16.9	23.5
Wadi Fari'a	14.2	14.8	17.8	22.2	27.0	29.5	31.0	31.6	30.1	27.3	22.0	16.5	23.7
South Shuneh	15.1	15.9	18.8	23.3	27.8	30.6	31.9	32.7	30.7	27.7	22.3	17.4	24.5
Jericho Airport	14.2	15.2	18.1	22.7	27.1	29.9	31.0	31.3	29.7	26.8	21.7	16.7	23.7
Wadi Hisban	14.5	15.6	17.6	22.2	26.3	28.8	30.2	30.9	29.6	26.9	22.5	17.3	23.5
Dead Sea North	15.2	15.6	19.1	22.3	27.5	29.9	31.2	31.6	29.6	25.6	22.4	17.1	23.9

N.B. All data was processed within the period 1923–1965

Source:– Jordan, Meteorological Department (1968), <u>Jordan Climatological Data Handbook</u>, p.21

coldest month although it has a mean of over 12 ^{0}C (53.6 ^{0}F). The average daily temperature in winter is around 15 ^{0}C (59 ^{0}F). Frosts are rare although they have occurred in each of the winter months at some stations in various years but all of these events were recorded in the north of the valley. Wadi Yabis Station recorded minima below zero in November (1958), December (1963), January (1961), February (1959) and March (1928). These are, however, unusual events. The only station to actually record its average length of frost period is North Shuneh and that has generally experienced only one night of frost a year and in only one recent year recorded two nights (1963) when an absolute low of -1.5 ^{0}C was recorded and some crop damage occurred. Because winter temperatures, like summer ones, tend to be higher in the southern parts of the valley where it is further below sea level, frost is unknown there with the katabatic effect stronger and the valley more sheltered from outside cooling influences.

While frosts are rare, cool winter temperatures can slow crop growth and whereas mean winter temperatures are relatively high, high diurnal temperature ranges could affect crop production in some parts of the valley. Table 2.10 shows the mean diurnal temperature ranges by months across the valley. It can be seen that particularly wide diurnal ranges are experienced in the summer months because of cloudless skies producing rapid daytime heating followed by night-time cooling. But it is the winter diurnal range, with the possibility of much lower night time temperatures, which is more important to the farmer. Wadi Yabis station, for example, as it can be seen in Table 2.10 has a mean diurnal range of nearly 18 ^{0}C in June but only 12 ^{0}C in January, but this is low enough to sometimes take night-time temperatures down towards zero.

2.3.3.3 Relative Humidity, Evapotranspiration and the Water Balance

Although a dry region, all of the Jordan Valley experiences quite high relative humidities in the winter, an important factor when considering the need to conserve irrigational water at a time of maximum cropping and, therefore, high water demand. For example, as Table 2.11 shows, mean January values at Deir Alla are 69 per cent compared with 47 per cent in July at the height of the dry season. Jericho at the southern and drier end of the valley has a much lower

TABLE (2.10) THE JORDAN VALLEY: MONTHLY MEAN OF DIURNAL TEMPERATURE(^{O}C)

Stations	January	February	March	April	May	June	July	August	September	October	November	December
North Shuneh	8.7	9.2	11.4	13.7	14.8	14.7	12.8	13.6	13.0	12.9	12.0	8.4
Wadi Ziqlab	7.4	8.0	10.1	12.0	12.6	13.3	11.2	10.7	10.6	11.3	10.9	7.5
Wadi Yabis	11.9	11.6	15.0	16.6	16.7	17.8	16.9	15.3	15.3	16.9	15.2	12.2=
Deir Alla	8.8	9.3	11.5	14.0	16.5	16.1	15.9	15.6	14.4	13.1	11.6	8.6
Wadi Fari'a	10.2	11.0	12.2	14.7	15.6	16.0	16.7	14.3	13.7	13.3	11.1	9.6
South Shuneh	7.0	7.2	9.5	11.4	12.3	12.4	11.9	12.0	10.1	9.6	9.0	7.3
Jericho Airport	9.7	10.6	12.4	13.6	14.4	14.6	14.6	13.1	12.2	12.5	13.1	10.2
Wadi Hisban	8.2	9.0	10.4	12.9	14.2	15.0	14.6	13.4	11.5	11.0	9.6	7.8
Dead Sea North	9.4	11.2	10.3	11.4	12.4	13.5	13.2	12.2	10.8	13.1	12.0	10.1

N.B. All data was processed within the period 1923-1965.

Source:- Jordan, Meteorological Department (1968), Jordan Climatological Data Handbook, p. 40

TABLE (2.11) THE JORDAN VALLEY:

MONTHLY MEAN RELATIVE HUMIDITY

	Deir Alla	Jericho Airport
January	69	67
February	63	60
March	62	55
April	56	48
May	48	39
June	47	35
July	47	38
August	51	43
September	53	46
October	49	46
November	49	50
December	60	61
Annual Mean	54	49

N.B. Data was processed within the period 1923–1965

Source:- Jordan, Meteorological Department (1968), Jordan Climatological Data Handbook, p.48

set of summer values with 35 per cent in June, although at 67 per cent in January they compare favourably with those at Deir Alla in the winter season.

These seasonal and spatial variations in humidity are a reflection of recorded evaporation rates. Because of the importance to the water balance and irrigation water demand of water losses by evaporation, nine of the weather stations in the valley collect data on mean monthly and annual evaporation rates. These have been measured by the Piche method for periods ranging from 5 to 24 years. These data are summarized in Table 2.12 in the form of mean daily rates for each month and for the whole year. It can be seen that mean evaporation rates are much higher in the dry south of the valley than to the north and also higher in the summer than winter. At Dead Sea North station, for example, the mean annual rate of 4964 mm. is well in excess of the average rainfall input to the water balance. In contrast at Wadi Jurum in the north the mean annual evaporation rate is only 1971 mm. which also suggests that at least for a few winter months there may be a small surplus of rainfall over evaporation loss.

Such figures alone can indicate little of moisture deficits but some of the features of the water balance in the valley have been studied to a limited extent by Manners and the Arab Organization for Agricultural Development. Manners used the Thornthwaite method to establish a theoretical evapotranspiration rate for the valley in order to calculate the moisture balance based on data for 1959/60 from two stations, North and South Shuneh, and also for 1963/64 using the same two stations as well as Deir Alla. The results which are summarized in Table 2.13 show that overall the moisture deficit was rather less, as one might expect, in the north of the valley at North Shuneh than to the south at South Shuneh. In 1959/60, a dry year, neither station, however, showed any moisture surplus in any month but the monthly moisture deficits were smaller at the north station as well as in the winter months at both stations. In 1963/64, a rather wetter year, with above average rainfall at all three stations and a particularly wet December, there was a rather more marked deficit to the south at South Shuneh and Deir Alla than at North Shuneh but some small surpluses

TABLE (2.12) THE JORDAN VALLEY: AVERAGE DAILY EVAPORATION BY MONTH (PICHE)

Station	Period of Observation	DAILY AVERAGE OF EVAPORATION (MM) Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Daily av. evaporation per annum	Total evaporation per annum	Total rainfall per annum
North Shuneh	Jul 58 – Dec 65	3.5	3.8	4.6	6.2	8.4	9.3	9.6	8.9	7.8	6.8	6.6	3.8	6.6	2409.0	385.0
Wadi Jurum	Jul 58 – Dec 65	2.8	3.3	3.8	5.5	7.9	8.5	7.9	5.6	6.2	5.5	3.9	3.7	5.4	1971.0	389.0
Wadi Yabis	Jul 60 – Dec 65	1.9	2.5	3.6	5.4	8.3	10.1	10.0	9.4	8.1	6.9	4.4	2.6	6.1	2226.5	336.2
Deir Alla	June 52 – Dec 65	5.1	5.5	5.6	7.8	10.3	11.5	11.2	10.3	9.7	9.9	8.3	6.2	8.4	3066.0	291.5
Wadi Fari'a	Jan 55 – Dec 65	3.9	4.6	6.9	9.5	12.9	15.1	15.4	14.1	13.2	11.8	8.0	6.2	10.0	3650.0	239.7
South Shuneh	Jul 58 – Dec 65	4.3	4.8	6.3	9.2	10.9	14.8	13.6	13.5	12.8	10.6	7.8	5.1	9.5	3467.5	167.5
Jericho Airport	June 41 – Dec 65	3.9	4.6	5.8	8.7	11.5	13.4	13.4	12.2	10.4	9.2	6.8	4.6	8.7	3175.5	149.9
Wadi Hisban	Nov 58 – Dec 65	4.0	4.2	4.6	6.4	8.7	10.3	9.2	9.5	8.2	7.6	7.0	4.8	7.0	2555.0	*
Dead Sea North	Jan 60 – Dec 65	6.3	7.0	13.1	12.9	16.6	19.9	17.8	18.6	16.3	14.1	11.5	9.6	13.6	4964.0	*

* No data available

Source:– Jordan, Meteorological Department (1968), Jordan Climatological Data Handbook, pp 51 and 85

TABLE (2.13) EAST JORDAN VALLEY:

THE WATER BALANCE FOR SELECTED STATIONS, 1959/60 AND 1963/64

	1959/60		1963/64		
Station	Shuneh North	Shuneh South	Shuneh North	Deir Alla	Shuneh South
Months	Moisture Deficit (MM)		Moisture Deficit (MM)		
October	111	115	98	127	155
November	48	61	32	52	61
December	17	26	0	0	0
January	0	12	0	0	0
February	9	35	0	0	0
March	0	27	0	0	1
April	30	107	15	23	28
May	144	193	75	96	109
June	174	191	150	174	182
July	202	211	182	194	195
August	186	201	179	193	197
September	167	170	148	161	164
Annual	1088	1349	679	1020	1092
	Moisture Surplus (MM)		Moisture Surplus (MM)		
October	0	0	0	0	0
November	0	0	0	0	0
December	0	0	0	0	15
January	0	0	0	3	23
February	0	0	79	62	33
March	0	0	36	13	0
April - Sept	0	0	0	0	0
Annual	0	0	115	78	71

Source:- Manners, I. (1969), p.105

did occur in some of the winter months. February was the main surplus month at all three stations although the overall monthly pattern varied somewhat between stations. Even so the total of these surpluses was no more than 8 per cent of the deficit for the other months of the year at two of the stations and about 15 per cent at North Shuneh, indicating the marked dryness of the climate and the need for irrigation to promote intensive and reliable crop production.

A second water balance study was made in the valley in 1976 by the Arab Organization for Agricultural Development when it compared annual and seasonal rainfall receipts with seasonal evapotranspiration rates based both on the Penman and the Turc formulae. Data for two stations - Deir Alla in the middle ghor and Baqura in the north - were used but the years on which the data is based are not stated. The results which are summarized in Table 2.14 show for Baqura a small moisture surplus of 69 mm. for the three winter months based on the Penman method, but with the winter inputs and outputs just balancing at Deir Alla. For the other nine months of the year, at both stations, there was a marked deficit which was particularly strong in summer but also marked in spring and autumn. Using the Turc method for calculating evapotranspiration, the different scale of the deficit at the two stations was accentuated somewhat but this in no way altered the general conclusions. These confirm the results obtained by Manners - that the moisture surplus even in the wetter north of the valley in the winter is too small and unreliable to compensate for the severe deficits at other seasons. Irrigation is therefore essential in any attempt to extend the cropping season beyond the winter and to intensify the use of the farmland, while the winter surplus is also too small and unreliable to risk agricultural intensification without full-scale irrigation.

2.4 Water Resources

2.4.1 Introduction

Without irrigation intensive agriculture is impossible in the valley and, as in other irrigation schemes developed in areas of low

TABLE (2.14) EAST JORDAN VALLEY:

SEASONAL EVAPOTRANSPIRATION AND WATER BALANCE FOR TWO SELECTED STATIONS

A) Penman Approach

		Annual Total	Autumn	Winter	Spring	Summer
Baqura	Precipitation (MM)	359	44	219	96	0
	Evapotranspiration (Penman) in MM	1286	279	150	362	495
	Water Balance (MM/Annum)	-927	-235	+69	-266	-495
Deir Alla	Precipitation (MM)	277	37	170	70	0
	Evapotranspiration (Penman) in MM	1346	306	170	376	494
	Water Balance (MM/Annum)	-1069	-269	0	-306	-494

B) Turc Approach

		Annual Total	Autumn	Winter	Spring	Summer
Baqura	Precipitation (MM)	359	44	219	96	0
	Evapotranspiration (MM)	1207	202	168	356	481
	Water Balance (MM/Autumn)	-848	-158	+51	-260	-481
Deir Alla	Precipitation (MM)	277	37	170	70	0
	Evapotranspiration (MM)	1446	335	185	390	536
	Water Balance (MM/Autumn)	-1169	-298	-15	-320	-536

Source:- Compiled from Arab Organization for Agricultural Development (1976), pp.76-81 rainfall amounts, with high temperatures and high rates of evaporation, efficient use of water supplies is a basic requirement of successful irrigated agricultural development. Accordingly consideration must be given to the area's water resources and their effect upon agricultural activities.

It is convenient to divide the water resources of the Jordan valley into surface and groundwater provision although the relationship between them is, of course, quite strong because surface wadi flows are frequently fed from springs while the wadis can, and do, recharge aquifers, particularly those under the valley floor. Only the water resources of the east part of the valley and the catchments which feed into that area, will be considered here.

A variety of data sources has been used in compiling this section. While some data has been extracted from various consultancy reports largely connected with feasibility and other studies for the East Ghor irrigation scheme, the most useful source has been the thesis by Manners.[13] Also useful is the hydrological data that has been regularly recorded on the rivers and wadis for various periods since 1926 but mainly since the 1950's, and related reports.[14] No data has been used here for years since 1963. This is because there has been no governmental or other study, since that made by Manners, to bring together and recalculate the very scattered hydrological data sets, and it did not seem necessary to do this for the present study simply to extend the run of data. Furthermore, since the irrigation scheme largely came into operation throughout the 1960's and most of the farmers considered in this study made many of their basic land use decisions at that time, it is perhaps appropriate to view the water resource situation as it was known at that time rather than as it is understood today.

2.4.2 Surface Water Resources

The surface water resources of the area under consideration consist of the Yarmouk and Zarqa Rivers and a number of smaller side wadis that all drain into the Jordan River. As Fig. 2.5 shows these southwards from the Yarmouk are the Wadis Arab, Ziqlab, Jurum, Yabis,

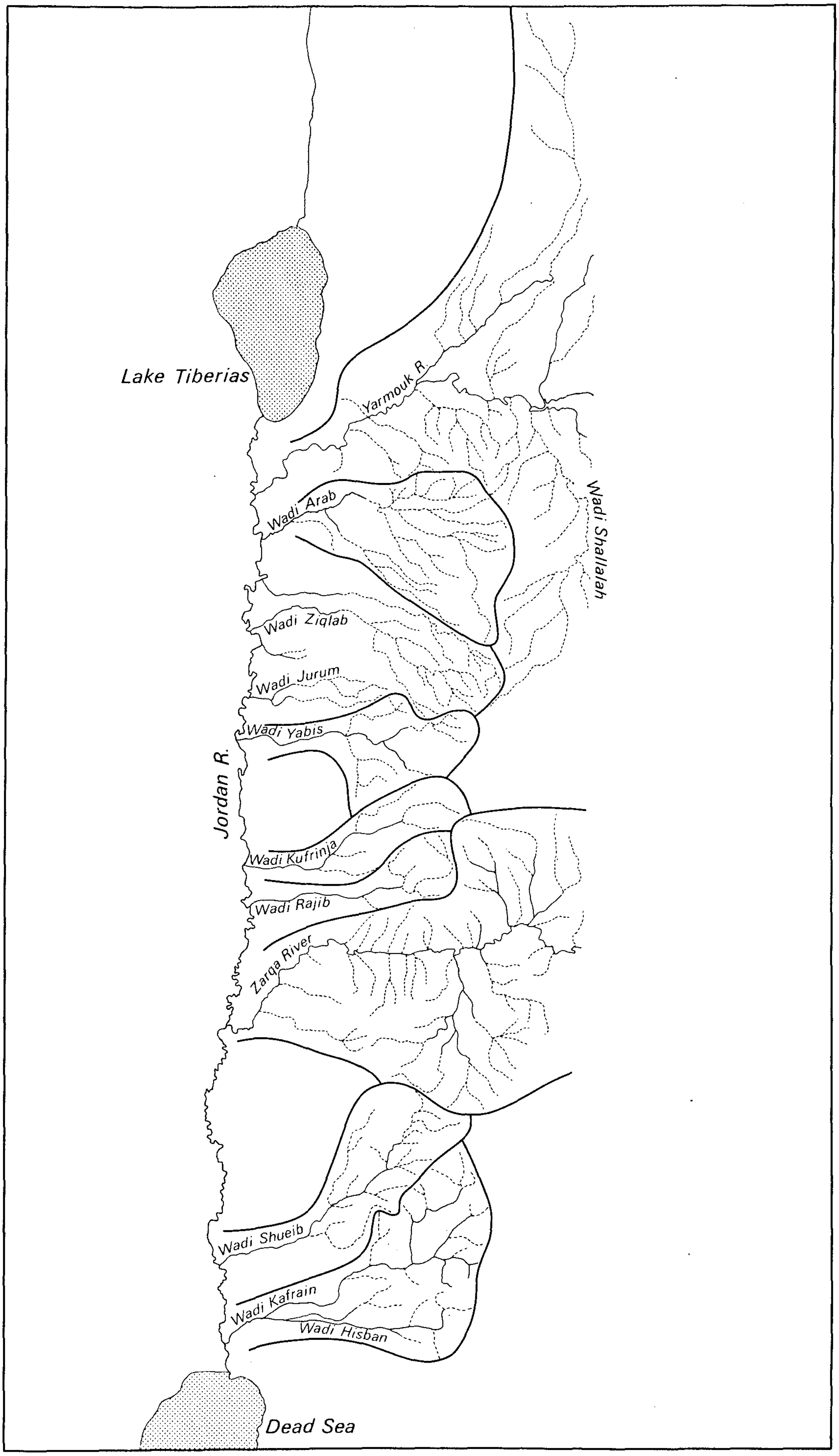

Fig. 2.5 EAST JORDAN VALLEY: RIVERS AND WADIS

(Sbeirra, Sleikhat), Kufrinja and Rajib. South of the Zarqa river are the Wadis Shueib and Kafrain with its tributary, the Hisban. With the exception of the small wadis Sbeirra and Sleikhat, on which no hydrological data is available, Table 2.15 shows the catchment area and the average annual flow of these wadis. It should be pointed out that the average flows for each wadi are calculated on different series of years, according to availability of data, although this little affects the general patterns.

It can be immediately noted that the two rivers, Yarmouk and Zarqa - considered as rivers because of their greater catchments and flow - make up nearly 90 per cent of the total catchment area of the project and, under average conditions, provide over 80 per cent of the recorded discharge from this catchment area into the valley.

In terms of water yield in relation to catchment size, however, it is clear that the two rivers, which tap higher land receiving greater rainfall, do not provide as much water per unit area of catchment as some of the wadis predominantly in the northern part of the valley. Table 2.15 also gives the maximum and minimum recorded flow from each catchment into the valley but here the data refer to different years depending on the occurrence of the events and the availability of records, so that these figures cannot be aggregated to determine extreme conditions in any one year in the whole study area. Rather, these variations in wadi discharge from one year to another seem to reflect preceding rainfall conditions and this is briefly considered in this section.

For simplicity of treatment it seems sensible to consider the various rivers and wadis, in terms of their general catchment and flow characteristics, in four main groups: the two main rivers; the main northern wadis; the main southern wadis; and, a number of smaller wadis of low discharge.

2.4.2.1 The two rivers

Yarmouk River: With a catchment area of 6805 sq. km. of which nearly three quarters is in Syria, the River Yarmouk is easily the largest and most important water source for the East Ghor Canal Project. Indeed

TABLE (2.15) EAST JORDAN VALLEY:

DRAINAGE AREAS AND ANNUAL STREAMFLOW OF THE MAIN RIVERS AND SIDE WADIS

	Drainage Area		Annual Streamflow (MCM)				
	Km^2	%	Average	%	Yield Area	Maximum	Minimum
East Bank Rivers:							
Yarmouk	6805	59.7	438	69.0	.064	870	240
Zarqa	3440	30.2	85	13.4	.025	148	29
East Bank Wadis:							
Arab	254	2.2	35	5.5	.138	42	14
Ziqlab	107	0.9	13	2.0	.121	16	7
Jurum	27	0.2	13	2.0	.481	15	9
Yabis	131	1.2	6	1.0	.046	11	1
Kufrinja	119	1.0	12	1.9	.101	25	2
Rajib	80	0.7	4	0.6	.050	8	1
Shueib	187	1.6	11	1.7	.059	20	4
Kafrain	161	1.4	12	1.9	.075	26	3
Hisban	90	0.8	6	1.0	.067	9	2
Total	11401	99.9	635	100.0			

Source:- Jordan, Irrigation Department (1974), p.6

the scheme has been largely designed around capturing Yarmouk River water. Made up of three main wadis - the Shallalah, Zeizoun and Allan - which converge just upstream of Maqarin dam, the Yarmouk's catchment provides 60 per cent of the project area's total catchment and, on average, contributes 69 per cent of water receipts.

Flow records for the Yarmouk have been kept since 1926, much longer than for the other catchments to be considered, and these show that discharge varies considerably both seasonally and from year to year. The mean annual flow of about 440 MCM is made up, as Table 2.16 shows, of a monthly base flow of between 19 and 25 MCM, which suffers only limited monthly fluctuation, and an average flood flow 73 per cent as large as the base flow and much more variable seasonally. The flood flow represents 42 per cent of the total streamflow. The great majority of this seasonal flood flow comes in the winter rain months of January to March which are also the peak months of baseflow. As a result the average streamflow in the winter months is two to five times that of the other months, leading to the need to control and store some of this discharge for the irrigation scheme by means of the Maqarin dam. The average flow in February, the peak month of discharge, represents 23 per cent of the annual discharge.

Actual annual flows can vary, however, markedly from this pattern and this helps to account for the variation in the flow estimates made earlier by other workers. As Fig. 2.6 shows, in 1927/28, the peak year recorded, the annual discharge was boosted by an exceptionally large February flow and a series of spring months of high discharge. That year's discharge of 878 MCM, about double the average, contrasts with the recorded flow for 1959/60 of only 240 MCM, little more than half the average, when no winter peak appeared. According to Manners' examination of relationships between streamflow and antecedent rainfall in some of these east bank catchments, the annual discharge of the Yarmouk seems to be most strongly correlated with rainfall receipt in both the year of recorded discharge and the immediately previous years.[15]

River Zarqa: With a catchment area just over a half the size of the Yarmouk's and equal to 30 per cent of the total contributory area for the project area, the River Zarqa forms the second largest surface water

TABLE (2.16) YARMOUK RIVER:

STREAMFLOW REACHING THE GHOR 1926-1966

	Av. Baseflow		Av. Floodflow		Av. Streamflow	
	MCM	%	MCM	%	MCM	%
October	20	7.9	2	1.1	22	5.0
November	20	7.9	3	1.5	23	5.3
December	21	8.3	13	7.0	34	7.7
January	23	9.1	45	24.2	68	15.5
February	24	9.5	77	41.4	101	23.0
March	25	9.9	34	18.3	59	13.4
April	22	8.7	10	5.4	32	7.3
May	21	8.3	2	1.1	23	5.3
June	19	7.5	0	0	19	4.3
July	19	7.5	0	0	19	4.3
August	19	7.5	0	0	19	4.3
September	20	7.9	0	0	20	4.6
Annual Total	253	100.0	186	100.0	439	100.0
Other Estimates:						
Ionides, M.G. (1939)	254		226		480	
Wozab, D.H. & Wilson, G.R. (1955)	225					
Baker-Harza (1955)					467	
Harza Eng. Co. Int. (1962)					452	

Source:- Manners, I. (1969), p.128

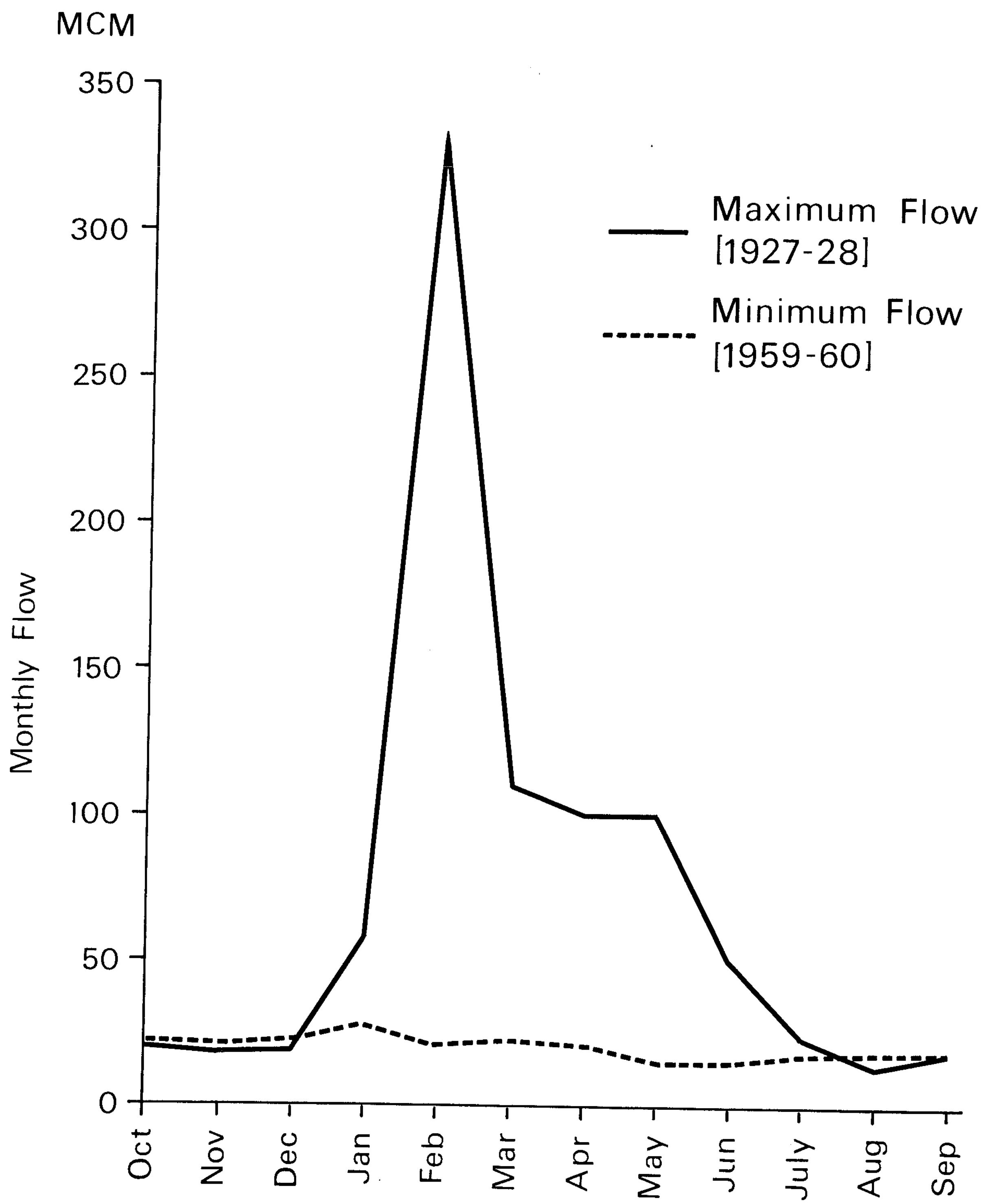

Fig. 2.6 THE YARMOUK RIVER: PATTERN OF MONTHLY FLOW FOR TWO EXTREME YEARS

resource for the East Ghor Canal Project. This was recognized in 1978 with the construction of the King Talal Dam to give better use of some of its discharge. But inspite of its large catchment the Zarqa is a much smaller discharge source than the Yarmouk, as Table 2.15 shows, accounting for only 13 per cent of the total average annual discharge of the various rivers and wadis considered here. Furthermore, with such a low water yield from such a large catchment its yield-to-area ratio is lower than all the other rivers and wadis. Part of the reason for this is that none of its catchment rises above 1000 metres and it rises on the East Bank in a relatively southerly location where rainfall amounts are considerably lower than to the north on the Syrian border. Furthermore much of the upper Zarqa is fed by springs including Ain Sukhna, the largest on the East Bank. Several of these close to Amman have been abstracted for municipal and agricultural use outside of the Jordan valley, so that less water enters the ghor. By 1964 about 2.8 MCM were annually abstracted along the course of the Zarqa above the east ghor for irrigation.[15] The baseflow has been recorded since 1949 to give a 14 year record to 1963. The floodflow has been recorded since 1951. Table 2.17 shows an average annual streamflow of 72 MCM, even less than the figure given in Table 2.15 derived from a different data source, although other estimates listed in Table 2.17 err towards a higher discharge. Like the Yarmouk River, base flow is fairly steady with a January-March peak but with some reduction in July-September over the rest of the year. Because it is spring fed, flood flow is proportionately rather less important than on the Yarmouk but is still a highly seasonal feature with over 72 per cent coming in the months of January to March. As a result those months account for 43 per cent of the total average annual streamflow of this river that reaches the ghor, compared with 52 per cent in the case of the Yarmouk in these same three months. The peak year recorded (1952) and the year of lowest recorded flow (1960), give a range of variation of the same magnitude as for the Yarmouk. Again this seemed to result largely from the failure of winter flood flow and reduced baseflow in the dry year, and excessive winter and spring rain and higher baseflow in the high discharge year. Manners suggests that baseflow on the Zarqa most strongly reflects the mean of rainfall during the same and the previous year whereas floodflow, of course, reflects immediately preceding rainfall events.

TABLE (2.17) ZARQA RIVER:

STREAMFLOW REACHING THE GHOR 1949-1963

	Av. Baseflow		Av. Floodflow		Av. Streamflow	
	MCM	%	MCM	%	MCM	%
October	4.19	8.2	0.28	1.3	4.47	6.2
November	4.21	8.2	1.14	5.3	5.35	7.4
December	4.46	8.7	3.04	14.2	7.50	10.3
January	4.99	9.8	3.71	17.2	8.70	12.0
February	4.99	9.8	8.05	37.4	13.04	17.9
March	5.72	11.2	3.90	18.1	9.62	13.2
April	4.39	8.6	0.05	2.3	4.89	6.7
May	4.38	8.6	0.91	4.2	5.29	7.3
June	3.71	7.3	0	0	3.71	5.1
July	3.36	6.6	0	0	3.36	4.6
August	3.31	6.5	0	0	3.31	4.6
September	3.41	6.7	0	0	3.41	4.7
Annual Total	51.12	100.0	21.53	100.0	72.65	100.0
Other Estimates:						
Ionides, M.G. (1939)	45.00					
MacDonald & Partners (1951)	45.00		57.00		102.00	
Wozab & Wilson (1955)	51.09					
Baker & Harza (1955)	59.20		33.1		92.30	
Harza Eng. Co. Int. (1962)					72.00	
MacDonald & Partners (1964)	65.23		17.66		82.99	

Source:- Manners, I. (1969), p.158

2.4.2.2 The Side Wadis

The Northern Wadis: Three of the northern wadis can be compared, as can be seen in Table 2.15 on the basis either of catchment size or average annual discharge but, being larger than average size, they are worth separate consideration. These are Wadis Arab, Ziqlab and Jurum although Jurum qualifies in this group on discharge rather than catchment size. It can also be shown, as indicated in Table 2.18, that these three wadis share similar flow characteristics. Wadi Kufrinja might also have been included on the basis of size and location but, by its behaviour, is more akin to the larger southern wadis to be considered in the next subsection.

The most northerly and largest of all the wadis (excluding the two rivers) draining into the study area is Wadi Arab. Its 254 sq. km. catchment lies immediately south of the Yarmouk catchment. The Yarmouk's south bank tributary, Wadi Shallalah, has restricted the Arab to a relatively small and lower lying catchment that nowhere rises above 850 metres, and has allowed it to develop only one major tributary, Wadi Zahar. Data on flow characteristics for the Arab, for the 15 year period from 1949 when records were first kept, show that with an average annual baseflow discharge of over 31 MCM into the ghor it is nearly three times as large as any of the other wadis and has 60 per cent the average annual baseflow of the Zarqa River. It also provides a fairly regular monthly baseflow with no one month having more than 10 per cent of the annual flow. Where it differs from the hydrology of the Zarqa River is in terms of its almost complete lack of a flood flow so that no record has been kept of this and only two estimates made, both of which gave a flood flow equal to no more than 8 per cent of base flow. The range of variation from the mean in annual discharge has also been markedly less than for the Yarmouk and Zarqa Rivers probably mainly because of the absence of a major flood flow regime. Its highest recorded discharge year (1954) was only 23 per cent above the mean and the lowest year of discharge was only 39 per cent below the mean, a much smaller range than for either the Yarmouk or the Zarqa, which is probably not in the main attributable to the shorter run of recorded years.

As Table 2.18 shows, the average discharge behaviour of the other two northern wadis, Ziqlab and Jurum is similar to the Arab in terms of

TABLE (2.18) EAST JORDAN VALLEY NORTHERN WADIS: STREAMFLOW REACHING THE GHOR

	Wadi ARAB (1949-63) MCM	%	Wadi ZIQLAB (1950-63) MCM	%	Wadi JURUM (1950-63) MCM	%
October	2.66	08.3	0.89	08.7	1.02	08.8
November	2.74	08.6	0.88	08.6	0.98	08.4
December	2.96	09.3	0.97	09.4	1.02	08.8
January	2.91	09.1	1.02	09.9	0.98	08.4
February	2.79	08.7	0.85	08.3	0.90	07.8
March	2.79	08.7	0.90	08.8	0.76	08.3
April	2.55	08.0	0.81	07.9	0.93	08.0
May	2.54	08.0	0.82	08.0	1.00	08.6
June	2.44	07.7	0.79	07.7	0.96	08.3
July	2.48	07.8	0.78	07.6	0.97	08.4
August	2.51	07.9	0.78	07.6	0.97	08.4
September	2.52	07.9	0.78	07.6	0.92	07.9
Av. Annual Total (Baseflow)	31.89	100.0	10.27	100.0	11.60	100.0
Av. Annual Total (Floodflow)	01.28		01.25		00.10	
Av. Annual Total (Streamflow)	33.17		11.52		11.70	

Other Estimates:

	Baseflow	Floodflow	Baseflow	Floodflow	Baseflow	Floodflow
Ionides, M.G. (1939)	15.00	-	08.00	-	11.00	-
Macdonald (1951)	15.00	-	-	-	-	-
Wozab, D.H. & Wilson, G.R. (1955)	34.95	-	12.55	-	12.91	-
Baker-Harza (1955)	34.90	02.40	12.70	01.20	13.30	00.20
Harza Eng. (1962) *	35.60		12.50		13.40	
Macdonald (1964)	33.21	01.28	11.79	01.25	12.50	00.10

*Baseflow and Floodflow jointly estimated.

Source:- Manners, I. (1969), pp.133, 140 and 145

the low variation in baseflow from month to month and the minor role played by flood flow which again, as for wadi Arab, has only been subject to various estimates. Indeed the small, relatively constant, flood-free flow of all three of these wadis meant that their importance was generally underestimated in earlier years as can be seen in the low estimates placed on the discharges of two of them by Ionides and Macdonald before regular records were available. A failure to appreciate their importance was also seen in the slowness with which any attempt was made to control and use any water from these wadis in the ghor. Dams and other structures were not built on these wadis until 1966.

Not only does Wadi Ziqlab have a regularity of baseflow similar to Wadi Arab but its variation of annual discharge is similarly restricted. Its peak discharge year (1950), when a winter flood flow made up 10 per cent of the total annual streamflow was only 17 per cent above the mean year, while the year of lowest recorded discharge (1962) only dropped 34 per cent below the mean. In attempting to explain the relationship between variable annual wadi discharge and rainfall in the ghor, Manners examined the coefficients of correlation for a number of preceding rainfall conditions for three of the catchments being considered here - Zarqa River, Wadi Arab and Wadi Ziqlab. These coefficients are given in Table 2.19 where it can be seen that the very variable annual discharge of the Zarqa River suggests a stronger correlation with the mean rainfall amount of the same and the previous year whereas the much more regular discharge of Wadis Arab and Ziqlab suggest a strong link to mean rainfall conditions over a longer period of preceding years.

The discharge behaviour of Wadi Jurum is again similar to that of Wadis Arab and Ziqlab except for the fact that its average annual yield of 11 MCM comes from the smallest catchment area (27 sq. km) of all the wadis being considered here. As a result, of the three northern wadis listed in Table 2.15, all of which are the highest water yielders in relation to the size of their catchments, Jurum is easily the most productive giving nearly half a million cubic metres of water per sq. km. of catchment. Flood flow estimates for Wadi Jurum are extremely low while its average monthly discharge shows the smallest degree of variation of any of the wadis and rivers being considered. Annual

TABLE (2.19) CORRELATIONS BETWEEN ANNUAL BASEFLOW AND AVERAGE RAINFALL OVER THREE WADI CATCHMENTS

Rainfall Occurring	River Zarqa	Wadi Arab	Wadi Ziqlab
1. During the same year	.490	-	-
2. In the preceeding year	.812	.309	.512
3. Two years previously	.059	.567	.507
4. Three years previously	Neg	.504	.345
5. Four years previously	Neg	.182	.470
6. Five years previously	-	.209	.082
7. Mean rainfall of same year and previous year	.878	-	-
8. Mean rainfall of same year and previous two years	-	-	.816
9. Mean rainfall of same year and previous three years	-	.809	-
10. Mean of 2, 3 and 4	-	.851	.721

Source:- Manners, I. (1969),pp.136, 142 and 159 variations were also small, varying no more than 26 per cent either side of the mean over the 14 years of records (up to 1963) being used here.

<ins>The Southern Wadis</ins>: The southern wadis are of more moderate size of catchment and discharge. They are Wadi Kufrinja to the north of Zarqa River, and Wadis Shueib and Kafrain just to the north of the Dead Sea. Their catchment areas, as can be seen in Table 2.15 range between 119 and 187 sq. km., that is intermediate in size between the catchment areas of Wadis Ziqlab and Arab. Yet their total average annual flow falls below the three northern wadis just considered, so that their water yield per unit area of catchment is also lower. But these southern wadis are similarly differentiated as a group from the northern wadis by their much more variable monthly flow. Again, as for their northern counterparts, no monthly records and few estimates of annual flood flow exist for these wadis but, as Table 2.20 shows, flood flows appear to be of limited importance although more than for the northern wadis. MacDonald's estimate of annual average flood flow on Wadi Kafrain placed it as 25 per cent of the baseflow but for Wadi Kufrinja as only 6 per cent. Rather than flood flows accounting for variable monthly discharge, it is caused by uneven baseflow which, as Table 2.20 indicates, peaks in March and falls off markedly in the summer.

The reason for this distinctive baseflow regime appears to be related to the spring-fed nature of each of these wadis because their catchments receive rather lower amounts of rainfall than the areas that feed the northern wadis. Many of these springs suffer abstraction at least in summer for municipal and agricultural use outside of the ghor. For example Wadi Kufrinja is almost entirely fed by Ain Ajlun and Ain Qantara but the first of these springs is almost totally used in the Ajlun area in summer while the second has a unreliable flow. Several of the springs which feed into Wadi Shueib near Salt are also abstracted for local irrigation. An estimated additional 1.5 MCM is abstracted along the course of the wadi for irrigation before it reaches the ghor. MacDonald estimated that over 3 MCM of base flow, mainly in summer, was being diverted from Wadi Kafrain for irrigation of 4100 dunums before it reached the ghor. The strength of the baseflow from spring sources

TABLE (2.20) EAST JORDAN VALLEY SOUTHERN WADIS: STREAMFLOW REACHING THE GHOR

	Wadi KUFRINJA (1951–63)		Wadi SHUEIB (1955–66)		Wadi KAFRAIN (1956–66)	
	MCM	%	MCM	%	MCM	%
October	0.30	04.4	0.42	06.6	0.38	06.4
November	0.33	04.8	0.44	06.9	0.40	06.8
December	0.70	10.2	0.52	08.1	0.46	07.8
January	0.67	09.7	0.59	09.2	0.59	10.0
February	1.01	14.7	0.69	10.8	0.74	12.5
March	1.27	18.5	0.76	11.9	0.77	13.1
April	0.86	12.5	0.67	10.5	0.66	11.2
May	0.53	07.7	0.57	08.9	0.59	10.2
June	0.40	05.8	0.48	07.5	0.42	07.1
July	0.29	04.2	0.47	07.3	0.30	05.1
August	0.27	03.9	0.41	06.4	0.27	04.6
September	0.25	03.6	0.38	05.9	0.32	05.4
Av. Annual Total (Baseflow)	6.88	100.0	6.40	100.0	5.90	100.0
Av. Annual Total (Floodflow)	0.44		1.70		1.47	
Av. Annual Total (Streamflow)	7.32		8.10		7.37	

Other Estimates:

	Baseflow	Floodflow	Baseflow	Floodflow	Baseflow	Floodflow
Ionides, M.G. (1939)	6.00	–	10.00	–	12.00	–
Wozab, D.H. & Wilson, G.R. (1955)	6.15	–	09.06	–	11.73	–
Baker-Harza (1955)	5.50	7.40	09.10	1.1	11.00	1.40
Harza Eng. (1962)*	6.40		9.80		12.00	
Macdonald (1964)	3.83	0.44	07.97	1.72	07.94	1.47

*Baseflow and Floodflow jointly estimated.

Source:– Manners, I. (1969), pp.152, 164 and 170 seems to be strongly correlated with recent rainfall events rather than with rainfall of previous seasons so that streamflow also varies considerably from year to year. Both of the southern wadis showed a wider range between years of extreme flow and the mean than is found with the northern wadis although this was less noticeable for Wadi Kufrinja.

The Smaller Wadis: Of the smaller wadis which drain into the East Ghor area, some data records have been compiled on three: Wadi Yabis to the north, the small Wadi Rajib, and Wadi Hisban, a tributary of Wadi Kafrain in the far south. Some flow data is provided on these wadis in Table 2.21. Wadi Yabis is the largest by catchment area (131 sq. km.) and could be grouped with its northern neighbours but for its lower discharge and the variation in its mean monthly flow. Its mean discharge of 5.4 MCM based on 1939-62 records is also much higher than for more recent parts of the period (1958-63). Like the southern wadis, Wadi Yabis is largely spring-fed and several of these springs are in the upper catchment. They are either abstracted for use outside of the ghor or fail to flow in the summer which accounts for the marked peaking of discharge in the winter months. The two available estimates of flood flow - by Baker-Harza and MacDonald - differ from each other considerably. Extreme conditions can differ markedly from the mean, with the year of highest discharge (1943) giving nearly twice the flow of the mean year and the lowest discharge year (1960) less than half of the mean.

Wadi Rajib is much smaller with an 80 sq. km. catchment and a mean annual discharge of 3.5 MCM based on a set of irregular baseflow records. Again it has suffered much spring abstraction from its upper catchment which partly accounts for its winter peak. There is also a wide range of readings for discharge in different years. In 1939 a baseflow of 5.4 MCM was recorded but in 1947 the discharge was only 1.1 MCM. Estimates of flood flow, like those for Yabis, also differ widely. Lastly, Wadi Hisban shows much the same characteristics as the other two, its catchment and discharge being of similar size to Wadi Rajib and its mean discharge (for the few years of available records) showing a winter peak because it is fed by small, unreliable springs and much spring abstraction has also occurred. Other estimates of its

TABLE (2.21) EAST JORDAN VALLEY SMALLER WADIS: STREAMFLOW REACHING THE GHORS

	Wadi YABIS (1958–63)		Wadi HISBAN (1956–63)		Wadi RAJIB (+)	
	MCM	%	MCM	%	MCM	%
October	0.15	06.6	0.23	06.5	0.16	04.6
November	0.16	07.0	0.25	07.0	0.20	05.8
December	0.24	10.5	0.31	08.7	0.26	07.5
January	0.32	14.0	0.35	09.9	0.34	09.8
February	0.29	12.7	0.37	10.4	0.40	11.5
March	0.31	13.6	0.39	11.0	0.44	12.7
April	0.19	08.3	0.32	09.0	0.43	12.4
May	0.13	05.7	0.31	08.7	0.36	10.4
June	0.12	05.3	0.30	08.5	0.30	08.6
July	0.12	05.3	0.27	07.6	0.23	06.6
August	0.12	05.3	0.23	06.5	0.18	05.2
September	0.13	05.7	0.22	06.2	0.17	04.9
Av. Annual Total (Baseflow)	2.28	100.0	3.55	100.0	3.47	100.0
Av. Annual Total (Floodflow)	0.43		0.92		0.49	
Av. Annual Total (Streamflow)	2.71		4.47		3.96	

Other Estimates:

	Baseflow	Floodflow	Baseflow	Floodflow	Baseflow	Floodflow
Ionides, M.G. (1939	05.00	–	06.00	–	05.00	–
Macdonald (1951)	–	–	06.00	10.00	–	–
Wozab, D.H. & Wilson, G.R. (1955)	08.06	–	05.43	–	07.06	–
Baker–Harza (1955)	05.40	03.00	04.80	00.80	03.50	03.10
Harza Eng. (1962)*	05.30		05.60			
Macdonald (1964)	04.93	00.43	05.22	00.92	04.27	00.49

+ No regular records are available. Data represents 7 years 1938–41, 1947 and 1950–51.
* Baseflow and Floodflow jointly estimated.

Source: Manners, I. (1969) pp. 149 and 173 and MacDonald (1965), Vol 2, pp.IV–11 annual discharge are rather higher. Its year of highest recorded discharge (1957) gave an output nearly twice the stated mean and its lowest year (1962) little more than half the mean. Estimates of flood flow differ widely as for the other smaller wadis.

2.4.3 Groundwater and Drainage Conditions[16]

2.4.3.1 Sources and occurrence: The groundwater resources of the Jordan Valley are derived from precipitation that falls over the valley's 17000 sq. km. of total catchment area but principally from rain that falls in the adjacent highlands. Direct recharge by precipitation over the valley floor is probably negligible although there is some downward percolation in the valley from the main side wadis, from canal seepages and surface water flow. Some of this precipitation percolates throughout the fractured rocks on to the flanking highlands, to emerge as springs below both the eastern and western escarpments. Some feeds wadi flows while some can only reach the surface by pumping. Artesian and semi-artesian conditions occur at various points in the valley. Semi-artesian conditions often occur on the fringes of the main alluvial fans, as below Wadi Shueib, while an artesian aquifer is believed to exist at the northern end of the Dead Sea.

Annual groundwater levels have been regularly contoured since 1961 in connection with the East Ghor Canal Project. These show that groundwater equipotential lines reflect the contours of the surface topography of the valley but are closer to the surface at the centre of the valley than at the sides. Their levels range from a depth about 100 metres below the surface at the escarpment foothills to about 15 metres below the surface of the flood plain (el zor) of the River Jordan. Where this simple pattern is disturbed it probably results from local heavy groundwater pumping or the effects of areas of denser vegetation cover.

Two classes of hydraulic gradient can be observed from the available maps of water level contours. Steep gradients occur in the groundwater levels near the escarpment foothills in association with the main rift faults and again in association with the Lisan marl formation of low permeability at the fringes of the alluvial fans and at the ghor-zor contact zone. On the other hand relatively flat hydraulic gradients occur within the main alluvial fans of the ghor where the high levels of permeability ease groundwater movements. Although this suggests a fairly simple pattern of groundwater resources, the longer-term evidence of trends in groundwater levels, derived from various studies, is conflicting for different periods and for different areas of the valley.

The first programme of well-level observations in the valley was conducted during the period 1938-44. These indicate that there had been some rapid groundwater depletion because of too much abstraction. Tleel, in discussing the nature of groundwater levels in various parts of the valley, concluded that excessive use of groundwater in the valley since 1950 had caused continuous lowering of water levels.[17] Table 2.22 shows that during the period 1961-5 depletion occurred beneath 129 sq. km. of the valley with major falls over most of the area when it was estimated that 40 MCM was depleted in the southern part of the valley. It appears that nearly all groundwater discharge and depletion has been artificially induced by well abstraction although normal discharge occurs in the zor by evaporation from the capillary fringe, where it is close to the ground surface, and by small seepages on the flood plain.

The groundwater balance of the southern Jordan valley has been studied for the period 1959-64 by MacDonald, covering Karameh, South Shuneh, Kafrain and Rameh areas where groundwater use by wells is much developed.[18] Recharge computation for that part of the valley showed an average annual groundwater deficit of 11.9 MCM based on a recharge of 35.3 MCM and a discharge of 47.3 MCM which largely confirms the findings of Tleel. No balance has been established for the northern valley where there has been little groundwater development.

More recent studies have suggested that there has been a net groundwater level increase of 3.8 metres over the period 1963-70, a rise that could be mainly attributed to lowered rates of groundwater loss or extraction and increased rates of recharge. The high groundwater level in 1967 and the high baseflow of Wadi Shueib, resulted from abnormal rainfall conditions which also reduced extractions, while the construction of the Wadi Shueib dam in 1969 contributed to higher rates of groundwater recharge. A similar response occurred in the Kafrain

TABLE (2.22) EAST JORDAN VALLEY:

DECLINE OF GROUNDWATER LEVELS AT KARAMEH – SWEIMEH AREA

Water level decline (in metres)	1962 – 1963 (Km^2)	1961 – 1965 (Km^2)
0 – 5	101.3	67.6
5 – 10	33.9	38.2
10 – 15	5.4	15.9
15 – 20	0.1	5.3
20 – 25	–	2.2
25	–	0.3
Total	140.7	129.5

Source:– Hirzalla, B. (1973), Ground Water Resources of the Jordan Valley.

and Rameh areas where the reduced groundwater extractions during the 1967 period and the construction of the Wadi Kafrain dam led to raised groundwater levels.

2.4.3.2 Groundwater quality: The content of mineral matter in solution in groundwater is normally higher than in surface water and with increasing aridity, groundwater tends to become even more saline and this can affect irrigation. It has been necessary for the irrigation specialist to examine groundwater qualities because they can be an influence upon irrigation practices and choice of crops while these in turn can effect the groundwater management programme.

Available studies of groundwater quality in the Jordan Valley, however, make it difficult to establish general patterns and trends since within an arid area like this a great range of water types may be found locally from fresh and brackish to saline and even super-saline. In an area of saline groundwaters, relatively fresh groundwater can occur in the vicinity of stream channels owing to the flushing effect of storm flows. Elsewhere one can have fresh groundwater derived from recent precipitation resting upon brackish or saline water. Generally, however, groundwater becomes more saline to the south and towards the centre of the Jordan Valley.

The principal characteristics which determine groundwater quality in the valley are the total dissolved salts (TDS). The isosalinity maps of the valley indicate that the TDS generally range from 500 ppm. near the foothills to about 3000 ppm. along the river with some exceptional figures of 4000 ppm. in the south at places where there have been major abstractions as at Karameh, South Shuneh and Kafrain. Sodium ions and notably sodium chloride, are dominant in these areas of saline water, their origin probably the result of the chemical weathering of the silicate minerals and evaporites in the Lisan marls. Relatively high concentrations of CO_3 and HCO_3 occur in the escarpment aquifers and the alluvial fans of the main wadis such as Shueib and Kafrain.

The main detail on the distribution of the saline and fresher groundwater resources in the valley was provided in 1964 in a study by the German Geological Mission. This suggested that one reason for the less saline water at the edge of the valley, which seems to lie like a lens over more salty groundwater, is the low permeability of the marls helping to reduce mixing between the two types of water. As a result the salt content of the groundwater increases in a vertical direction. The position of the interface between the strongly salted and less saline groundwater is, however, dependent on such factors as the quantity of enriching fresh water, the rate of groundwater pumping and the nature of the aquifers. It appears that alterations in the interface and resultant mixing only occur slowly over long periods although overpumping from wells put deep down into the salt water might cause salt contamination of other shallow fresh water wells nearby. On the other hand the interface between the more and less saline groundwater in the more permeable marginal zones of the valley are subject to more rapid seasonal variation and is, nowadays, decisively dependent on the groundwater extraction rate.

Past hydrological investigations suggest that this interface between fresh and salt water might have once been close to the escarpment foothills with essentially freshwater under the hills and salt water under the valley and once related to the Lisan Sea. Since the post-Pleistocene regression of the Lisan Sea this contact zone has been pushed continuously inwards towards the Jordan River by fresh groundwater flows from the east and west sides of the valley. The present position of the saline groundwater in the valley is probably now fairly stable because of continuous enriching of fresher groundwater with salts from the evaporites of the Lisan marls. As a result there is salt accumulation in soils in contact with the water table in the centre of the valley and where Lisan marls occur.

2.4.3.3 Groundwater Subdistricts: Using the main geologic structural elements of the valley, the area can be divided into seven main groundwater subdistricts shown in Fig. 2.7 but the following discussion will only outline the three East Bank subdistricts:

1) The East Ghor subdistrict
2) Karameh - South Shuneh Subdistrict
3) Kafrain - Rameh - Sweimeh Subdistrict

1. The East Ghor Subdistrict is easily the largest. It lies between the eastern foothills and the Jordan River and extends from the Yarmouk

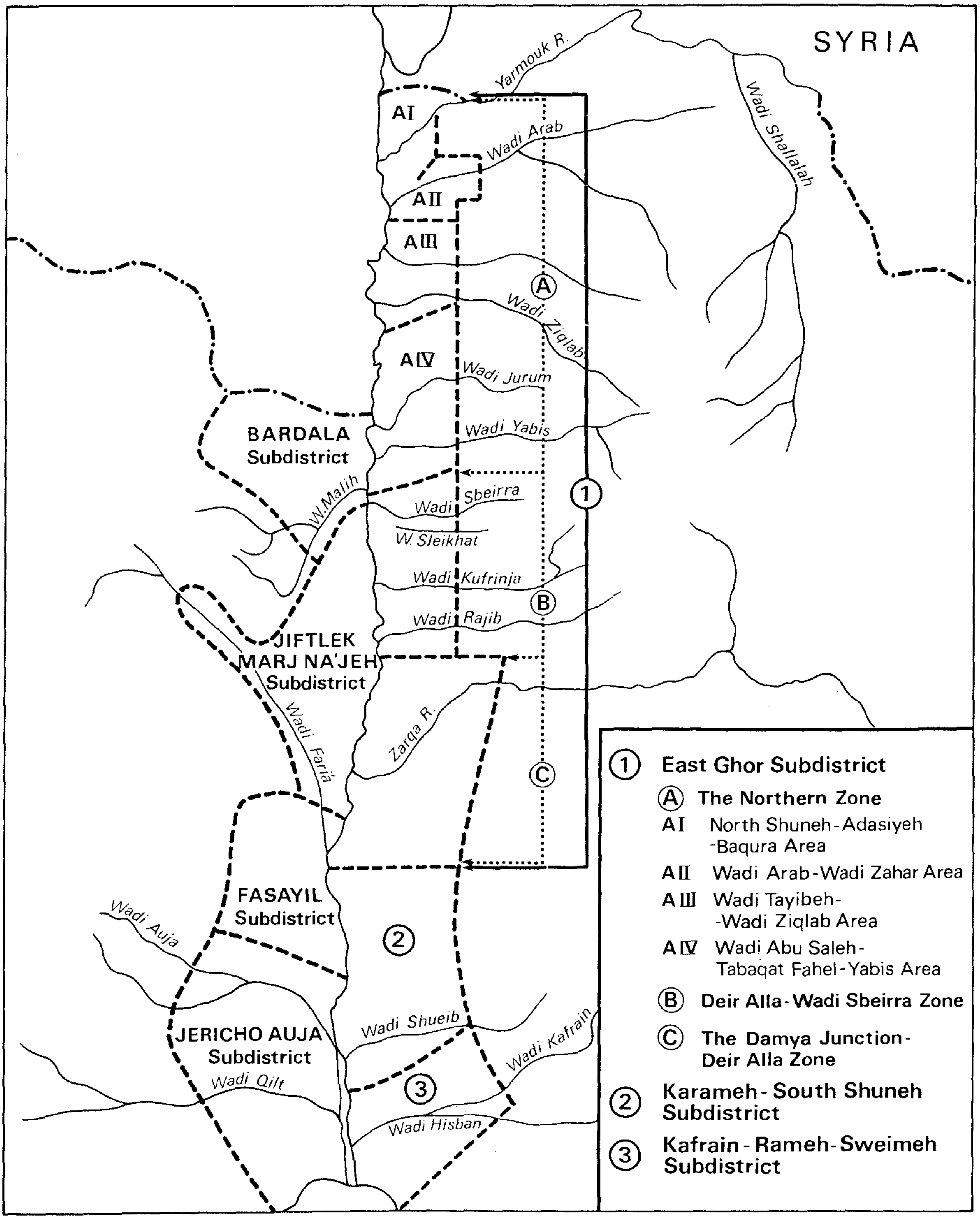

Fig. 2.7 THE JORDAN VALLEY: GROUNDWATER SUBDISTRICTS (AFTER HIRZALLA)

River in the north to Palestine grid N-156 in the south. It is a zone of limited value because of low yields and medium to high salinity. There are no available figures on total yields. Many of the wells are now disused with secure water supplies available from the canal. Because of its size it can be subdivided into three main zones from north to south.

A) The Northern Zone which extends between Yarmouk River in the north and Wadi Sbeirra in the south includes four smaller areas from north to south.

A.I) Adasiyeh - Baqura - North Shuneh Area: About 110 wells have been sunk in this area, 92 being in use. All are low yielding apart from some saline, deep ones. They are mostly shallow, less than 10 metres deep, and are used for domestic purposes. Groundwater quality from the main aquifer at Adasiyeh and Baqura ranges between 1000 and 2500 ppm. This aquifer is mainly recharged from the base flow of the Yarmouk and from the eastern escarpment.

A.II) Wadi Arab - Wadi Zahar Area. It produces a moderate flow of fairly fresh water (TDS 500 ppm) from a small groundwater reservoir which depends for its behaviour on the rainfall. The hydrograph of Ain Zahar which is fed from this source demonstrates the fluctuating nature of this flow ranging from a minimum of 382 m^3/hr (March 1962) to a maximum of 1520 m^3/hr (February 1968).

A.III) Wadi Tayibeh - Wadi Ziqlab Area. A zone of little groundwater value, a well drilled in this area to 400 metres with a yield of 60 m^3/hr encountered water of increasing salinity downwards from 600 TDS at 0-22 metres to 1000-1400 TDS at 140-400 metres.

A.IV) Wadi Abu Saleh - Tabaqat Fahel Area. All but two of the wells sunk in this zone have been abandoned because of low yield. The two that operate are low-yielding and shallow.

B) The Deir Alla - Wadi Sbeirra Zone lies south of the Northern Zone and extends between Palestine grid lines 198-180, and includes the alluvial fans of Wadis Sbeirra, Sleikhat, Kufrinja and Rajib. 27.2 MCM/year of groundwater is estimated to be available from this zone but few wells are used because of salinity. Only 27 wells have been sunk in this area ranging from a depth of 40 to 260 metres. TDS range between 500-2500 ppm. Nine of the wells are abandoned because very saline water was encountered at depth.

C) The Damya Junction - Deir Alla Zone forms the southernmost part of the East Ghor groundwater subdistrict between Palistine Grid 180-156. Several wells have been drilled in this area but abandoned because of high salinity and low yield. These ranged in depth from 20 to 96 metres with TDS of 1800-8500 ppm.

2. The Karameh - South Shuneh Subdistrict lies south of Palestine Grid line 156 as far south as South Shuneh. Unlike the zone to the north it is an area of intensive groundwater development. It includes the alluvial fans of Wadi Shueib and other smaller wadis to the north. Because irrigation development occurred later here, groundwater resources have been more highly developed in this area with 210 wells drilled of which 118 were in use in the 1970s. The depth of these varies from less than 5 metres in the zor to 90 metres near the escarpment foothills. Water levels, recharged from the escarpment at the rate of 26.5 MCM a year as well as from Wadi Shueib, have probably risen recently in these areas, especially since the 1967 reduction in pumping. TDS figures range from 500 ppm near the escarpment to 4000 ppm in the valley where the maximum decline in water level has occurred. Because of local overdraught a water management programme has been undertaken based on prohibition of further drilling. A dam was built at Wadi Shueib in 1969 to give increased groundwater recharge and there has been exploration for new groundwater sources. Some fresher well water from the escarpment is now piped into the valley floor to supply areas that suffer from aquifer depletion and salinity.

3. The Kafrain - Rameh - Sweimeh Subdistrict is the most southerly district and is another important area of groundwater use. Lying just north of the Dead Sea, it receives much of its recharge from the eastern escarpment although the alluvial aquifer receives water directly from Wadis Kafrain and Hisban. The Kafrain dam, like the Shueib reservoir

to the north has led to a rise in water levels. Some 148 wells have been drilled in this subdistrict, 95 of them in use in the 1970s. Their depth varies from very shallow ones in the Sweimeh area on the edges of the alluvial fan to 50 metres depth further east. Water is generally less salty than in the Shuneh - Karameh Subdistrict, ranging from 500 - 2000 ppm TDS, but high sodium chloride contents are found at depth.

2.4.3.4 Natural Drainage

No overall study of drainage has been made for the ghor because under normal conditions, disposal of excess water from the ghor terrace is rapid. Water moves overland generally east to west across the natural slope until it is picked up by one of the branches of the drainage system. It is then taken through the katar on to the zor and into the Jordan River. No complete artificial drainage system was installed for the East Ghor Canal Project but part of the Project's main drains were laid to discharge storm runoff from land above the main canal and to take runoff under the main canal to the Jordan River. Some of these drains also take overspill from the main canal and laterals. Generally there is no field drainage system.

Although no general drainage study of the ghor exists, various engineering reports have been made on the drainage problems of the project area. In 1955 Baker-Harza proposed a sub-surface drainage system for the entire ghor at a cost of $17 per dunum.[19] Energoproject reconsidered this plan and suggested only the areas of saline soils needed artificial drainage.[20] The Karameh area may become a drainage problem area in the future because of higher water tables and a recent switch from groundwater pumping to canal irrigation could raise these water levels. Soils are already more saline in this area. There are also areas of long gentle slopes around Kafrain where there are distances of 6 or 7 km. across the ghor from the canal to the katar with limited natural slope. Water tables are already rather high as a result of artesian effects.

There are, additionally, a number of other areas where drainage is imperfect. These are:

1) the ghor north of Wadi Arab where there is an extensive area of relatively flat land underlain by heavy soils which naturally drain slowly;
2) in the remains of some old watercourses which are subject to flooding;
3) where uncontrolled runoff from the foothills concentrates in gulleys and flows overland to affect an area between Karameh and Damya;
4) in the lower ghor-katar transition zone where pools can gather in some gulleys;
5) on the zor where some runoff from the ghor fans out across the valley floor.

In summary, inspite of these local drawbacks, the Jordan Valley has offered a set of favourable conditions for irrigation development in terms of suitable level land, well drained soils, available water closeby and a climate generally conducive to intensive agriculture. That the area encouraged irrigation at an early stage in history can be seen in the various small uncoordinated attempts made to use the waters of the Jordan and some of the side wadis, while more recent schemes to enlarge the area's irrigation potential have now culminated in the East Ghor Project. The next chapter considers how the development of the project took place.

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CHAPTER 3 IRRIGATION DEVELOPMENT IN THE EAST JORDAN VALLEY

In order to provide further background on the project for this study, this chapter traces out the development of irrigation in the valley in general and in connection with the East Ghor Canal Project in particular before going on to examine aspects of the water use on which the development has been based.

3.1 The Development of Irrigation Pre-East Ghor Canal Project

3.1.1 The Development of irrigation prior to the 20th Century

Archaeological and other evidence, revealed in the last century, suggested that irrigation and other means of water conservation had been practised in the Jordan Valley for thousands of years, and that parts of the valley had had a settled population based on irrigated farming since the late Neolithic period. Mellart, in an archaeological survey conducted in connection with the development of the present project, identified 22 population centres in the valley, dependent on spring or other groundwater resources, which appeared to have been inhabited in early Bronze Age times.[1] The discovery of simple farm implements, like sickles, at these settlements also pointed to their association with farming activities. In further supporting this view that these early valley settlements were supported by irrigation, Kenyon suggested that the closeness of the ancient town of Jericho to the spring of Ain es Sultan indicated that some form of canal system must have existed to take water to the farms around the settlement.[2]

The utilization of the surface water sources for irrigation appears to have developed in the valley in Roman and Byzantine times. Several canals dating back to this time have been unearthed and in some cases restored for re-use as water distributors at the present time. Over 40 settlements which originated in the Romano-Byzantine period lasted through at least till early Arab times (13th century) in the northern part of the valley. Several of them provide evidence of surface water conservation.

In some cases ancient qanat systems have remained in use right up till the present day. Manners reported in 1969 that there were several small areas of the valley outside of the project area still under irrigation with water received through old qanats.[3] The Ionides survey of 1939 reported one qanat system still operating near Karameh and another area between the Zarqa River and Wadi Shueib where five qanats were in use.[4] Archaeological evidence suggested that all of these were of Roman origin. The Baker-Harza survey made in the 1950s for the present irrigation scheme discovered evidence of some 22 qanats, three of which between Wadis Malih and Fari'a in the western part of the valley, were still in use.[5]

It is believed by Reifenberg that the development of irrigation and settlement progressed more or less continuously from the Roman and Byzantine period through to that of early Arab times.[6] He considers that the Ommayyad and Abbassid periods during the 7th and 8th centuries maintained the existing irrigation systems and even carried out some extensions to them, when canals and aqueducts were constructed, for example, in Wadi Neuimeh, north of Jericho.

The Arab geographer, Al-Mukaddasi, who lived in the 10 th century, described the agriculture and water use around the two cities of Beisan and Jericho.[7] In 1102 Jericho was visited by Saewulfus who acknowledged that the area was "abundant in all kinds of palms and fruit."[8] In the 13th century Jacques de Vitry was the first to mention the cropping of sugar cane in the Jordan Valley and his description of the agriculture around Jericho has been confirmed by the Arab geographer, Yakut, who also described the palm trees and sugar cane at Jericho.[9] Although Jericho town was almost entirely destroyed in the 13th century the irrigation system survived in use.

Generally speaking from the Hellenistic period until the time of the Crusades the people of the Jordan Valley maintained their agricultural systems regardless of the increasingly unstable political conditions in the region. But the presence of the Crusaders aggravated the insecurity and speeded up agricultural deterioration. The movement of nomads into the settled areas increased in the 14th and 15th centuries and there was little to protect the farmers. In time this resulted in a semi-nomadic farming system relying on animals and sporadic cropping.

This replaced the more settled agriculture and a gradual shrinkage of the irrigated area occurred.[10]

During the four centuries of the Ottoman period the continued insecurity of the area kept agriculture at a low ebb. The Ottoman rulers divided the lands under their control along feudal lines with fief holders being permitted to exercise seigneurial powers over the peasants, including the provision of military service.[11] But the authorities were unable to restrain the activities of the Bedouin who frequently raided across the Jordan Valley.

In 1831-1840 the region was administered by Ibrahim Pasha who provided more security for the peasants and encouraged others to come from Egypt to settle in the valley. New settlements appeared in the north-western part of the valley and agriculture revived, but this did not last long because Ibrahim Pasha soon withdrew his troops to Egypt.

By the 1870s, however, fresh signs of agricultural revival appeared in the valley with the arrival of new immigrants from Morocco, Algeria and more recently, Iran. In 1910 the Bahais community came from Iran and established the village of Adasiyeh in the north-east of the valley. By the start of the present century also, Jewish immigrants had begun to arrive, some of them settling in the northern part of the valley especially in the Yarmouk Triangle.[12] Under the British mandate the security of the area improved. The Bedouin started to settle down and later claimed land and water rights in the parts of the valley where they settled.[13]

3.1.2 Irrigation Development in the 20th Century

Nearly all irrigation conducted in the valley until the early part of this century was based on the use of wells, springs and side wadis with little apparent attempt to use water from the Yarmouk River or even the Jordan. Even so the amount of land under irrigation on the ghor had expanded considerably reaching about 190,000 dunums according to a fiscal survey of the eastern side of the valley made between 1928 and 1933. This represented 73 per cent of the irrigated land in the whole east bank area at that time.

A number of rock and rubble weirs or low dams had been built, or were being constructed in the early decades of this century on the side wadis in order to increase the amount of runoff water that could be captured and led on to farmland by small networks of canals. But still no direct use appeared to be made of Jordan or Yarmouk River waters since they commanded little useful land in the flood plain which was also subjected to periodic floods. Until 1938 only 4300 dunums of the zor along the Jordan were reported as under irrigation.

With control works small, distribution canal networks unintegrated, and each irrigation farmer individually attempting to make better use of local water resources, none of these irrigation systems were able to adequately supply more than a limited proportion of the land that might have benefited from watering. Many farmers with registered water rights found they were not able to obtain the water they deemed themselves entitled to because of inadequate control of stream flow or over-exploitation of well sources. Most farmers found that insufficient supplies of water limited them to rotational systems of irrigation requiring them to leave their land fallow every alternate year.

3.1.2.1 <u>The Settlement of Water Rights</u>

In an arid region like the Jordan Valley the definition of individual water rights can be just as important to farmers as their land tenure rights. Like tenure rights, water rights had grown up through local custom and practice in a confused manner not least because the use of force had often decided the rights of communities and individuals to particular water sources. In the Ottoman period, and even during the time of the British mandate, it was not unusual for a stronger tribe or community to block off a wadi and to divert the flow of its water on to its lands at the expense of weaker neighbours. Water theft was common. As Ionides noted "with no accurate means of dividing the water, and crude earth channels on steeply sloping hillsides where banks can easily be broken and the water diverted from the rightful user, squabbles and thefts are common."[14] As a result of local conflicts and complaints resulting from this situation, Ionides recommended that individual water rights should be more clearly defined and that weirs should be constructed on each side wadi to give the government more control over the distribution of supplies to individual landholders. "On each stream, therefore, the water must be collected and distributed over weirs which all the farmers can see to check for themselves the proper proportion".[15] The government in 1938 had selected some areas over which it set up controls on the allocation of water from side wadis, allocating water in proportion to the size of individual land holdings. But it was not until 1946 that the Jordanian government attempted to enact legislation to clarify water rights as a step towards more rational and efficient water use. This legislation was, however, only partly successful because vested interests amongst landowners curtailed the restriction of existing rights, and partly because surface and groundwater sources (both of which were important to the ghor farmers) had different rights attached to them.[16] Generally, farmers were able to claim rights to the use of surface flows from the side wadis on the basis of having constructed or helped to construct some form of irrigation works, such as a weir and canal. This allowed them to retain and lead water on to their land, even if the wadi did not flow across their land. Whereas in the north most such rights were held individually, in the south such rights had sometimes been established by whole tribes or communities.[17] None of these would be easy to extinguish. Groundwater rights had grown up rather differently being attached to the holder of the land on which the spring or well existed.

3.1.2.2 Irrigation from Surface and Groundwaters

Following these attempts to better define water rights a major expansion occurred in irrigation in the 1950s based on larger diversions from the side wadis and especially groundwater sources. There seem to be several reasons for the groundwater development. Not only had most of the side wadi surface flows already been taken by landholders, so that little further expansion of irrigation was possible by that means, but the partial failure of the water rights legislation still meant that landholders might lose their wadi supplies to other riparian users higher upstream or by later court settlement. The development of groundwater sources seemed to offer rather more promise not least because these rights were attached to individual owners who drilled wells on their own land but also because Ionides' survey had suggested that some aquifers were underused. Ionides' limited well drilling programme had demonstrated that there was an estimated 26 MCM of groundwater available yearly for pumping.

A small number of new hand dug wells had been sunk in the 1940s to supplement a scattered pattern of much older ones that had for long existed for domestic supply purposes. But then in the 1950s there was a sudden spate of well drilling for irrigation purposes partly as a result of the success of a well drilled by the Arab Development Project near Jericho. Between 1950 and 1961, 588 wells were sunk mainly in the arid south where surface water flows were least in amount and least reliable.

Very soon in the 1950s the degree of abstraction exceeded the recharge rate and, as clear evidence of this showed up, efforts were made to restrict further well drilling. In 1961 the government prohibited any new wells in declaring the valley an overdraft area. In 1967 it was estimated that 72 MCM of water was being drawn off from 402 wells, three times the recharge rate. Most of these wells were drilled by individual landholders for farm irrigation purposes. In 1978 in the Karameh-Sweimeh area, for example, the 146 active wells were under 106 different ownerships with about half of the wells belonging to landholders with only a single well each. Only three of the owners had more than three wells.[18] That most of the uplifted water was used for irrigation is seen in some 1960s figures which indicated that two thirds of the irrigated land in Wadi Shueib was fed from wells and an even higher proportion of the lands on Ghors Kafrain and Rameh were watered at least in part from wells.[19]

3.1.2.3 The History of Plans for Utilizing the Jordan Basin Water

The Pre-Israeli Period

The first systematic hydrological survey of the Jordan Valley to consider what potential existed for large scale water resource development was made by Ionides in 1939.[20] This study demonstrated that the prime value of the waters of the Jordan River area would be for irrigation to provide a substantial increase in the cultivated area on the valley floor. Ionides saw that the best means of achieving this was by diverting water from the Yarmouk River, the main left-bank tributary of the Jordan, to irrigate 300,000 dunums on the east side of the valley. He also suggested this Yarmouk water should be fed into Lake Tiberias which could act as a storage reservoir.

In 1944 four years before the establishment of Israel, Dr. Lowdermilk of the US Soil Conservation Service published a book, Palestine, Land of Promise, which reflected Zionist ambitions to develop Palestine's agricultural potential by utililizing the Jordan system. He envisaged a canalization of the Jordan River with water diversion from the Mediterranean into the Jordan Valley in order to generate power and to increase the level of the Dead Sea inspite of the loss to it of Jordan River water. Another Zionist plan that emerged in 1944 went even further than Lowdermilk in proposing the diversion of a large part of the Litani River, which rises and flows entirely within Lebanon, into the upper Jordan to increase its irrigation potential.[21]

Plans After the Creation of Israel

After the establishment of the State of Israel in 1948 and the creation of the Palestinian refugee problem, with many of the refugees taking shelter in Jordan, the development of the Jordan River resources became more urgent. Most proposals for the irrigational development of the Jordan Valley focused to a large extent on the Yarmouk River waters, as the primary resource. But they have differed both in their plans for the role of Lake Tiberias and in their estimates of the potential amount of irrigation possible in the valley. Part of the reason for these differences simply reflect changing assessments of the civil engineering difficulties involved, and of the available amounts of water and useful irrigable land. But part of the reason results from the uncertain and hostile political background against which the various proposed schemes were formulated, with the Arab states of the region and Israel unable or unwilling to agree on the best way to share out and utilize the waters in an efficient and integrated manner.

The government of Jordan first announced its intention to tap the Yarmouk River in order to irrigate the east ghor of the Jordan Valley in 1951.[22] At about the same time the neighbouring Arab states expressed ideas for the exploitation of two rivers that rose in their territory but which could be of potential benefit to Israel - the Hasbani River which rises in Lebanon 32 miles north of the Israeli border, and the Baniyas which originates in Syria only a mile north of Israel. The announcement by Jordan to exploit the Yarmouk river led immediately to Israel's closure of an existing dam south of Lake Tiberias which fed water south into the Jordan River where it could be of use to landusers within Jordan.[23] Israel also started operations to drain the Hula swamps as a first step to divert the waters from the Jordan. Shortly afterwards, in 1953, Israel started to divert part of the Jordan River in the demilitarised zone between Israel and Syria at Jisr Banat Ya'qub ostensibly for power development, but this was stopped by United Nations efforts.

In 1952 a plan was put forward by M.E. Bunger, an American engineer working with the U.S. Technical Co-operation Agency in Amman to build a dam on the Jordan-Syrian border at Maqarin where three smaller wadis join together to form the Yarmouk River. Bunger had first noticed this possible dam site on a flight over the area and convinced his agency and the Jordan government that this supply would make irrigation of a major part of the Jordan Valley possible. His agency agreed to advance nearly $300,000 for the project, the Jordan Government a further $200,000, while the bulk ($850,000) would come from United Nations (UNWRA) which was anxious to find ways of settling some of the Palestinian refugees. Because Israel objected to the plan on the grounds that it would deprive her of the share of the Yarmouk waters she was entitled to as a riparian state and would make future co-operative development of the Jordan Valley more difficult, the U.S. Technical Co-operation Agency and UNWRA withdrew their financial support for the plan.

These preliminary, and often, provocative, moves by individual states in the Jordan Basin to extract water resources, with little or no regard to the interests of neighbouring states, led the UN and USA to intervene to help reach an agreement. UNRWA in 1953 asked the

Tennessee Valley Authority (TVA) to carry out a desk study of the feasibility of a "unified plan" as a means of helping to settle the Palestinian problem with "a scheme to use the waters of the Jordan and Yarmouk Rivers for irrigating the Jordan Valley and for establishing the refugees there".[24] The published plan envisaged total water resources of 1305 MCM available for irrigation, of which 63 per cent would come from sources in Jordan, 33 per cent from Israel and 4 per cent from Syria. The plan provided for 936,000 dunums of irrigated land of which 52 per cent would be in Jordan, 44 per cent in Israel and nearly 4 per cent in Syria.

<u>The Johnston Mission</u>

Following the TVA Plan the American President Eisenhower sent his special envoy Ambassador Johnston with some proposals for both Israel and the other riparian Arab states based on the TVA Plan for the allocation and utilization of the Jordan waters. Johnston invited counter proposals from both parties and carried out two years of negotiations.

The Arab states responded with what became known as the Arab plan which appeared in March 1954. Although it represented a certain loosening of the Arab stance towards Israel by recognizing it as a riparian state with rights to a share of the region's water, the Arabs proposed that this share should be 20 per cent and not 40 per cent as suggested by Johnston.[25] The Arab Plan also proposed that Israel should irrigate the Hula region from the Jordan River and not divert Jordan water out of the basin. Two storage dams would be built on the Yarmouk for irrigation and power generation for the Arab states while the Hasbani in Lebanon would be retained entirely for Lebanon's benefit.

The Israelis countered with their own plan, the Cotton Plan, named after the American engineering consultant who was working for the Israeli government. Apart from claiming 40 per cent of the basin's water, there were three features to the Israeli Plan the Arabs could not accept. These were to take water entirely away from the Jordan basin by means of a diversion canal on the Jordan river at Jisr Banat Ya'qub where her earlier diversion had been stopped, and at another point on the Jordan headwaters in order to feed a reservoir near Nazareth for eventual transfer to the Negeb desert in the south of

Israel; to take about one third of the waters of the Litani River in Lebanon to reduce the salinity of Lake Tiberias.[26] At the same time Israel would recognize the rights of Jordan to develop its own irrigation scheme on the Jordan Valley fed by waters from the Yarmouk only, rather than the Jordan as proposed by Johnston, by means of a canal system entirely within Jordanian territory.

The Arab and Israeli counter-proposals to the Johnston Plan clearly revealed the wide differences that existed between the two sides on the best means of sharing their common water resources. While negotiations continued for sometime on the Johnston Plan no final agreement could be expected. On the Arab side there was an insistence that any agreed scheme would have to be carried forward by a neutral authority, like the United Nations, since the Arab states would accept no other formula which would result in co-operation with Israel and a breaking of their boycott. In response Ambassador Johnston assured the Arab states that the water allocations would be externally supervised and that the US Government would meet two thirds of the estimated $200 million cost of the dams and canals. The Israelis were more keen on the Johnston Plan, mainly on political grounds in that it was hoped that a united approach to water resource development would help generally to improve relations with the neighbouring Arab states.

In October 1955 the Arab countries finally rejected the Johnston Plan, largely on political grounds since it would entail a loosening of their Israeli boycott and would allow Israel to take in more immigrants and to become economically and politically even stronger in the region. In its final form the Johnston Plan offered the three Arab states of Jordan, Syria and Lebanon 60 per cent and Israel 40 per cent of the water of the Jordan River system and while the Plan was never accepted these water shares are still adhered to. Both sides then laid out their own proposals and because both sides tacitly accepted the Johnston water allocations, the United States of America was prepared to make financial assistance available for water resource development.[27]

The Baker-Harza Plan

While the negotiations were still proceeding on the Johnston Plan, the Jordan government commissioned two American engineering consulting firms - the Michael Baker Co. of Rochester, New York, and the Harza Company of Chicago - to prepare a study on the feasibility of developing the soil and water resources of both the east and west parts of the Jordan Valley that lay within the Kingdom. This resulted in a joint eight volume study - the Baker-Harza Master Plan Report - published in 1955.[28] This report came to several conclusions. The most important of these was that likely water requirements for each irrigated dunum on the Jordan Valley floor would be less than previous estimates suggested so that a bigger scheme could be developed than was envisaged in reports like that of Ionides. In support of this, the area of irrigable land was also estimated to be greater than previously suggested.

The main features of the plan which were to form the basis of the future East Ghor Scheme were:

a) the construction of a storage reservoir on the Yarmouk River at Maqarin (or possibly a few kilometres downstream at Wadi Khalid) to store 460 MCM of water (Fig. 3.1).

b) the erection of a diversion structure at Adasiyeh to lead water into a main canal running down the eastern ghor of the Jordan Valley. Any excess flow would be taken by canal from this diversion structure to Lake Tiberias for storage. Baker-Harza considered the Tiberias store "an absolute essential element of the Master Plan for the complete development of the Jordan Valley within Jordan. Without it an adequate water supply for all irrigation needs cannot be met."

c) the construction of a 47 km canal on the western ghor of the valley running from the north west corner of Jordan to just north of the Dead Sea, this canal to be supplied from the main canal on the eastern ghor by means of a siphon across the Jordan River.

d) four large hydro electric plants would be installed on the Yarmouk and two smaller ones on the East Ghor Main Canal.

It was envisaged that about 80 per cent of the 520,000 dunums of land that could be irrigated in the valley by this scheme would be gravity-fed leaving only about 104,000 dunums where pumping of water would be

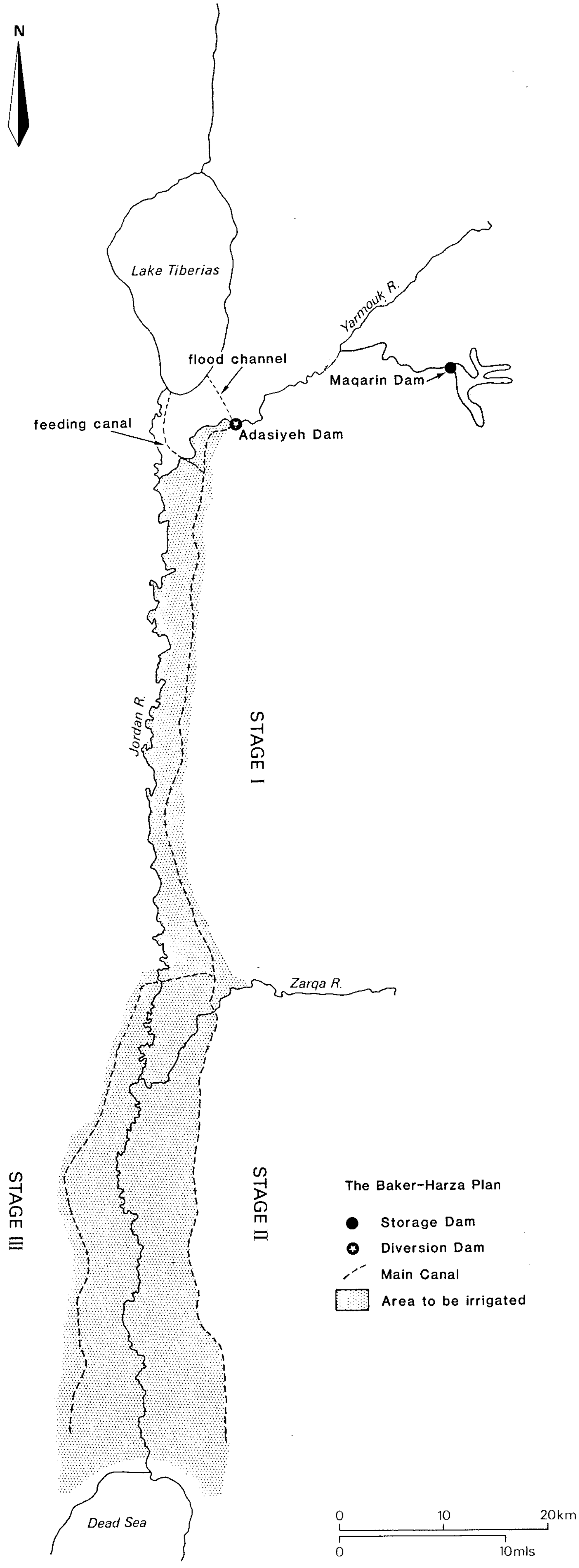

Fig. 3.1 THE JORDAN VALLEY: BAKER-HARZA PLAN

required. The plan included the installation of nine pumping stations for this. It would take 12 years to implement the whole plan which included establishing 30,700 irrigated farm units. The total cost was estimated at $170 million of which the hydro-electric generation component represented 31 per cent.

Soon after the Baker-Harza proposals were laid out the Jordan Government decided to set up the East Ghor Canal Project. To reach this point the Jordan Government modified the Baker-Harza Plan with the Simansky Plan in order to ensure the viability of the scheme without the co-operation of Israel which was not now possible following the collapse of negotiations on the Johnston Plan. The Simansky Plan proposed the construction of a 60 km main canal down the eastern ghor from the diversion structure at Adasiyeh without any involvement with a Lake Tiberias store which needed Israeli co-operation.

3.2 The East Ghor Canal Project (EGCP)

The Baker-Harza Plan envisaged irrigation development in the Valley in five main stages (see Fig. 3.1):

- Stage I Constructing the East Ghor Main Canal for 70 km along the ghor from the Yarmouk offtake for irrigation of the ghor mainly by gravity flow.
- Stage II Extending irrigation further south towards the Dead Sea by lengthening the main canal.
- Stage III Developing irrigation on the west ghor by a branch canal from the main east canal.
- Stage IV Developing irrigable areas east of and above the main canal by using side wadis.
- Stage V Developing other areas above the main canal by pumping canal water up to them.

3.2.1 Description and construction

The East Ghor Canal Project represented a modified version of mainly the first stage of the Baker-Harza plan although development of stages II and IV has also been proceeding. No development of stage III on the western ghor has occurred or is envisaged. This study restricts itself to the stage I area of the project which extends from the Yarmouk River in the north to the Zarqa River 70 km to the south. The water is supplied to this stage through a 1 km tunnel near the village of Adasiyeh. This feeds into the main canal which runs almost parallel with the Jordan River but a few kilometres east of it beneath the foothills edging the east ghor. This enables the canal to command most of the irrigable land on the ghor by gravity flow with drainage water running into the Jordan River.

Once the project agreement had been signed in May 1958, the Jordan Government began to set up the necessary institutional arrangements to organize the construction and operation of the scheme. In 1959 the East Ghor Canal Authority was established to carry out "the planning, constructing, operating and maintaining the East Ghor Canal Project as well as carrying out activities relative thereto."[29] These activities extended into several related fields - "reclaiming and irrigating lands and dividing such lands into farm units, developing agriculture, determining the agricultural cropping pattern, processing and marketing of crops, setting up social and economic programmes aimed at developing the community in the Project area."[30]

Two months after the project agreement was signed, work on the scheme was commenced with a government crew employed to begin excavation for the first six kilometres of the northern end of the main canal. In November 1959 a contract was signed between the government of Jordan and the Italian Construction firm, Impres Venete Construzioni, to cut the tunnel at the northern end of the canal by which the Yarmouk River waters are diverted into the ghor. The same firm were also to construct the first 23 kilometres of the main canal across what became Section I, or Blocks 1-10, of the project. This work was completed in September 1961. Meanwhile the system of distribution canals for Section I was completed in part by the Jordanian Shahin Company and in part by the Jordan Government. Later the contract with the Italian firm was extended in order to allow it to complete the first 70 kilometres of the main canal. This was finished in 1963 with all the laterals and primary drains being completed by July 1966.

In 1964 soon after the first 70 km of the main canal had been completed and irrigation commenced in the northern part of the project, a Yugoslav engineering consultancy firm, Energoproject, was called in to draw up a revised version of the later stages of the Baker-Harza Plan for the further development of the project. This had become necessary as it was clear that several parts of the Baker-Harza Plan would no longer be viable. The water demand was rising faster than had been anticipated. The main features of the Energoproject Plan were:[31]

a) the construction of two storage dams on the Yarmouk, one at Makheibeh (250 MCM) and another at Maqarin (350 MCM) where the Bunger Plan had originally proposed a dam.

b) the extension of the existing main canal from its current 70 km length to 110 km since the increased water supply would make it possible to irrigate virtually the whole of the eastern part of the valley as far south as the north of the Dead Sea.

c) doubling the capacity of the East Ghor Main Canal from 10 to 20 m^3/sec.

d) the construction of a second main canal with a 16 m^3/sec capacity from the Mukheibeh Dam south to the Zarqa River and parallel with the existing main canal.

e) the construction of storage dams on various side wadis. These together with the second Yarmouk dam at Mukheibeh would contribute as much water as the Tiberias store proposed originally by Baker-Harza.

f) construction of supply canals to the zor of both banks of the Jordan since the increased salinity of the Jordan River had made irrigation water from the river increasingly difficult to use on the zor.[32]

It was expected that the Energoproject Plan would take 13 years to complete and, to this end, its proposals were built into the National Plan for the 7 years, 1964-70. Unfortunately the plan was soon disrupted because work started on the Mukheibeh Dam in 1965 but was halted by the 1967 Arab-Israeli war by which Israeli occupied Syrian territory on the north side of the dam site. Work did however go ahead on doubling the capacity of the main canal, lengthening it southwards and on building dams on the side wadis of Ziqlab, Shueib and Kafrain. In fact the main canal has been extended by two more segments since 1963 and a third extension is proposed under the current five year national development plan. The first extension was a further 8 kilometres completed in 1970, the second added a further 18 kilometres to bring the main canal just to the south of the town of Karameh. The third extension will be a further 14½ kilometres to Sweimeh just north of the Dead Sea (Fig. 3.2).

As with any properly devised irrigation scheme, the East Ghor Canal Project aimed to do rather more than simply provide a water supply to farms from its main canal and lateral distributors. The scheme also involved a programme of land reform to redistribute land into consolidated farm units of from 30 to 200 dunums each, in order to create a pattern of farms best suited to the effective use of the irrigation water. Further details of this land reform programme and its relative success are given in the next chapter. Another objective was to provide assistance to the farmers in the project, in the form of technical services, financial help and co-operatives to support farm supplies and marketing. Aspects of this range of assistance programmes and their use by farmers, are considered in Chapters 8-10. In turn it was hoped that the project would give the participating farmers a higher living standard than before as well as benefiting the national economy, particularly through its balance of payments, by creating crops exports and reducing the level of food imports. This thesis does not, however, attempt to consider the significance of the project in terms of this wider, national role of the development, since too little data could be gathered on this.

3.2.2 Irrigation Development and the National Planning

After the Energoproject modification to the Baker-Harza Plan was activated in 1964 under Jordan's first national development plan, various other proposals were made for the further development of the project in later national plans. As some of these have been acted upon and become incorporated into the irrigation plans for the valley they deserve a brief mention here.

By 1971 at the end of the first seven year national plan period many of the more ambitious parts of the East Ghor irrigation plans

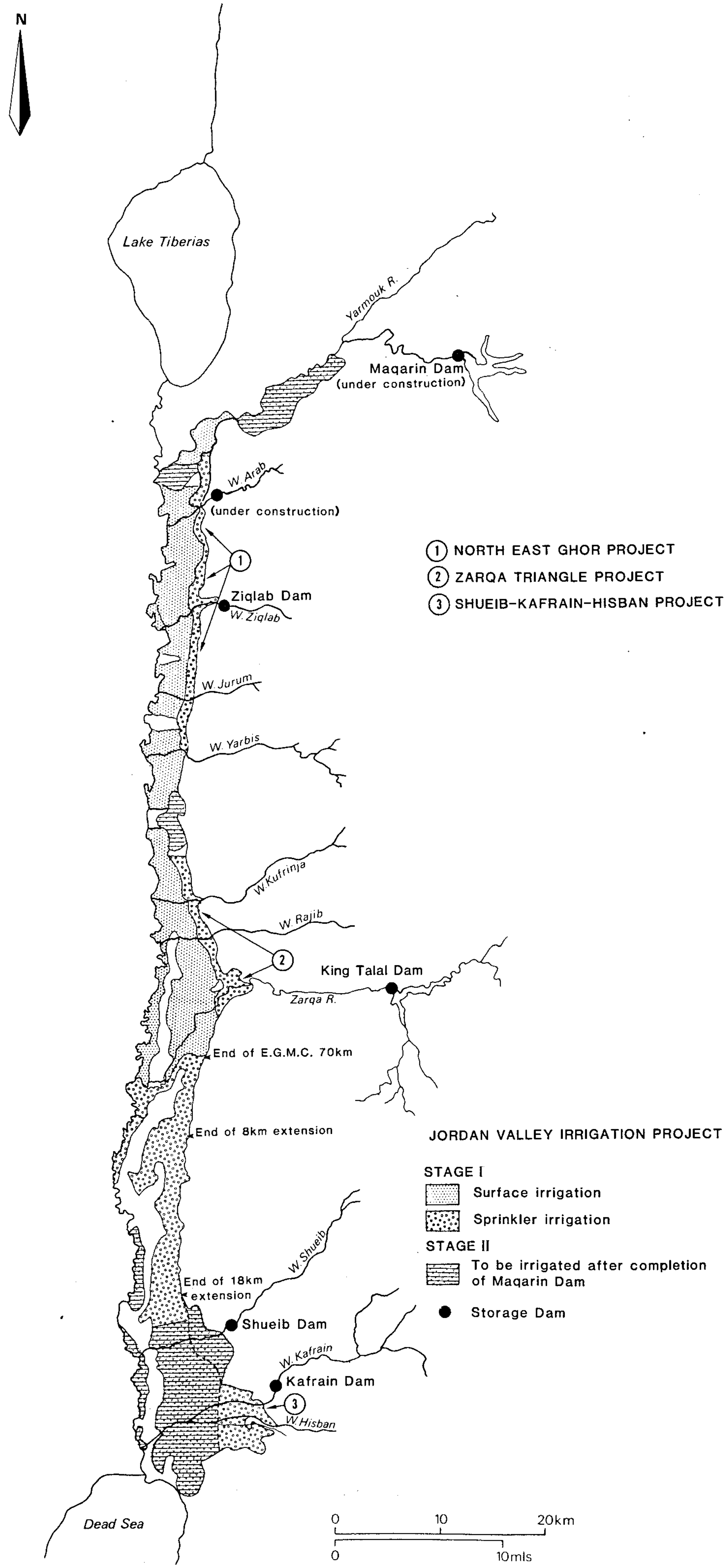

Fig. 3.2 EAST JORDAN VALLEY: DEVELOPMENT OF IRRIGATION SINCE THE BAKER-HARZA PLAN

remained uncompleted beyond the Stage I, II and IV elements already referred to. Thus in 1971 the following parts of the projects were in being:[33]

1) the 70 km of main canal on the east ghor completed in 1963 together with 600 km of laterals. This provided water to irrigate about 111,000 dunums.

2) a further 8 km of main canal had been completed to the south in 1970 which added another 13,178 dunums of irrigated land.

3) the sides of the main canal had been raised in 1967 to double its capacity.

4) the Ziqlab Dam was completed in 1967 on Wadi Ziqlab with a gross water yield of 10.8 MCM per year. In the following year storage dams were completed on the Shueib and Kafrain Wadis able to irrigate 13,000 dunums south of the main canal.

5) work on the 200 MCM Mukheibeh Dam on the Yarmouk to increase the irrigated area fed from the main canal by 200,000 dunums was still halted as a result of Israel's occupation of the Syrian bank of the river.

In 1972 the Jordan Government set up a technical committee to draw up a new comprehensive three year plan for the further development of irrigation and social improvement of the valley, to be put into operation during the period of the 1973-75 National Plan. It was then expected that by developing parts of Stages II and V of the original Baker-Harza Plan it would be possible to increase the irrigated area of the valley from 147,000 dunums in 1971 to about 200,000 dunums by 1975. This expansion would largely be achieved by the implementation of seven sub-projects.

1) The rehabilitation and development of the main East Ghor Canal area by means of an extension of the land drainage network to drain a further 12000 dunums; the construction of various flood protection works; and the cleaning and rehabilitation of the main canal and its subsidiary laterals and distribution channels.

2) The construction of the King Talal Dam on the Zarqa River together with canals to take the water into the main canal. It was envisaged that this dam would provide water for an additional 48,000 dunums of irrigated land. It came into use in 1978.

3) The extension of the main canal by another 18 km to the south to irrigate the further 48,000 dunums with water from the King Talal Dam, together with the necessary grading, levelling and drainage improvement of that land.

4) The irrigation of 3,340 dunums of land above the main canal but below the Ziqlab Dam; the irrigation of 11,520 dunums in the north-eastern part of the ghor but above the level of the main canal by means of pumping water up from the canal; the irrigation of 2430 dunums of land above the main canal by pumping from side wadis excluding those referred to.

5) The irrigation of 13,000 dunums of land south of the main canal in the Shueib-Kafrain-Hisban area by means of the dams already constructed on the Shueib and Kafrain Wadis and a pipe to take water from Wadi Hisban to the dam on Wadi Kafrain.

6) The distribution of the above mentioned areas of land to farmers along with the provision of water distribution networks, a water management system including supervised distribution and the training of farmers in the use of the water.

7) The undertaking of various feasibility studies including the further protection of zor and ghor lands from flooding and erosion; the development of underground water resources; assessing the need for improved land drainage.

Parallel with this programme of development the Jordan Valley Commission (JVC) was established in 1973 in order to prepare a plan for a fuller programme of integrated development based on the irrigation potential of the Jordan Valley. Over the period 1973-75 the Commission carried out various studies covering agriculture, rural development and housing. Here it is only necessary to note that it concluded that a further 250,000 dunums could be developed in the valley mainly by the construction of the Maqarin dam which would provide water for an additional 154,000 dunums.[34] A further 48,000 dunums would become available by extending the main canal southwards by a further 26 km. Part of the extension was already underway.

Several of the projects proposed by the Jordan Valley Commission, and the government technical committee that went before it, were in turn encompassed in the plans for the valley summarized in the National

Plan for the period 1976-80.[35] These became known as the second development stage of the Jordan Valley and envisaged the extension of the irrigated area of the valley by at least another 150,000 dunums to about 360,000 dunums. The various parts of the second stage for the valley can be conveniently grouped under four headings and some indication given of the extent to which they were developed in the plan period.

Perhaps most important of the schemes was to be the further extension of the East Ghor Main Canal southwards as far as the Dead Sea together with surface and subsurface drainage networks and other facilities. To make the major expansion of the irrigated area possible it would be necessary to build the Maqarin Dam on the Yarmouk, with a 200 MCM storage capacity, to replace that never completed at Mukheibeh. Hydro-electricity generation facilities were also envisaged with the dam,and additional works also involved the construction of a canal to take the water from the reservoir created to the East Ghor Main Canal. Although none of this work had been completed as of 1981, the Canal was extended a further 18 km as far as Karameh although, for the time being this was being supplied from water delivered from the King Talal Dam.

The Wadi Arab area project was also proposed in order to water about 27,000 dunums of land by sprinkler systems in the northern part of the valley, of which 10,000 dunums were previously irrigated by surface means. The water for this was to be derived from the Wadis Ziqlab, Arab and Jurum so that diversion dams would be required on the latter two wadis together with supply pipes. This work was partly completed and in operation by 1980 (Fig. 3.2).

The Zarqa River project was planned to take water from the King Talal Dam into the extended main canal in order to irrigate a further 35,000 dunums by sprinkler systems with additional water for 15,000 dunums outside the area being fed by the Main Canal in the Zarqa Triangle Project around Deir Alla. Both the dam and the Zarqa Triangle Project were in operation by 1980.

Lastly the 1976 plan proposed the development of irrigation under the Kafrain-Hisban project in the southern part of the valley. The irrigation of 13,000 dunums had already been proposed in this area by taking water from dams on the two wadis at a point south of where the main canal had reached. Now the project envisaged watering 15,000 dunums by sprinkler with pipes to take water from the Hisban to the Kafrain Dam from where it would be taken to the irrigation area. It was expected that this scheme would be completed by 1982 (Fig. 3.2).

Mention was also made in the 1976 plan of the conversion of the greater part of the East Ghor Canal Project to sprinkler irrigation systems involving works on 117,000 dunums as well as the construction of necessary pumping facilities. Although several areas in the project are now irrigated by sprinklers most of these are connected with the latest areas to be developed, outlined above. A total of only 31,000 dunums had been converted from surface to sprinkler irrigation by 1981.

The five year National Plan for 1981-85, currently in progress, includes four projects in the east Jordan Valley.[36] Most important of these is the completion of the Maqarin Dam on the Yarmouk (Fig. 3.2) to store the river's flood flow both for additional irrigation in the valley and for domestic and industrial use in other parts of the country. Until this is finished the fuller extension of irrigation in the valley is clearly not possible. The further extension of the main canal by 14.5 km to Sweimeh is also proposed during the current plan period to allow for the irrigation of a further 120,000 dunums. Together with the provision of pressurized pipe systems, pumping and other requirements it should eventually allow up to 300,000 dunums of the total 360,000 dunums of the eastern valley to be watered by sprinklers.

The plan also indicated that it was intended to raise the heights of the King Talal Dam on the Zarqa River and the Kafrain Dam to increase their storage capacity and the irrigation flow from these wadis. Raising the King Talal Dam by 15 metres from its current 92 metres would nearly double its storage capacity to give 74 MCM live storage to allow for the irrigation of a further 50,000 dunums in the ghor area. A small hydro-electric generating station has also been envisaged in this scheme as well as a new 7 km canal to convey water from other side wadis to the dam. Increasing the height of the 28 metre high Kafrain Dam by another 6 metres would increase its storage capacity from 3.8 to 6.8 MCM and allow it to water a further 2,100 dunums. Lastly an earth dam with a 9.1 MCM storage capacity was proposed on Wadi Arab to irrigate 12,500 dunums in the area between Wadi Arab, the Yarmouk and Jordan Rivers.

It is perhaps worth noting that in the 1981-85 plan period about JD 521 m was to be spent nationally on irrigation and water supplies, so that the expenditure on the valley schemes would take up about 45 per cent of this, but 84 per cent of the cost of all irrigation projects proposed for the nation.

3.3 The Changing Pattern of Irrigation Water Income in the Valley

Having outlined the development of irrigation and the related planning for it in the valley, it seems appropriate to consider the changing pattern of water supplies which supported this expansion of irrigation. Several estimates of potential water sources were made along with the plans previously considered, but a better indication of the actual changes in the pattern of irrigation supply can be gained from various surveys of irrigated land areas made betwen 1960 and 1975. The first of these, dating from 1960, was made by the Department of Statistics just before the East Ghor Canal Project was put into operation whilst the later ones show the increasingly important role of the Main Canal for irrigation supply supplemented by side wadi and other sources.

3.3.1 The Pattern of Supply Prior to the Canal

The only survey of irrigated land and their water sources in the Jordan Valley prior to the East Ghor Canal Project was made in 1960 and was restricted to the area from the Yarmouk River in the north to El Masri Triangle, which corresponds roughly to the Stage I of the project as later developed.[37] Six sources of irrigation water were distinguished and the areas commanded by these are given in Table 3.1. What is particularly noticeable is the major role played by the side wadis, the Zarqa and the Jordan Rivers and the predominance of only partially irrigated land. This pattern of supply was to be changed markedly on the development of the project.

TABLE (3.1) EAST GHOR CANAL PROJECT AREA:

IRRIGATED AREAS BY SOURCE AND DEGREE OF IRRIGATION, 1960

Source of Irrigation	Total Irrigated Area		Fully Irrigated Area			Partly Irrigated Area		
	dunums	%	Dunums	Col %	Row %	Dunums	Col %	Row %
Side Wadis*	81 026	53.0	4 938	15.9	6.1	76 088	62.5	93.9
Zarqa River	37 446	24.5	4 408	14.2	11.8	33 038	27.1	88.2
Jordan River	19 682	12.9	18 329	59.0	93.1	1 353	1.2	6.7
Yarmouk River	3 130	2.0	2 655	8.6	84.8	475	0.4	15.2
Springs	10 969	7.2	437	1.4	4.0	10 532	8.6	96.0
Wells	459	0.3	270	0.9	58.8	189	0.2	41.2
Total	152 712	99.9	31 037	100.0	20.3	121 675	100.0	79.7

* Side wadis include wadis between Yarmouk River in the north and Zarqa River in the south.

Source: Jordan, Department of Statistics (1961) The East Jordan Valley: A Social and Economic Survey, p. 173 (compiled).

The major share of the irrigated lands of the north eastern part of the Jordan Valley were watered in 1960 by the various side wadis located between the Yarmouk and the Zarqa Rivers. The 81,000 dunums irrigated from them represented 53 per cent of all the irrigated land reported in the study area, but nearly all of this (93.9 per cent) was only partly irrigated. The Zarqa River was the second largest irrigation source, accounting for about one-quarter of all the irrigated area but, again, the great majority of it (88.2 per cent) received only partial irrigation. The pattern of supply from the Jordan and Yarmouk Rivers, however, was different with most of their lands being fully irrigated. The Jordan River was the third most important water source for irrigation, accounting for 13 per cent of all the irrigated area and, because of the perennial nature of its supply, it provided no less than 59 per cent of the fully irrigated area. The Yarmouk River was far less important for irrigation purposes, at this time, than either the Jordan or even the Zarqa River, accounting for only 2 per cent of the total irrigated area although, like the Jordan, providing full irrigation to most of the small area it commanded. Springs and wells formed the two least important water sources for irrigation. 7 per cent of the total irrigated area was fed from springs in this region of the Jordan Valley, but nearly all of these (96 per cent) were only partially irrigated. Wells were even less important as an irrigation source. On the other hand ground-water sources were important at this time for irrigated farms south of the area surveyed in this census.

3.3.2 The Pattern of 1969

An indication of the new pattern of irrigation sources in the Jordan Valley created by the inauguration of the East Ghor Canal Project can be gained from a survey by the Dar Al Handaseh engineering consultants in 1969.[38] Unlike the 1960 survey this covered the whole eastern side of the Jordan Valley and so estimated the total irrigated area at 238,000 dunums, or 36 per cent more than the 1960 survey which had been confined to the northern area. At the same time it should be noted, however, that Dar Al Handaseh estimated the irrigated area north of the Zarqa River at 138,000 dunums, about 10 per cent less than that of the 1960 survey indicating that the project did not increase the irrigated area so much as make its irrigation more intensive and reliable.

Five sources of irrigation water were recognized by Dar Al Handaseh, summarized in Table 3.2, but no attempt was made to divide the irrigated lands into partial and fully irrigated types since the latter was now dominant. Easily the most important single source was now the newly constructed East Ghor Canal which supplied water to 122,000 dunums or 88 per cent of all the irrigated land in the northern part of the eastern side of the valley. So important was this source that it also accounted for 51 per cent of all the irrigated land in the larger survey area. The side wadis, including here the Zarqa River, previously the main irrigation supply, were now relegated to second position, accounting for 22 per cent of all the irrigated land in the area and now, relatively, a rather more important water source in the south than the north. Even so it was estimated that side wadis still commanded about 16,000 dunums of land in the north, mainly lying above the East Ghor Main Canal.

The Jordan River had also become a less important source of irrigation water as a result of the development of the East Ghor Canal, but still it was estimated to command 16,000 dunums (compared with 20,000 dunums in the northern area in the 1960 survey). This represented nearly 7 per cent of all the irrigated area in the valley. Wells were seen as a more significant water source for irrigation in the Dar Al Handaseh Survey than in the 1960 study, but almost entirely because of their importance in the southern area. They were estimated to account for about 19 per cent of the irrigated area, with much pumping from them to irrigate lands in the Karameh, South Shuneh and Kafrain areas. Very few wells were recorded in use north of the Zarqa River. Springs were considered to be of much less importance for irrigation than even in the 1960 survey, accounting for under 1 per cent of the total irrigated area.

3.3.3 The Pattern in the mid 1970s

Two further indications of the pattern of irrigation sources in the mid 1970s, when the East Ghor project was well advanced, can be

TABLE (3.2) EAST JORDAN VALLEY:

IRRIGATION SOURCES AND IRRIGATED AREAS, 1969

Source of Irrigation	Irriated Area Dunums	%	
East Ghor Canal	122 000	51.3	
Side Wadis:-			
in the EGCP Area	16 000	6.7)	22.3
in the Southern Valley	37 000	15.6)	
Wells	45 000	18.9	
Jordan River	16 000	6.7	
Springs	2 000	0.8	
Total	238 000	100.0	

Source: Dar Al Handaseh et al (1969) Jordan Valley Project: Agro and Socio Economic Study, Final Report, Annex GI, pp. 1-2.

gained from the surveys of the valley conducted in 1973 and 1975 by the Department of Statistics.[39] The results of these two surveys are summarized in Tables 3.3 and 3.4. What is particularly clear from these is the increasing dominance of the East Ghor Canal as the main irrigation source and the consequent demise of the Jordan River's supply role, although side wadi and ground water sources continued to play important supplementary roles. The total area of irrigated land had not increased over the 1960s estimates although much more of it would have been fully irrigated.

The 1973 survey by the Department of Statistics covered the whole eastern side of the Jordan Valley. This was subdivided into northern, middle and southern areas which did not, unfortunately, correspond with earlier subdivisions of the valley. The four types of irrigation water source also were not entirely comparable with earlier ones.

In this survey the East Ghor Main Canal was shown to be easily the largest single supplier of irrigation water even though it only commanded areas in the northern and middle parts of the valley. Not only did it account for 63 per cent of the total irrigated land (compared with 51 per cent in Dar Al Handaseh's survey) but it provided water to over 70 per cent of the irrigated land in each of the two more northerly areas. The 1973 survey also revealed the almost total loss of irrigation capacity from the Jordan River which had increasingly become a saline drain for run off from Jordan's main irrigation project and those of other states to the north and west. In 1960 the Jordan River was estimated to irrigate in the northern area alone nearly 20,000 dunums on the zor (flood plain) mostly on a perennial basis, and was then a major supplier of irrigation water in the valley. By 1973 it was only irrigating 1500 dunums (or less than 1 per cent of the total irrigated area), mostly in the north where its water was less saline. The Jordan River had changed from a position where it watered nearly 60 per cent of the fully irrigated land in 1960 in the north of the valley to less than 2 per cent. Springs and side wadis were enumerated together in this survey, unlike earlier ones, and it can be seen that these supplied about 16 per cent of the irrigated lands compared with 23 per cent in Dar Al Handaseh's survey and about 70 per cent before the East Ghor Canal was constructed. Pumping from wells was again much

TABLE (3.3) EAST JORDAN VALLEY:

PATTERN OF IRRIGATION SOURCES BY REGION, 1973

Source of Irrigation	North Area		Middle Area		Southern Area		Total Valley	
	dunums	%	dunums	%	dunums	%	dunums	%
East Ghor Canal	58 936	75.0	55 673	71.0	-	-	114 609	63.1
Springs & Side Wadis	6 351	8.1	9 442	12.0	12 580	51.3	28 373	15.6
Pumping from wells	195	0.2	5 962	7.6	8 263	33.7	14 420	7.9
Jordan River	1 202	1.5	270	0.3	37	0.2	1 509	0.8
Non-Irrigated	1 086	1.4	2 353	3.0	515	2.1	16 068	8.9
Fallow	10 804	13.8	4 749	6.1	3 315	12.7	6 554	3.6
Total Sources	78 574	100.0	78 449	100.0	24 510	100.0	181 533	99.9

Source: Jordan, Department of Statistics (1973) Social and Economic Survey of the East Jordan Valley 1973, pp. 148-151 (compiled).

more common to the south, as had been noted by Dar Al Handaseh. In the southern area well pumping provided a third of all the irrigated land, a proportion much greater than in the areas to the north. The 1973 survey also recorded some 12 per cent of the irrigable land as non-irrigated or fallow and no data is available on which sources could have been used to water this land.

Some information on water sources additional to, and confirmatory of, that given in the 1973 survey can be gained from the 1975 survey. This divided the valley into three areas although these do not exactly correspond to those in the 1973 survey. Water supply sources were also grouped differently as can be seen in Table 3.4. The total irrigable area, at 181,012 dunums, was, however, very close to that given in the 1973 study.

It can be firstly noted that, as expected, stream sources, including the East Ghor Main Canal and the side wadis, were the major single supply source accounting for about 82 per cent of the irrigable area of the eastern valley. They accounted for an even higher proportion of the irrigated land in the northern and middle areas, where they included both the canal and side wadi sources. But they were rivalled by groundwater (well) sources in the drier southern area to which the canal had not yet reached. Well supplies were insignificant, as has already been noted, further north.

Springwater irrigation sources, which were not separately enumerated in the 1973 survey, appeared more significant in this survey than in that by Dar Al Handaseh in 1969. Whereas the 1960 survey estimated that some 11,000 dunums were at least partially watered from springs in the northern part of the valley, the 1975 survey gave a similar figure for the whole valley. That is, apart from the dominant canal and side wadi sources, springs have remained a useful supply source in the north where wells were insignificant.

3.4 The Water Budget of the East Ghor Main Canal

Having discussed the development of the East Ghor Main Canal and its increasing significant as the principal source for irrigation in the East Jordan Valley it is appropriate to examine the changing balance of water sources as the canal was extended southwards.

TABLE (3.4) EAST JORDAN VALLEY:

IRRIGATED AREAS BY SOURCE OF IRRIGATION, 1975

Source of Irrigation	North Ghors (Northern Valley)		Deir Alla (Middle Valley)		South Shuneh (Southern Valley)		Total Valley	
	dunums	%	dunums	%	dunums	%	dunums	%
Streams only*	84 953	91.7	47 799	97.3	15 295	39.0	148 047	81.8
Ground water only	283	0.3	500	1.0	16 003	40.8	16 786	9.3
Springs only	6 949	7.5	838	1.7	2 406	6.1	10 193	5.6
Mixed sources	482	0.5	-	-	5 486	14.0	5 968	3.3
Other sources	18		-	-	-	-	18	
Total	92 685	100.0	49 137	100.0	39 190	99.9	181 012	100.0

* This includes the East Ghor Main Canal and the Side Wadis.

Source: Jordan, Department of Statistics (1977) General Results of the Agricultural Census, 1975, pp. 306-307 (compiled).

3.4.1 The Pattern of Water Income to the East Ghor Main Canal 1962-79

These surveys for selected years suggest that the East Ghor Main Canal, fed from the Yarmouk River, played an increasingly important role in the irrigation of the valley at the expense of other sources. But the surveys are insufficiently comparable or detailed to show how this pattern developed over the period since the project was launched. Data presented next shows that the relative importance of the Yarmouk River and the side wadis varied from year to year as sources for the Canal.

The East Ghor Canal Project was first planned to use water largely derived from the unregulated flow of the Yarmouk River. This supply to the main canal was to be supplemented by the mainly unregulated flows of side wadis located on the eastern flank of the project area, although some of those wadis would be dammed to allow their waters to be stored for release into the main canal during the critically dry summer season. As the scheme has been developed additional sources of water and increased amounts of flow control have been introduced or proposed. The plan to construct the Maqarin Dam on the Yarmouk has been the most recent of these, but the presently unregulated flows of that river and of the side wadis, along with the side wadi storage reservoirs, have remained the most significant sources of supply. For this reason some indication is here given of their changing pattern of use since the commencement of the project.

On average about three-quarters of the water entering the main canal of the project has come from the Yarmouk River but this amount has varied considerably from year to year. During the first year of the scheme's operation (1962), the water supplied to the project's main canal came entirely from the Yarmouk River, but from 1963 water was also obtained from some of the east bank side wadis. Over the next few years these side wadi supplies increased and became proportionately more important as the main canal was lengthened and the irrigated area spread southwards. More land tributary to additional side wadis was taken into the project.

Table 3.5 summarizes the volumes of water supplied to the main canal from the Yarmouk River and these side wadis between 1962 and 1979.

TABLE (3.5) EAST GHOR MAIN CANAL:

ANNUAL WATER INCOME BY SOURCE (1962-1979)

Year	Yarmouk River		Side Wadis		Ziqlab Dam		King Talal Dam		Total Income
	M^3	%	M^3	%	M^3	%	M^3	%	M^3
1962	77 499 700	100.0	-		-		-		77 499 700
1963	93 437 134	97.0	2 865 579	3.0	-		-		96 302 713
1964	109 078 604	93.2	7 988 925	6.8	-		-		117 067 529
1965	139 938 021	93.4	9 819 084	6.6	-		-		148 757 105
1966	133 932 562	85.9	22 055 329	14.1	-		-		155 987 891
1967	136 147 705	81.6	30 691 226	18.4	-		-		166 838 931
1968	150 541 798	77.8	43 017 926	22.2	-		-		193 559 724
1969	97 733 720	66.3	49 726 678	33.7	-		-		147 460 398
1970	63 217 288	51.2	60 297 095	48.8	-		-		123 514 383
1971	115 857 641	69.4	51 027 460	30.8	-		-		166 885 001
1972	149 636 160	77.2	44 282 660	22.8	-		-		193 918 820
1973	112 008 488	74.6	31 343 853	20.9	6 693 172	4.5	-		150 045 513
1974	124 572 082	75.6	36 936 511	22.4	3 251 426	2.0	-		164 760 019
1975	125 595 354	78.7	29 484 753	18.5	4 532 362	2.8	-		159 612 471
1976	126 104 120	86.8	12 864 781	8.8	6 391 251	4.4	-		145 360 106
1977	126 777 673	90.9	5 922 057	4.2	6 709 380	4.8	-		139 409 110
1978	128 860 972	84.6	11 092 801	7.3	5 842 622	3.8	6 587 751	4.3	152 384 146
1979	113 626 770	85.6	11 732 683	8.8	4 905 968	3.7	2 514 908	1.9	132 780 329

Source: Compiled from the records of the East Ghor Canal Project.

With the construction and operation of storage dams on Wadi Ziqlab from 1973 and on Zarqa River from 1978 these two streams became more fully regulated so that these two side wadi sources are treated separately in the table after those dates. It can be seen that the proportion of the water supplied to the main canal from the unregulated Yarmouk River fell continuously during the 1960's as the total water income rapidly expanded. From a situation in 1963 where 97.0 per cent of the water in the main canal had been derived from the Yarmouk, by 1970 only 51.2 per cent came from that supply. At the same time the amount and the proportion of the canal water that came from the side wadis increased from under 3 MCM in the former year to over 60 MCM in the latter year. It must be noted, of course, that during these nine years there were marked annual variations in the actual incomes. The Yarmouk income, for example, fluctuated, from about 77 MCM in 1962 to a peak of 150 MCM in 1968 before falling to only 63 MCM in 1970.

Several factors help account for the variable water income to the Main Canal from the Yarmouk during these early years. Most obviously, annual incomes were influenced by rainfall receipts and runoff that could be made available in the various contributing catchments. The volume of water that could be extracted from the Yarmouk was restricted by the need to maintain a base flow and to allow for the needs of other users downstream. Jordan has to allow at least 30 per cent of the Yarmouk waters to flow past the canal intake partly to allow Israel to take water for its own irrigation scheme on the Yarmouk Triangle.[40] At the same time the amount of water that flows into the lower Yarmouk where the East Ghor Canal intake is situated is influenced by other offtakes higher up the catchment, most notably by Syria in the Muzereb area where over 20,000 dunums are irrigated from the river. Finally mention should be made of the marked seasonal variation in the Yarmouk's flow whereas the water requirement of the scheme varies less from month to month. As a result, without any regulation of the flow of the Yarmouk, one can often have periods when much more water is available at the canal intake than is required followed by other months when it is not possible to meet demands.

Since 1970 the amount of water taken from the Yarmouk River on an annual basis has fluctuated less than in the early years. This is partly as a result of its more regular flows but also due to better demand management within the project area with the flexibility of supplies provided by the introduction of the side wadi sources. As a consequence the amount and the proportion of the total water income to the canal derived from side wadis, has sharply declined again from the situation till 1970. Whereas in 1970 the Yarmouk only provided 51 per cent of the water in the canal, this proportion rose rapidly to over 90 per cent in 1977, and in the last four years of the run of figures, the side wadis never contributed more than 15 per cent of the water going into the canal. This recent decline in the importance of the side wadi sources has occurred in spite of the greater control provided to two of these sources by the construction of the Ziqlab Dam and the King Talal Dam on the Zarqa.[41]

A dam on the Ziqlab to better store and regulate the wadi's flow for irrigation purposes especially in the summer months was one of several proposed by Sir Murdoch McDonald and Partners in 1965. Completed in 1967 with a reservoir capacity of 4.5 MCM it was put into operation in 1973. It has an estimated annual gross yield of 10.8 MCM. But as can be seen in Table 3.5 in no year so far has it provided more than 6.7 MCM, so that its supply has never even reached 5 per cent of the total annual water income of the main canal. The much more recently constructed King Talal Dam on the Zarqa River had similarly not been fully used by 1979. With a live storage capacity of 48 MCM it can be seen that in neither 1978 or 1979, its first years of operation, did it supply anywhere near that volume of water and again contributed well below 5 per cent of the total water income to the main canal.

Some reason for the apparent decline in the importance of the side wadi sources throughout the 1970s, and the under-use of these dams, can be deduced from an examination of the average monthly income pattern of water from the various sources outlined. This is summarized in Table 3.6 for the years 1965-79. It can be seen that while slightly more water is taken into the canal in the main hot season period (March-November) when demand can be expected to be greatest, the most noticeable feature of the income is its overall regularity from month to month. In no one month did income rise above 9 per cent of yearly

TABLE (3.6) EAST GHOR MAIN CANAL:

MONTHLY PATTERN OF WATER INCOME BY SOURCE, 1965–1979

	Total		Source of Water Income							
			Yarmouk River		Side Wadis		Ziqlab Dam*		King Talal Dam**	
	M^3	%	M^3	%	M^3	%	M^3	%	M^3	%
January	10 275 800	6.6	8 574 600	7.0	1 625 458	5.4	67 101	1.1		
February	10 496 866	6.7	8 566 533	7.0	1 853 302	6.2	171 149	2.9		
March	12 581 266	8.1	10 072 800	8.2	2 451 538	8.2	854 060	14.3		
April	13 739 200	8.8	10 896 533	8.9	2 548 733	8.5	506 734	8.5	433 400	10.1
May	14 404 133	9.2	10 613 933	8.7	2 991 338	10.0	1 383 129	23.1	1 150 618	26.9
June	13 953 200	8.9	10 504 333	8.6	2 886 267	9.6	845 210	14.1	677 535	15.8
July	13 532 200	8.7	10 617 933	8.7	2 792 581	9.3	221 350	3.7	138 360	3.2
August	13 447 333	8.6	10 441 466	8.5	2 774 582	9.2	350 878	5.9	327 446	7.7
September	14 082 266	9.0	10 628 133	8.7	3 049 895	10.2	720 028	12.0	511 404	12.0
October	14 665 133	9.5	11 438 800	9.4	2 821 573	9.4	614 897	10.3	733 482	17.1
November	13 333 333	8.5	10 925 000	8.9	2 272 113	7.6	207 211	3.5	306 707	7.2
December	11 591 800	7.4	8 862 000	7.3	1 908 690	6.4	45 459	0.8		
Annual Total	156 102 008	100.0	122 142 064	99.9	29 976 070	100.0	5 987 206	100.2	4 278 952	100.0

* The average of Ziqlab Dam represents 7 years observation (1973–1979).

** The average of King Talal Dam represents two years only (1978–1979).

income. Because of high evaporation losses demand is almost as high in the hot dry summer months (June-August) when less land is being cropped as in the spring and autumn cropping months. It is a little lower in the winter months (December-February) because more rainfall is available then but high crop demand ensures a continued irrigation water need. It can also be seen that the Yarmouk, which on average has provided about three quarters of this water to the canal, most closely matches this pattern with the river supplying between 7 and 9 per cent of its annual supply each month.

The side wadis, on average, however, have provided a slightly more variable income to the canal each month, particularly as they can most usefully meet summer demands. As a result one can see that they provided 57.7 per cent of their contribution to the canal in the six months from May to October. Their average contribution in January was little more than half of that in the peak summer months of May and September. This pattern of summer flow provision from the side wadis to the main canal is even clearer in the case of the two dammed wadis, Ziqlab and Zarqa, where it can be seen in Table 3.6 that the majority of their supply to the canal occurs in the dry period of the year. This was intended with the construction of their storage reservoirs. On average 69.1 per cent of the flow from Ziqlab Dam into the main canal occurred in the period May to October. In the case of King Talal Dam this percentage rose as high as 82.7 with no water at all being delivered in the winter months. Quite clearly, then, the side wadis, especially the dammed ones, serve a mainly summer supplemental role, but since this summer water demand has not been large in the 1970s, with the changed cropping emphasis and with more favourable Yarmouk River supplies, major call has not yet been made on these side wadi sources, and the main canal has continued to rely on the Yarmouk as its prime water source.

3.4.2 The Pattern of the Main Canal Water Utilization 1962-79.

In any irrigation scheme not all of the water made available will be used to water the crops. Losses occur in the carriers by evaporation and leakages. Some water is made available when the farmers do not need it and is therefore drained away. Some is used to leach salts out of soils. Clearly one needs some measure of the efficiency of water use in a project to see if it is improving or declining as the scheme develops. No data is available on the farmers' efficiency of water use within the project and the author did not attempt to measure this but later in this chapter some attention is given to changes in irrigation techniques reflecting the need to reduce water wastage at the farm level. But first it is necessary to consider the efficiency of the conveyance of water in the project to the farmers.

The effectiveness of an irrigation water delivery system can be measured by its conveyance efficiency (Ec) where:

$$Ec = \frac{Wd}{Wr} \times 100$$

and where:

Wd = The quantity of water delivered to the farms over a certain time.

Wr = The quantity of water entering the system (the Main Canal) over the same period.

Thus the conveyance efficiency is basically a measure of the percentage proportion of the water that enters the main canal which is delivered to the farms rather than lost in evaporation, percolation, leakage or escape through drains and spillways.[42]

In his study of the East Ghor Main Canal Manners calculated its conveyance efficiency as the amount of water actually delivered to farmers against that which was taken off into other parts of the system. On this basis he calculated that for the years from 1962/3 to 1965/6 the conveyance efficiency rose from 34 to 57 per cent, mainly as a result of the amount of water delivered to farms being increased to meet enhanced demand. But Manners did not seem to distinguish losses of water resulting from physical factors such as evaporation and leakage and other losses simply due to the economic factor of variable farm demand. Much water clearly drained straight through the project canals simply because farmers did not want it or had declined to purchase it. While on an economic basis it could be argued that all of this was wasted water and is, therefore, a measure of the operational efficiency of the scheme, it seems appropriate to separately consider those water losses which result from the physical attributes of the system rather than from economic choices of farmers.

As a result Table 3.7 which lays out for the years 1962 to 1979 the annual totals of water passing through the canal and being delivered to farmers, also lists the water "lost" under two separate headings - that drained into the Jordan River, and that lost by evaporation and other means in the conveyance process. It can be seen that the percentage of water delivered to farms - the conveyance efficiency (Ec) - ranged from only 19 per cent, in the first year of the scheme, to a maximum of 65.7 in 1973. If one ignores the first three unsettled years of the scheme's operation, the years 1965-1979 had an average conveyance efficiency of 48.4 per cent. That this figure was so low can be seen to be mainly the result of large quantities of water annually being drained from the Main Canal into the Jordan River, much of it because farmers chose not to purchase it. For the years 1965-79 this averaged 33.1 per cent of all the water that passed into the system.

Water losses resulting from evaporation and leakage were rather lower and averaged 18.5 per cent of the total supply between 1965 and 1979. Since this part of the supplied water was unavailable for use, unlike that which farmers chose not to purchase, it seems sensible to consider this under the heading of a water loss index, separate from the index of conveyance efficiency. It can be seen in Table 3.7 that after the first four years of the scheme's development, when the amount of water entering the project rapidly increased, the amount delivered to farmers tended to stabilize at around 60-90 MCM with the exception of the militarily disturbed years after 1967. This gave a conveyance efficiency of between 35 and 65 per cent over most of those years. Water losses to evaporation and seepage (the water loss index) was also very variable annually as a result of several factors, including seasonal and yearly variations in weather conditions and the degree of maintenance against leakages which the canals received. Hence a maximum 61.5 MCM of water loss was recorded in 1970 when farm water demand and canal repair work were both at very low levels at a time of military activity. In that year these losses represented 47 per cent of all the water entering the system, but in most years these losses have stood at under 20 per cent of the total supply.

The amount of water drained into the Jordan River has been the most variable component from year to year since it has been influenced

TABLE (3.7) EAST GHOR MAIN CANAL:

ANNUAL PATTERN OF WATER USE, 1962–1979

Year	Total Water in the Canal	Water delivered to farms		Water drained to Jordan River		Water remaining in the Canal		Water loss Index	
	M^3	M^3	%*	M^3	%	M^3	%	M^3	%
1962	77 499 700	14 925 285	19.3	57 846 171	74.6	–	–	4 728 244	6.1
1963	96 302 713	37 373 694	38.8	43 329 269	45.0	–	–	15 599 750	16.2
1964	117 067 529	43 159 105	43.0	55 467 101	55.2	–	–	18 441 323	1.8
1965	148 757 105	61 824 053	41.6	75 076 775	50.5	–	–	11 856 277	8.0
1966	155 987 891	94 260 433	60.4	41 703 663	26.7	–	–	20 023 795	12.8
1967	166 838 931	73 062 050	43.8	69 570 060	41.7	–	–	24 206 821	14.5
1968	193 559 724	68 286 291	35.3	110 953 252	57.3	–	–	14 320 181	7.4
1969	147 460 398	48 004 046	32.5	61 275 866	41.6	–	–	38 180 486	25.9
1970	123 514 383	39 340 720	30.2	29 632 426	22.7	–	–	61 487 534	47.1
1971	166 885 001	64 939 885	38.9	49 625 535	29.7	4 085 833	2.4	48 233 948	28.9
1972	194 418 820	74 828 324	38.4	77 180 272	39.7	–	–	42 410 224	21.8
1973	150 045 513	98 552 594	65.7	34 282 526	22.7	–	–	17 795 393	11.8
1974	164 760 019	76 614 289	46.5	65 917 756	40.0	–	–	22 177 974	13.5
1975	159 612 471	87 101 724	54.7	45 638 531	28.6	–	–	26 555 992	16.7
1976	145 360 106	80 374 158	59.0	26 358 010	19.3	1 808 831	1.3	27 819 107	20.4
1977	139 409 110	89 784 037	64.5	27 290 103	19.6	–	–	21 934 970	15.8
1978	152 384 146	95 369 111	62.6	25 990 680	17.0	–	–	31 024 354	20.4
1979	132 780 329	86 327 080	65.0	16 861 235	12.7	5 249 861	4.0	24 342 153	18.3

* This is the conveyance efficiency (EC)

by the changing balance of supply and demand. In some years, such as the militarily unsettled ones of 1967 and 1968, about a half of all the water entering the scheme was merely passing into the Jordan River unused as had been the case in the first four years of the scheme's operation, when much land was not yet in use. In certain years, like 1968 and 1972, the larger than average volumes of water supplied from the Yarmouk also ensured considerable amounts were drained into the Jordan. Generally, however, the proportion of water spent in this way declined in the latter part of the data period to below 20 per cent of the total supply. Water use efficiency in the project appeared to rise in the late 1970s.

Too much reliance cannot be placed on annual figures like these because they conceal important seasonal fluctuations in water supply and demand. For this reason Table 3.8 gives the average monthly pattern of water use and loss from the main canal system based on figures for the years 1965-79. These data show the strong seasonal pattern for all three pathways by which water passes through the system - to farms, as drainage into the Jordan River, and by evaporation and leakage losses. As might be expected more water was delivered to farms, on average, in the warmer half of the year even though less land was being cropped at that time. 68 per cent of water delivered to farms was provided in that half of the year between May and October when rainfall amounts are low and evaporation rates are high. Of the cooler, wetter part of the year only 8 per cent, on average, was delivered in the three months between December and February, normally the rainy season when crops would need least supplemental irrigation.

For the years 1965-79 this supply to farms made up only about half (48.8 per cent) of all the water entering the canal system, because of the considerable amounts of water allowed to drain into the Jordan River unused and the rather smaller but still significant amounts lost by evaporation and leakages. The seasonal pattern revealed in Table 3.8 helps to indicate why these losses, on an annual basis, are so large. It has already been shown (in Table 3.7) that the volumes of water allowed to drain into the Jordan River have varied considerably from year to year, peaking at over 110 MCM, or 57 per cent of the total supply, in 1968, but falling as low as 17 MCM (13 per cent of supply)

TABLE (3.8) EAST GHOR MAIN CANAL:

MONTHLY PATTERN OF WATER USE 1965-1979

	Water delivered to farms		Water drained to Jordan River		Water loss index	
	M^3	%	M^3	%	M^3	%
January	1 434 144	1.9	7 324 333	14.1	1 428 008	4.9
February	2 136 006	2.8	6 671 267	12.8	1 625 728	5.6
March	4 812 210	6.3	5 947 984	11.4	1 902 630	6.6
April	6 617 698	8.7	4 712 920	9.1	2 567 333	8.8
May	9 323 400	12.2	2 363 306	4.5	2 699 849	9.3
June	8 987 000	11.8	1 890 668	3.6	2 873 437	9.9
July	8 186 800	10.7	2 291 895	4.4	3 253 963	11.2
August	8 412 800	11.0	2 022 021	3.9	2 924 304	10.1
September	8 778 266	11.5	2 139 044	4.1	3 052 845	10.5
October	8 676 733	11.4	4 635 519	8.9	2 801 302	9.7
November	6 215 206	8.2	4 884 825	9.4	2 103 314	7.2
December	2 578 608	3.4	7 158 733	13.8	1 784 555	6.2
Annual Total	76 158 871	99.9	52 042 515	100.0	29 017 268	100.0

in 1979. Part of the reason for this annual variation is the generally high volumes of water available to the Main Canal from the Yarmouk River and side wadis in the winter months at a time when farm demand for water is lower. As a result much of this simply passes straight through the canal system. 41 per cent, on average, of all water release into the Jordan River from the Canal occurred in the three winter months (December-February). In contrast only 12 per cent was released in the three months from June to August. Water losses by evaporation and leakage rose, on average, in summer. 31.8 per cent occurred in the three months from July to September as a result especially of the high evaporation rates from canal water surfaces. Only 16.7 per cent occurred between December and February. These summer losses are, of course, happening in the dry hot months when losses can be least afforded but are not easily avoidable.

3.5 Water Distribution and Farm Irrigation Techniques in the EGCP Area

It has not been possible to extend this examination of water use efficiency down to the level of the individual farm, but it is appropriate to consider the types of irrigation techniques in use on project farms as an indication of their effectiveness. In recent years the EGCP Authority has been moving towards the conversion of much of the project to sprinkler systems as a means of controlling and reducing water demand. But the author's farmer survey has shown that this move could conflict with a shift to drip irrigation systems which some progressive farmers have unilaterally adopted.

3.5.1 Water Distribution

For the purposes of the management of water distribution, the project area is divided into a number of districts, or "marhaleh", each of about 30,000 dunums. Each of these is under the control of a water master, generally an irrigation engineer or agronomist. Within each "marhaleh" there are about four water distribution advisers with between 35 and 45 water distributors or ditch riders. The ditch rider's job is to deliver water to the 50 or 60 farm units within his area, which could be a four kilometre stretch of lateral canal. He will generally ride across this area twice a day on his motor cycle to open and close the delivery gates by which the flows of water to farms are controlled and measured.

Water cannot be supplied to a farm in any quantity at any time because total water supplies are relatively scarce. As a result supply has been arranged on a modified demand basis to provide a weekly supply to all farms although individual farms growing crops like marrow, lettuce or cucumber, or seedlings that need more frequent watering can get a twice per week supply. The planting of crops with high water demand, such as banana, rice, sugar cane, and perennial fodders can only be undertaken on permit from the project authorities, so helping to restrict water demand.

The size of the flow to a farm - whether for part or the whole of the appointed day, and the volume per hour - would be decided on the basis of the farmer's request, the crops being grown and the capacity of the lateral to meet the needs of all the farms on that lateral and, above all, water availability in the main canal. In periods of water shortage the better quality lands would get priority rights to water. Similarly banana and citrus would get priority supplies up to a limited amount after which remaining supplies will be shared equally between farms growing other crops.

To get water a farmer requests a flow, normally for 6, 12, 18 or 24 hours on the day of the week on which he is entitled to water. This request must generally be made on a written form of application two days before the appointed day. Such applications can normally be left in the canal side mail-boxes which are emptied daily by the water distributors, or submitted to the irrigation office in the area. Farmers pay monthly for the water they receive. Until 1974 the charges were 1 fils (1/6 penny) per cubic metre for the first 1800 cubic metres per dunum per year. Water used beyond this amount was charged at double-rate. Since 1974, however, a standard charge of 3 fils (½ penny) per cubic metre has been levied on all water used giving an incentive to farmers to use water more efficiently or to grow higher value crops.[43]

3.5.2 Irrigation Techniques in the EGCP Area

Three main types of irrigation are practised in the project area - surface watering, drip and sprinkler methods. Traditional surface watering methods, of which there are several variants, are easily the most commonly used although drip methods which employ far less water have been adopted by some farmers, especially to the south, in recent years, while a switch to sprinkler methods is being encouraged for virtually the whole project by the Project Authority. Already sprinkling has become common in a few areas especially where the topography is not flat enough for surface watering or where water had to be pumped above the main canal level and can therefore also be pumped on to crops through sprinklers.

3.5.2.1 Factors Influencing Irrigation Method Selection

Several factors can influence the choice of irrigation technique adopted by farmers within an irrigation scheme. These can obviously include physical constraints and opportunities such as soil depth, texture and quality, topography, water quality and availability, and the size of farm unit and crops to be grown on it. There are also the relative installation and maintenance costs, both capital and labour, of alternative methods to be considered as well as the influence of the educational, skill and social background of the irrigators. No less important are the institutional limitations imposed by the irrigation authority in terms of how the water is supplied and charged to individual farmers.

Traditional surface methods of irrigation were favoured in the early years for the East Ghor Canal Project area because the physical, financial and cultural conditions all pointed to the need for less elaborate, if rather inefficient, methods of watering. But enlarged needs for water saving, as well as greater technical and capital inputs, now favour increasingly sophisticated methods of irrigation.

It does not seem necessary here to more than point to the range and importance of the factors that can influence the choice of irrigation method adopted by farmers. Withers and Vipond indicate several of these factors.[44] These include, for example, the topographic factor since for surface water application one needs land of a uniformly gentle slope to ensure equal watering and slow water movement. Land regrading or terracing can provide acceptable alternative conditions but this may not always be possible. If the topography is particularly varied or the soils are shallow, regrading can reduce soil depth or bring the subsoil to the surface in places. In areas of more varied topography or soils, alternative and more costly methods of irrigation need to be considered. Variations in certain soil qualities such as texture and drainage capability, or fertility, can also reduce the effectiveness of simple surface water methods of irrigation because different areas will need different amounts or types of watering. If, for example, some soil areas have higher infiltration rates so that more water penetrates to below the root zone, then they will benefit from more frequent watering with smaller water volumes. In areas of soil or topographic variety, drip or sprinkler watering from pressure pipes are generally more suitable to allow the amount of water to be more carefully adjusted to needs. Other factors such as equipment and pumping costs, the build up of soil salinity, or sediment that blocks the pipes, are all influences, however, that may work against these alternatives unless additional costs are to be incurred. These extra costs may include occasional heavier applications of water to leach out salts and higher maintenance charges to replace blocked pipes.

The choice of irrigation method is not likely to be made by a farmer without regard to the needs of the crops he is growing or to the climatic conditions and water supplies he has to contend with. Clearly some crops, particularly the high value ones, are more likely to be watered by drip methods of irrigation than others, as their value helps to offset the high installation costs of these more advanced techniques. If the area frequently experiences moderate to high wind speeds, sprinkler use is made difficult whilst in areas like the Jordan Valley, with high temperatures and low humidity, sprinkling efficiency is much reduced by high evaporation rates. Clearly drip and sprinkler methods require a more regular water supply on the farm whereas surface methods allow water supply to be rotated on a weekly basis. In fact much of the project was originally laid out for a rotational supply via open channels for surface watering but is now being converted in several areas to provide a constant supply under pressure to farms for sprinklers to be introduced on a wide scale.

3.5.2.2 Surface Water Irrigation

Surface water irrigation is an age old and simple method of watering, widely used throughout the world and the original basis of farm water use in the East Ghor Canal Project. The author's sample survey of 353 farms in 1980 showed that 94 per cent of them were still using simple surface methods of crop watering, a proportion that would have been even higher in earlier years. That there should have been this level of dependence on the least complex method of irrigation in the project area is not surprising in view of the project authority's decision to provide water to farms via open channels on a rotational basis. This meant that farmers could not adopt drip or sprinkler methods without installing their own reservoirs and pressure pumps. Because nearly all of the farmers originally had little capital, they needed a system of watering that was cheap to install and operate. This was provided by the traditional surface means with which most were already familiar. The uniform topography and soils of much of the ghor also suited surface methods. Surface applications also generally suit sharecroppers and tenants, as well as small farm owners, since they would have little incentive to install expensive pumps and pipes on land they may occupy for only a few seasons.

Four main types of surface irrigation are to be seen in use by the project farmers. The oldest and most widespread is simple field flooding where the farmer allows water to pass across his field to a certain depth before shutting off the supply, repeating the operation every few days. This is particularly used with cereal crops like wheat, barley and forage crops such as alfalfa where the unevenness of watering that results is less damaging to the crop. Waterlogged or dry and saline spots, when too much or too little water is received, are less of a problem with these than for more delicate crops. With little control on the water supplied and distributed across the field, much water is wasted.

Zig zag irrigation is also a widely practised local form of watering in the project area. Water is directed across a plot along zig zag channels with the crops normally planted on only one bank of the channel, the soil from the opposite bank being used to shore up the eroding bank opposite as needed to protect the crop. It is believed to give a more controlled form of irrigation than surface flooding in spite of some of the land being kept uncropped. Waterlogging may occur in some parts and much land preparation is often necessary to get a satisfactory spread of water.

Furrow irrigation is an even more controlled system of surface watering in that water is directed along field furrows in which the plants are growing. In this way more water is directed to the root zone and less water is wasted in general infilitration and surface evaporation. Because more of the water can be applied to the root zone salts can be leached down the soil by this method where they can do less harm. Furrow irrigation now appears to be widely practised in the project area especially for vegetable production. In his 1978 survey the writer found many farmers had switched from the more traditional zig zag method to furrow watering as a means of saving water (Plates 1 and 2).

Lastly some basin irrigation can be found in use in the project. With this method a flat area which is bounded with small banks is flooded, possibly with the aid of internal check banks to better distribute the water. This method is often used with banana, citrus and other fruit trees although the writer has also seen it used for fodder, small grains and some vegetables like jew's mallow.

3.5.2.3 Drip Irrigation

Drip or trickle irrigation has been practised in glasshouse crop cultivation for many years but has only been applied in open fields more recently. It appears to have been adopted by a few farmers in the Jordan Valley about 1975, often in association with crops grown under plastic covers or in plastic "houses", but it has become increasingly common both for crops grown under these shelters and others grown in the open air.[45] That it should be a recent innovation, in place of

Plate 1. Tomato cropped in the open air and watered by furrow irrigation

Plate 2. Tomato watered by the zigzag method of irrigation

traditional surface irrigation methods, reflects its advantages, notably considerable water savings, in relation to its drawbacks, particularly the high initial costs of equipment. One has therefore seen drip methods spreading on farms geared up to produce the higher value crops, particularly in the south where water shortages are a bigger problem.

The high initial installation costs and moderate maintenance expenses are the result of the considerable amount of equipment needed for this method of irrigation. These can be grouped under two headings. As Withers and Vipond have pointed out "the basis of the system is a perforated plastic pipe laid along the ground at the base of rows of plants and supplied from a field main".[46] The perforations in the pipes are designed to emit a trickle or drip of water, rather than a jet, at the rate of often no more than half a gallon per hour per orifice. This is achieved by keeping water in the pipe under a constant pressure. The spacing of the orifices can be adjusted to create the most suitable wetted area around each plant or row of plants. To provide the necessary water pressure, a pumping system is also a part of the equipment which, as practised in the Jordan Valley, also normally includes a pond for a regular supply, main distributor pipes, screen and sand filters and a fertilizer mixer. The soil being watered and the lateral feed pipes are normally covered by a plastic mulch to reduce evaporation losses from the wetted soil, with the seedlings growing through spaced-out holes (Plates 3 and 4).

Apart from the high level of efficiency of water use which this method of irrigation offers, it is also more effective than traditional surface watering methods because deep percolation can be almost entirely avoided and runoff and evaporation greatly reduced. The plastic mulch not only aids the reduction of evaporation but cuts weed growth as well. Problems resulting from the use of more saline water for irrigation are also often reduced since less water need be applied and hence less salt concentration builds up in the soil. These salts also tend to gather at the outer edge of the wetted zone where they can do less harm. Nevertheless salinity problems have occurred in soils that have been drip-irrigated in southern parts of the valley in the last few years so that the difficulty is not entirely removed. Since fertilizer can be

Plate 3. Drip irrigation used with plastic mulch to irrigate vegetables grown alongside young fruit trees

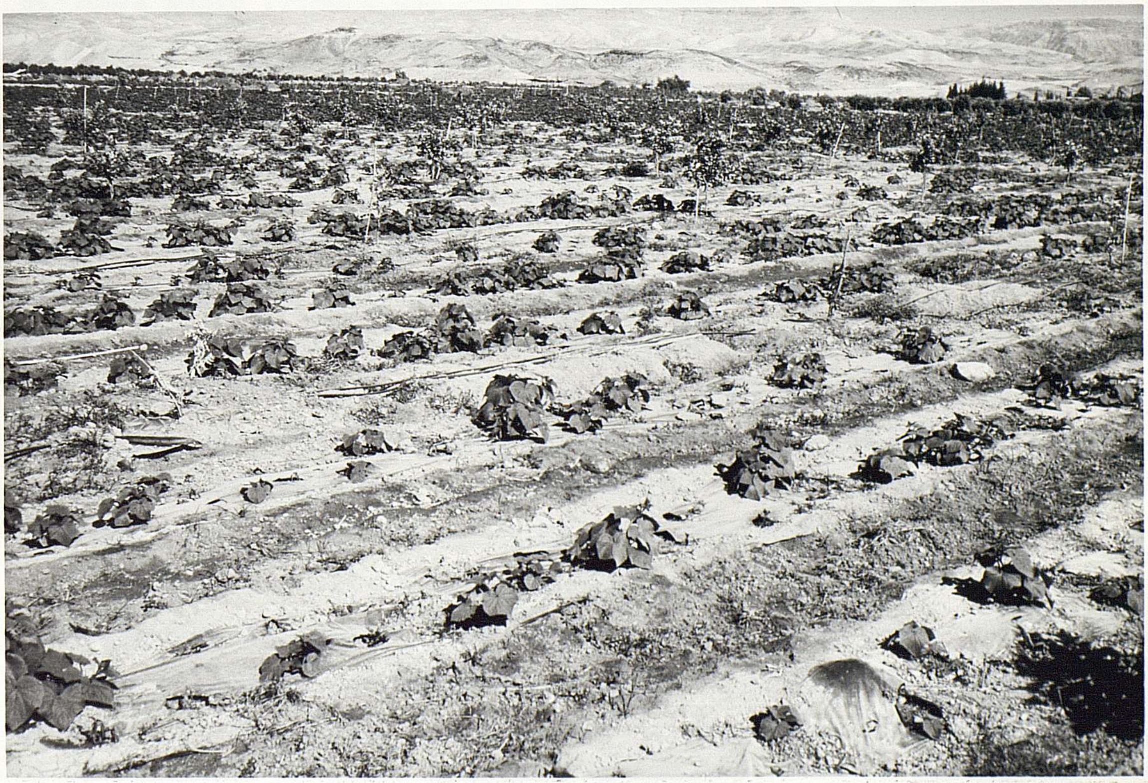

Plate 4. Cucumber watered by drip irrigation with plastic mulch in the open

added into the pumped water for direct application to the root zone this method can also reduce the cost of fertilizer use. Crop yields appear to be as good as, and possibly better than, those obtained from other irrigation methods.

To set against these advantages of the system are the high capital outlay of installation and continued maintenance costs. It is probably for this reason that it is only found in use on holdings producing higher value crops. The 1978 survey showed that most operators using the system were share-croppers who paid an annual charge for its use to their landlords who purchased and installed the equipment. The high capital costs often mean that the more ordinary small farmer cannot consider making the outlay when other more immediate farm needs must take priority so that only landlords are likely to be in the position to make this sort of investment.[47] Annual maintenance and repair costs can also be a problem, partly as a result of pipe blockages which often involves cleaning or even replacing the orifice drippers. Several of the farmers using drip irrigation interviewed by the writer stated that they found this a major problem.

Because the system's advantages largely outweigh these disadvantages, at least where farmers can find the necessary capital and are growing high value crops, there has been a considerable expansion in drip irrigation practised in the valley in recent years even though the irrigation authority has done nothing to encourage this. There is, however, little data on this particular development. A survey made by Steitieh in 1978-79 showed that 115 holdings covering 10,283 dunums used drip methods although some of these were south of the project area. 83 per cent of this land was being cropped with vegetables, particularly tomato, marrow and eggplant, with most of the other 17 per cent under fruit including citrus, banana, olive, grape and guava. 58 per cent of these holdings applied drip irrigation on open fields, the rest using the method in association with plastic covers.

Figure 3.3 shows the distribution of the 71 farms in the project area known to be using this irrigation system in 1979-80. These all lay in the central and southern parts of the project area south from Block 12, with a marked concentration in the south. Most farms using it were of more moderate size able to bear the cost of the installation.

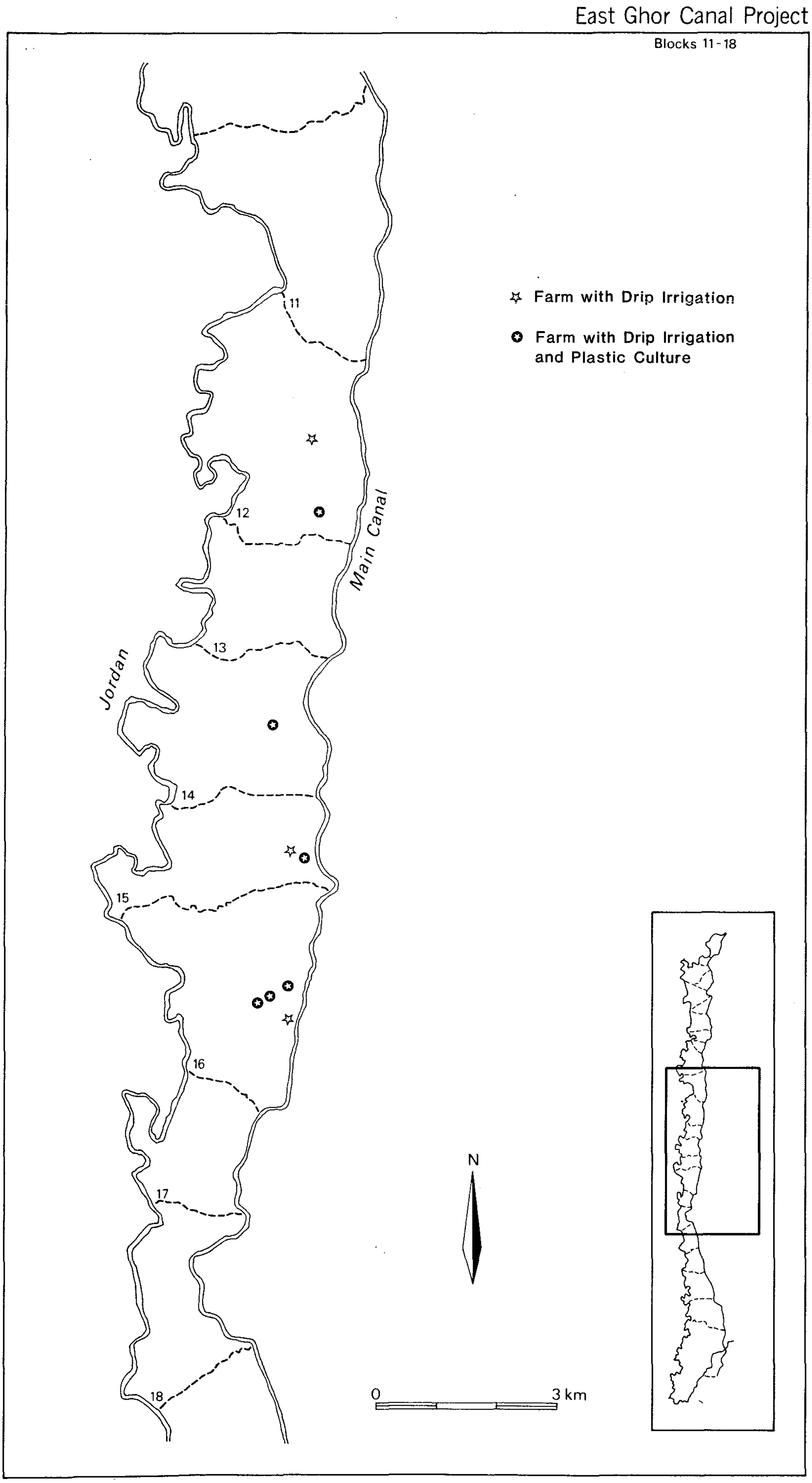

Fig. 3.3 EAST GHOR CANAL PROJECT: DISTRIBUTION OF FARMS WITH DRIP IRRIGATION, 1979/80

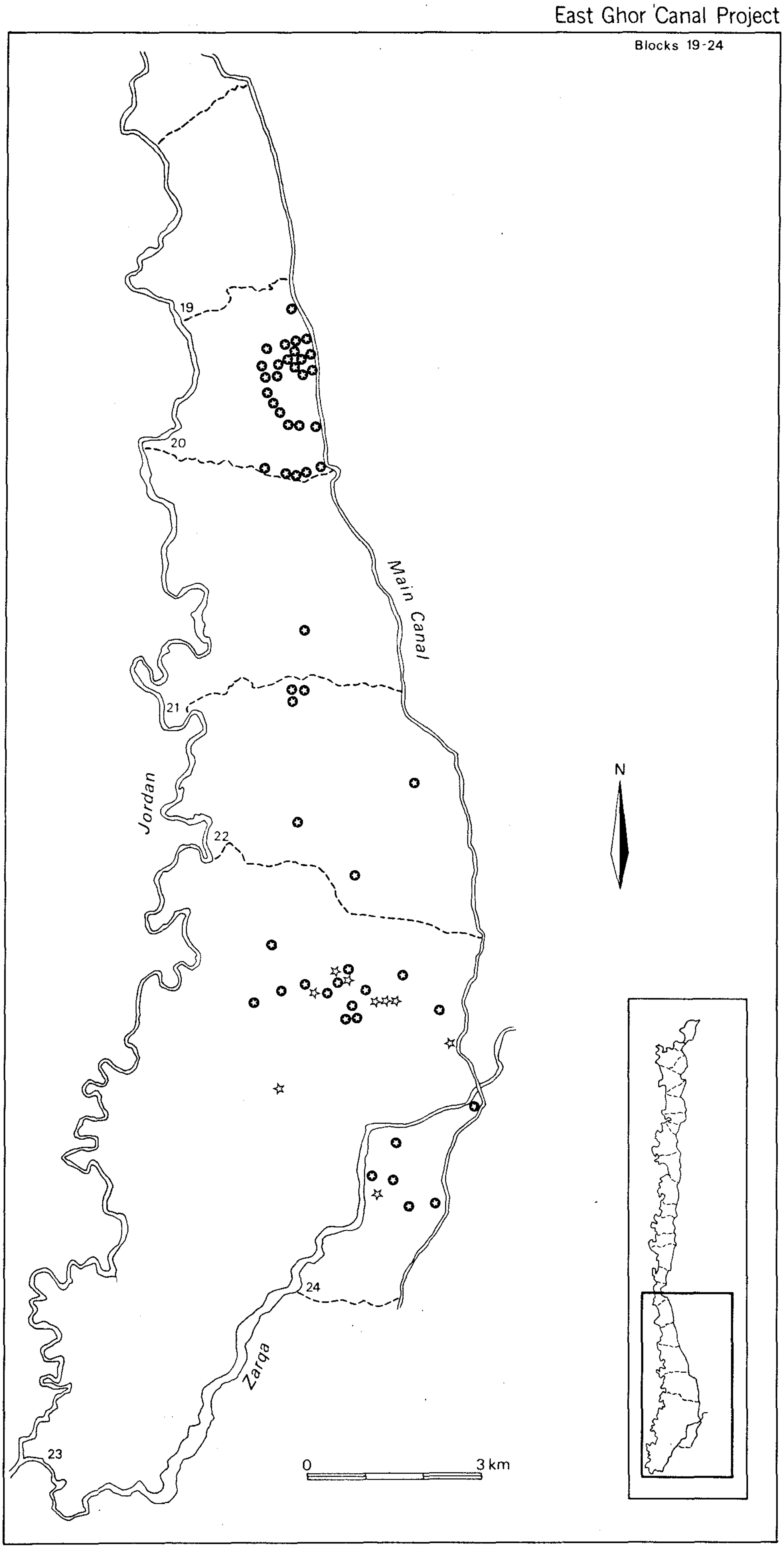

Fig. 3.3 continued

This pattern of development of drip irrigation is not surprising since the northern farmers with their well established and traditional surface watering systems could not be expected to switch to a new, costly and a largely untried method especially when they seldom suffer from water shortages to warrant the change. On the other hand water shortages are common in the south and these farmers could see the success of drip methods that had been installed for some years by farmers in areas south of the project around Karameh.

In the writer's 1980 survey he found 21 farms, 5.9 per cent of his sample, using drip irrigation and 20 of these were able to provide further information on their experience with, and reasons for using, this irrigation method. 16 (80 per cent) of the group were in their first year of drip-watering and only one had used it for as long as four years. Three-quarters of these 20 farmers stated that they had learned about drip irrigation from other farms and three of the remaining five heard of the technique from agricultural supply companies. Only one claimed that he got the necessary information from the agricultural extension services. That the centre of diffusion of this method lay to the south of the project area, where drip methods have been in use for some years, is confirmed by the fact that 11 of the 20 farmers stated that they had obtained their information on drip-watering from either Karameh or Ma'adi, both to the south. Three others simply learnt from the agricultural company representatives while others stated that they had obtained information from the Deir Alla experiment station or Europe.

The same farmers were asked to indicate which of six possible reasons had attracted them to the drip irrigation system and to list the drawbacks they had experienced since installing the system. The farmers were free to indicate more than one reason or drawback. On average farmers listed three reasons for their adoption of the system but only one indicated the relative importance of his reasons. Most indicated no drawbacks. Water saving and labour savings were the most highly rated reasons reported by 90 and 85 per cent of the sample respectively. Profitability and its value for use with cropping under plastic covers were also widely appreciated among not less than 70 per cent of the sample. Seven of the 20 farmers reported pipe blockages as their main problem and one other, the only sampled farmer who had used the technique for as long as four years, also had run into salinity problems. Another farmer found correct fertilizer application difficult with this method of watering but the 11 (55 per cent) other farmers questioned reported no particular problems. When asked if they would be prepared to switch to sprinkler methods of irrigation, as proposed eventually for all farmers by the Project Authority, 65 per cent of the sample rejected this against 20 per cent who expressed willingness.

3.5.2.4 Sprinkler Irrigation

Irrigation using sprinklers is the newest method to be adopted in the project area although it is likely to be rapidly expanded in future since the Authority decided, in its 1975-82 development plan, to convert much of the valley to this method.[48] Such a decision was prompted mainly by the considerable water saving available by this type of watering instead of traditional surface forms of irrigation and the possibility of avoiding large extra costs of land levelling and grading where the shallow soils are also often damaged by such activities.

Until very recently, however, little sprinkler irrigation was to be seen in the project area and the writer also found very considerable resistance amongst farmers to its introduction on their land. The 1975 Agricultural Census showed that only six holdings in the entire valley were using sprinklers. These in total covered no more than 19 dunums with five of the farms in the southern part of the area and only one in the older-settled northern area. In his 1978 fieldwork season the author found only one farmer in his sample using sprinklers. These were irrigating citrus groves. Experimental work on sprinkler methods, however, has been conducted for some years at the research stations in the area.

Expansion of sprinkler methods was not under way in the project area until the 1980s. By the spring of 1980, 33 farms in Blocks 8, 9, 10 and 19 were using sprinklers. Those farms in Blocks 8, 9 and 10 are part of the North East Ghor Project, which had been completed in March 1979. Under this project 27,600 dunums was being irrigated mainly from the regulated flow of the Wadi Ziqlab and the unregulated flow of Wadis Arab and Jurum. About 18,000 dunums of this land lies above the level of the East Ghor Main Canal and so was well suited to the pumping required for sprinklers.

In 1980 work commenced on the Wadi Arab Dam to allow a further 4500 dunums in the same area to be irrigated by sprinklers while plans also exist to convert considerable areas of land in the same district, at present watered by surface methods from the main canal, to sprinkler methods. Since 1980 the Authority has made other moves to increase the use of sprinklers. By 1981 it had purchased equipment to allow for some 2785 farm units to be irrigated by sprinklers, arranging to sell this equipment to farmers on long term credits at low interest. Perhaps most significant of all of these efforts to convert more of the farmers to the use of sprinkler methods of irrigation, the Authority had commenced to convert the feeder canals in the Stage I and II areas to pressure pipes to make widespread use of sprinklers possible.[49] In the Harza report in 1978 on this repiping programme it was stated that "all these forms (surface, hose and drip irrigation) can be operated from the conveyance facilities that will be provided, and it is expected that they will be used in some cases."[50] Although in the Stage I area farmers were free to choose their own method it is clear that sprinkler methods were expected to become dominant.

The writer has found in his surveys of farmers, however, considerable reluctance to consider switching from their current method of watering to the sprinklers favoured by the Project Authority. Several justified their reluctance with fears of fungal and other diseases in crops like tomato, cucumber and marrow by this type of watering, a fear supported by one consultant who had visited the area. In his report in 1977 Stevens had commented that "sprinkler irrigation will increase the frequency and severity of diseases that are promoted by high humidity and free water."[51] In the same year Keller stressed the need to adequately test sprinkler methods in the valley before adopting them on a wide scale, and advised the Jordan Valley Authority to warn some farmers not to use sprinkling. "If for these crops (tomato, cucumber and marrow) a foolproof production package cannot be put together, then the JVA should advise farmers to hold off sprinkling them ... on the other hand, there is agreement that the root, forage, grain, citrus and most other vegetable crops (except eggplant) will produce very well under sprinkler irrigation with no unexpected difficultues."[52]

None of this is so much of a problem in the more southerly parts of the project area where the greater shortages of water favour irrigation methods and cropping programmes that use less water. It has already been noted that drip methods of irrigation are more widespread in the south and that has caused increased soil salinity sometimes to become a serious problem. Sprinkler methods could here become a welcome alternative offering the possibility of the periodic leaching of salt concentrations from the soil.

There is, nevertheless, the problem of likely crop yields to be obtained from sprinkler methods as against the more traditional surface watered or the drip methods widely used already in the valley. In theory the more controlled application of water through sprinklers should, along with other improvements, raise yields but the few tests so far reported for the valley suggest that yields from sprinkler irrigation could fall below those obtained by other types of irrigation. Marlowe and Sarraf carried out crop yield trials for the 1979-80 season to compare results for furrow (surface), drip and sprinkler methods.[53] Using tomato yields they found that furrow and drip irrigation methods gave very similar yields both for total and early harvests. But those for sprinkler methods of irrigation were much poorer especially for the higher value early crops, where sprinkler irrigation gave a yield below one quarter of those given by either furrow or drip method of irrigation. However, the overall yield of sprinkler was not much lower than that of the two other methods of irrigation. While the performance of the tomato crops, a plant not well suited to sprinkler methods, is not necessarily indicative of other likely crop performances, it would appear that any switch to new sprinkler irrigation methods enforced on farmers reluctant and unprepared to adopt them, could create many new problems within the project area.

It is clear from the varied material presented in this chapter that the implementation of the EGCP was no more than one step in a series aimed at intensifying resource use in the valley and that many changes have occurred in the project since then. It is now appropriate to turn to the land tenure systems within the project to see how they have evolved over the first few decades of the project.

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13. For instance the Sukhor el Ghor tribe settled in the area between Wadis Arab and Ziqlab, while Al Adwan tribe settled in the southern valley between Wadis Shueib and Hisban.
14. Ionides, M.G. (1939) Ibid, 254.
15. Ibid.
16. For example Davies stated that one influential landlord at Wadi Yabis, whose land was situated near the take-off point, managed to persuade other owners to reject the governmental interference (Davies, H.R. 1958), op.cit.

17. In the southern valley (i.e. Ghor Kafrain and Rameh) the water of Wadis Kafrain and Hisban is owned collectively by members of Al Adwan tribe who normally reside in the area and own their own lands.
18. Data given by the agriculture extension office at South Shuneh during the field work in 1978.
19. MacDonald, M. and Partners (1965) East Bank Jordan Water Resources, Vol. 2, VI-3.
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22. Stevens, G.G. (1965) Jordan River Partition, The Hoover Institution on War, Revolution, and Peace, Stanford University.
23. The dam was constructed in 1932 in order to regularize the flow of the lower Jordan for a hydroelectric station at the Yarmouk-Jordan confluence. However, the station was destroyed during the 1948 Arab-Israeli war.
24. Stevens, G.G. (1965) Ibid, p. 43
25. The Arabs offer was not unreasonable, since only 23 per cent of the Jordan system water comes from the Israeli territory, while the remaining 77 per cent rises in the three Arab States of Jordan, Syria and Lebanon.
26. The Litani River is not part of the Jordan River system. It emerges and runs entirely within Lebanon.
27. The Zionist leaders long before the establishment of the State of Israel looked at the Litani and always dreamed to make it their northern frontier in order to capture its water.
27. Stevens, G.G. (1965) Ibid, 46.
28. The 8 volume, 2 year study cost $2.4 million paid for by the predecessor of the US-AID (49%), together with UNRWA (42%) and the Jordan Development Board (8%).
29. East Ghor Canal Temporary Law No. 31 of 1962, Article 111a.
30. Ibid.
31. Jordan Development Board, (1964) 7 year Programme for Economic Development of Jordan 1964-1970, Amman, Jordan Development Board, 168-169.

32. The increased salinity of the Jordan River had resulted from several factors including the diversion of the Yarmouk, the upper Jordan and the saline waters of Lake Tiberias into the lower Jordan by the Israelis. Although subject to occasional floods the influx of Palestinians in the 1950s led to a major increase of settlement and cultivation in the Jordan zor. 12,095 dunums were being irrigated in 1954. By the early 1960s an estimated 35 MCM of water was being taken from the Jordan for irrigation on the zor, possibly representing 35,000 dunums of irrigated land.
33. Jordan, National Planning Council (1973) The Three Year Development Plan 1973-1975, Amman, National Planning Council, 94-95.
34. The 250,000 dunums to be irrigated were to be distributed as follows:

A) First stage:

Wadi Arab area	18,000 dunums
Hisban-Kafrain	15,000 dunums
Zarqa Triangle	15,000 dunums
Extending EGMC by 8 km	13,000 dunums
Extending EGMC by 18 km	35,000 dunums

B) Second stage:

Maqarin Dam	154,000 dunums

35. Jordan, National Planning Council (1976) Five Year Plan for Economic and Social Development 1976-1980, Amman, National Planning Council, 133-138.
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39. The two studies are:

Jordan, Department of Statistics (1973) Social and Economic Survey of the East Jordan Valley, Amman,

and

Jordan, Department of Statistics (1977) General Results of the Agricultural Census, Amman

40. Jordan has restricted its intake of the Yarmouk water so as to allow Israel to receive at least 3 MCM per month, slightly more than the amount agreed before the canal's construction.
41. The Ziqlab Dam is officially called Sharhabeil Dam.
42. Oliver, H. (1972) Irrigation and Water Resources Engineering, London, Edward Arnold, 127.
43. The water fees collected from the farmers are supposed to cover only the operational and maintenance cost of the scheme, but according to some project officials such fees fail to meet such cost.
44. Withers, B. and Vipond, S. (1974) Irrigation: Design and Practice, London, Batsford 129-131.
45. The cultivation of crops under plastic covers (Plastic culture) is fully discussed in Chapter 5.
46. Withers, B. and Vipond, S. (1974) Ibid, 56.
47. One farmer interviewed by the author in 1978 in Ghor Kafrain stated that his drip irrigation system on his 260 dunums (65 acres) had cost JD 25,000 (£45,000) to install and involved annual maintenance equal to £1000.
48. Although the sprinkler technique is new to the project area sprinkler irrigation was being used on the Arab Development Project Farm at Jericho in the early 1960s.
49. Stage I includes all the irrigation projects served by the unregulated flow of the Yarmouk River as well as the regulated flow of the side wadis. Stage II refers to the project that will be supplied by the regulated flow of the Yarmouk River after the construction of the Maqarin Dam (Fig. 3.2).
50. Harza Engineering Company (1978) Feasibility Study for Stage II Development of the Jordan Valley, Chicago, Illinois. Quoted by Dajani, J. et al (1980) An Interim Evaluation of the Jordan Valley Development Effort: 1973-1980. Prepared for the U.S. Agency for International Development (US-AID), Project No. Evaluation 278-0181, 74.

51. Stevens, M.A. (1977) Incidence of Control of Tomato, Cucumbers, Eggplant, and Peppers under Sprinkler Irrigation in the Jordan Valley Davis, California, Department of Vegetable Crops, University of California, quoted by Dajani, J. (1980) Ibid, 75.

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53. Dajani, J./et al (1980) Ibid, 76.

CHAPTER 4 LAND TENURE SYSTEMS

4.1 Introduction

Having outlined the development of irrigation in the valley, it is appropriate to consider next the data available on the land tenure systems in the project area. This will complete a review of the background information on the scheme prior to a consideration of the author's field data in chapters 5 to 11. This chapter discusses what is known of the patterns of land holding in the valley and changes in these patterns over recent years especially as a result of the effect of land reforms associated with the project.

Mazur has pointed out that there are two approaches to the examination of farm land distribution in Jordan, and a distinction has to be made between landholding units and landownership.[1] When considering the productive efficiency of the farming system one is mainly concerned with farm units in terms of their size, their fragmentation and, to a lesser extent, their legal status. In an area like the valley with small farms, a farm unit will often consist of some land owned by the operator together with some he rents in order to increase the size of the holding. But the distribution of land ownerships cannot be ignored because in a predominantly peasant society land is the main source of wealth, and the land reform programme associated with the East Ghor Canal Project was chiefly focused on lessening differences in the amounts of wealth in land owned by individual farmers. This has had only an indirect effect on sizes of operating farm units, however, because many farmers increase the area of land they operate by "topping up" what they own with rented plots. Owners of large areas of land also found ways of reducing the impact of expropriation on them under the land reforms.

Most of the data available in the various official surveys on farmland in the valley since the 1950s have focused either on farm holdings or on ownership of land, rather than on both. This makes comparison from survey to survey difficult, as does the fact that different surveys included rather different areas. A 1955 UNRWA survey and the 1961 socio-economic survey of the valley collected data on land ownership but both of these were enumerated at a time before the project and its land reforms were properly underway.[2] The only census to consider ownership patterns since the land reform programmes took full effect was made as long ago as 1971. Neither the 1973 socio-economic survey, nor the 1975 agricultural census provided data on ownership of land but gave information on landholdings.[3] Nothing can be said of the 1978 socio-economic survey of the valley which had still not been published by the time of drafting this chapter.[4]

With a number of rather varied survey sources to consider, it is convenient to first outline the background to, and the nature of, the land reform programme before going on to examine the changing patterns of landholdings and landownerships and the apparent impact of the land reforms.

4.2 Ottoman Land Law and the Mashaʿa System

As in other Arab countries which were once part of the Ottoman Empire a number of traditional classes of landownership were in existence in the region until the 1950s. These largely owed their origins to the Ottoman land law of 1858. They included privately-owned, or *mulk*, land. This was the most clearly defined form of private landownership and consisted mainly of land occupied by buildings in the villages and main settlements and other small areas of land which had been obtained by transfer from state ownership. Owners of *mulk* land had full rights of disposal of the land by sale or other transfer, some of which became *waqf* or trust land when it was gifted for religious or charitable purposes. Overall *mulk* land probably formed a small proportion of the total land area in the Jordan Valley.[5] Much more common was land leased from the state land, or *miri*. This was land which had been granted by the state to individuals on an indefinite lease so long as certain conditions of use were fulfilled. Holders of *miri* land could assign it to their heirs although its title remained vested with the state. In the case where a holder neglected to use the land for three years or more it also reverted back to the state.

Three other less common types of state land included *mawat*, or literally 'dead' and normally uncultivated land, which was land assigned entirely for public use and on which individuals had no rights; and matruka which included such areas as community pastures, threshing floors and roadways. Finally there were those lands under state forest reserves, occupied by state buildings and similar uses where again there were no individual rights. The writer has been unable to get any data on the amounts of land in the Jordan Valley which were held in the past by the state, individuals and others under these various titles.

This Ottoman land law had also been superimposed upon the traditional masha's system whereby most village land was held communally but shared out to individuals for cultivation for periods of between two and nine years.[6] Clearly this gave no continuity of occupation and provided farmers with no incentive to improve the land. This and the Ottoman system continued in existence in parts of the Jordan Valley through to recent decades even though the British mandate authorities and, subsequently, the Jordan Government encouraged the more permanent sharing out of farmland to individuals, but the confused pattern of landholding in the valley which had resulted did not suit the needs of a newly developing irrigation project. Much of the privately-owned land was held by a relatively small number of individuals while most farmers owned very little of the land they operated.

4.3 Land Reforms in the 1950s and under the East Ghor Canal Project

Major changes occurred in the pattern of landownership in the early 1950s which were to have far-reaching effects for the East Ghor area. Under the national Land Law 41 of 1953, if certain conditions were met miri, or leased state land, became mulk, or privately-owned land. This greatly increased the amount of privately occupied land in the valley, mainly in and around the village settlements. Following on from this under the East Ghor Canal Law 14 of 1959, all lands in the project area benefitting from irrigation works became private-owned mulk land but with a further stipulation that no landholding should be less than 30 dunums in extent or should be allowed in future to be subdivided into units smaller than that.

Whilst these two laws set in train the process of turning more irrigated, or potentially irrigable, valley land over to private lands, several other laws followed in the 1960s as the project got underway in order to redistribute land more fairly and to ensure that fragmented holdings were consolidated and further fragmentation of holdings was prevented. Indeed much of the eight main pieces of land legislation which governed the establishment of the project focused on land reform and the redistribution of land from larger to smaller holdings, with limits set for the maximum and minimum size of units.

The 30 dunum minimum specified size of irrigated holding finally chosen for the project area was partly based on the recommendations of a mission of the International Bank for Reconstruction and Development (IBRD) which had visited Jordan in 1955. This had recommended a minimum of 20 dunums for a holding on good land and 30 dunums on inferior land.[7] It was felt that this was sufficient land to provide a hard-working family with a subsistence return together with sufficient additional income for the purchase of other needs not produced on the farm. Since the topography of the irrigated areas in the valley required a complex pattern of feeder canals which would create a series of miniature irrigation basins and fields, the mission saw little scope for mechanized farming on larger units and therefore also proposed a 100 dunum maximum farm size.[8]

In fact the 1959 Land Law,[14] on which all later land laws in the project area were based, did not entirely follow the IBRD recommendations. Not only was the minimum farm size set at a slightly higher level on some farms - 30 dunums for farms on the more productive (class 1 and 2) land and 50 dunums on the more marginal (class 3) land - but it also allowed for farms up to a maximum size of 300 dunums. The 1959 law also laid out the scales by which large landholders were required to relinquish some of their land in order to benefit the very small landowners or the landless. Table 4.1 A shows that landowners with over 1000 dunums were allowed to keep a maximum of 300 dunums, and landowners with 100 dunums or less were able to keep rather smaller amounts.

This system of land redistribution also included "expropriation with compensation" which roughly followed IBRD recommendations, but various concessions were made to those suffering expropriation. Landowners forced to relinquish land were able to choose which part of

TABLE (4.1) EAST GHOR CANAL PROJECT:

DEVELOPMENT OF REGULATION FOR LAND EXPROPRIATION

UNDER THE LAND REFORM LAWS 1959–77

Number of irrigable dunums held prior to the project	Number to be allotted to the holder
(A) 1959, Law 14 (The Original Law)	
30 – 50	to be allotted in full
51 – 100	50 dunums plus 50% of the excess
101 – 500	75 dunums plus 25% of the excess
501 – 1000	175 dunums plus 15% of the excess
Over 1000	300 dunums
(B) 1960, Law 13 (Amendment)	
30 – 70	to be allotted in full
71 – 100	75 dunums plus 50% of the excess
101 – 500	87.5 dunums plus 25% of the excess
501 – 1000	187.5 dunums plus 22% of the excess
Over 1000	300 dunums plus 10% of the excess
(C) 1962, Law 31 (Amendment)	
30 – 50	to be allotted in full
51 – 100	50 dunums plus 25% of the excess
101 – 500	62 dunums plus 17% of the excess
501 – 1000	130 dunums plus 12% of the excess
Over 1000	200 dunums (except that lands planted with trees might be excluded from this limit)
(D) 1977, Law 18 (Amendment)	
40 – 50	to be allotted in full
51 – 100	50 dunums plus 25% of the excess
101 – 500	62 dunums plus 17% of the excess
501 – 1000	130 dunums plus 12% of the area exceeding 500 dunums
Over 1000	200 dunums

Source: Hezleton, J.E. (1974) The Impact of the East Ghor Canal Project on Land Consolidation, Distribution and Tenure, p. 18.

and Jordan, Official Gazette (1977) No. 2977, Jordan Valley Development Law, Temporary Law No. 18 for the year 1977, Article XXII, N.

their land they would dispose of and were able to get compensation at an appraised value not only for the land but for any trees it carried, other improvements and the water rights foregone. All such expropriations were settled by a committee under a court judge.

Further amendments to the 1959 land law in 1960 reduced the scale of expropriation of land suffered by landowners with medium to large holdings, as can be seen in Table 4.1B, and raised the maximum permissible farm size as well as the sizes of smaller farms that could be kept without expropriation. But the 1962 amendment to the original law considerably increased the scale of expropriations, returned the minimum farm size to 50 dunums and set a maximum of 200 dunums for most farms. The Land Law 18 of 1977 largely reconfirmed this policy although slightly raising the smallest permitted farm size from 30 to 40 dunums.

There are several reasons why, soon after the liberalization of the 1960 land law, the later land laws became more restrictive for larger land holders. One was that the 1960 land law also changed the definition of a landholder and so allowed many larger landholders to avoid the more harsh effects of expropriation by registering some of their land in the names of other family members as separate farm units, but continuing to operate them as one. After 1960 much use was made of this concession especially in the northern parts of the project area such that the supply of expropriated land for new small land holders declined. As the project area was extended southwards larger landowners in those areas also anticipated the impact of expropriation by similarly subdividing their holdings between family members. In 1975 all such further transfers were banned by the Project Authority.

A second reason for restricting the retention of larger holdings in the project area was the need to improve the conditions for the smallest farmers in the area who, above all else, often needed more land to make their enterprises viable. This involved modifying the system of land acquisition priorities to further favour the smaller owner-occupiers and renters as against the absentee owners.

Under the original land law of 1959 applicants for redistributed land were put into one of five priority classes. These were:

first priority: the smallest landholders in the project area.

second priority: absentee landowners whose land was used by renters and share croppers in the project area.

third priority: other farmers in the project area.

fourth priority: other farmers in surrounding districts.

fifth priority: other farmers from other parts of the country.

Under the 1962 land law the priority given to absentee landowners was relegated below that of all others, and farmers from outside the project area were for the first time allowed to acquire project land even if they already owned land elsewhere that gave them an adequate income.

Furthermore, ownership rights were granted in 1962 to lessees of state land in the project area who had occupied that land for five years and renters of private land were able to take over its ownership if they had occupied it without interruption for fifteen years. Some share-croppers who had planted trees on the land obtained some land ownership rights. All of this increased the demand for land and this could be met only by increased redistribution from the larger landholders.

Before considering the actual impact of these land reforms upon landownership and, by implication, on the pattern of landholdings and their size and fragmentation, it is appropriate to examine the various surveys to see what types of tenure existed amongst the farms in the valley at various stages throughout the development of the project.

4.4 The Tenure of Farms in the Valley

The earliest available information on land tenure in the Jordan Valley dates from 1953 when an UNRWA study of both the east and west banks divided the farmers into three types of occupancy: owners, tenants who rented their land, and mixed occupance holders where the farmer owned part of the land he operated and rented the rest either for cash or for kind.[9]

Table 4.2 summarizes the numbers of farmers classified by tenure types in that survey. It shows that owner-occupied farms were more common than tenanted ones particularly on the east ghor. About 54 per cent of the farms enumerated on the east ghor were owner-occupied, a much higher proportion than on the west ghor (39 per cent). But in both areas about 30 per cent of the farms were fully tenanted. The rest were under some form of mixed tenure and these made up about 30 per cent of the west ghor farmers but only 15 per cent of farms on the east ghor.

TABLE (4.2) THE JORDAN VALLEY: FORMS OF LAND TENURE, 1953

Land Tenure	EAST GHOR		WEST GHOR		TOTAL VALLEY	
	Freq	%	Freq	%	Freq	%
Owners	1245	53.9	598	39.5	1843	48.2
Tenants	716	31.0	449	29.7	1165	30.5
Mixed	350	15.1	467	30.8	817	21.3
Total	2311	100.0	1514	100.0	3825	100.0

Source: Dajani, N.I. (1957) Economic Appraisal of the Yarmouk-Jordan Valley Project, p. 96

TABLE (4.3) THE JORDAN VALLEY: FORMS OF LAND TENURE, 1953 (DAJANI MODIFICATION)

Land Tenure	EAST GHOR		WEST GHOR		TOTAL VALLEY	
	Freq	%	Freq	%	Freq	%
Owners	1362	59.0	754	49.8	2116	55.0
Tenants	949	41.0	760	50.2	1709	45.0
Total	2311	100.0	1514	100.0	2825	100.0

Source: Dajani, N.I. (1957) Ibid, p. 96.

In 1957 Dajani reworked the same data and by allocating the farms of mixed tenure status to either an owner or renter category, on the basis of how the majority of the land in each holding was held, confirmed that owner-occupied farms had been most numerous in the east ghor in 1953.[10] As Table 4.3 shows he calculated that 59 per cent of the farms in the east were fully or predominantly owner occupied compared with 41 per cent in the tenanted category. In the west ghor, on the other hand, he showed that predominantly tenanted units just outnumbered those that were owner-operated. That the west ghor had a higher proportion of renters than the east ghor probably reflected the greater numbers of Palestinian refugees who had settled there as tenants.

The second study to consider land tenure in the valley was the socio-economic survey of 1961, conducted by the Department of Statistics on the basis of data collected in 1960.[11] Because it covered only the eastern part of the valley and included a slightly different area from that of the 1953 survey, the two studies are not strictly comparable, particularly as a different system of classifying tenure types was adopted. Seven main types of land tenure were distinguished although only three of those were really significant: owner-occupiers, mixed tenure farmers and the share-croppers. Small numbers of holdings were also classified as leasehold, that is cash-renters, and other holdings were occupied rent-free. Table 4.4 shows the numbers of holdings in each of these five categories, the land area they occupied, and the mean size of each type of holding.

Because the survey was conducted seven years after the UNRWA study and covered a slightly different area, it produced results markedly different from the earlier study. Share-croppers now appeared as the dominant type of tenure, accounting for 56 per cent of the holdings in the eastern valley. The next most important were owner-occupied units (25 per cent) and mixed tenure holdings (13 per cent). Only 6 per cent of holdings were held on lease or were occupied rent-free.

It is also noticeable that the holdings of share-croppers, leasehold tenants and those of mixed tenure were, on average, significantly smaller in area than owner-occupied units. Whereas owner-occupied farms made up a quarter of total holdings, they took up a third of the land and had a mean size of 81 dunums. In contrast the more numerous share-cropped holdings made up 56 per cent of all units but accounted

TABLE (4.4) EAST GHOR CANAL PROJECT: FORMS OF LAND TENURE, 1960

	Holding		Area		Average size of Holding (dunum)
	Freq	%	Freq	%	
Entirely Owned	830	24.8	67 551	32.5	81.4
Entirely Sharecropped	1872	56.0	81 161	39.0	43.4
Entirely leased	94	2.8	3 693	1.8	39.3
Mixed Tenure	424	12.7	49 366	23.7	42.8
Occupied free of rent	121	3.6	6 170	3.0	51.1
Total	3341	99.9	207 941	100.0	62.2

Source: Jordan, Department of Statistics (1961) The East Jordan Valley: A Social and Economic Survey.

for only 39 per cent of the total land area, with an average holding size of 43 dunums. Cash-rented and mixed tenure units, as well as holdings occupied rent-free, all had a mean area considerably below that of the owner-occupied farms.

In a fuller socio-economic survey of the East Jordan Valley, carried out by the Department of Statistics in 1973, four types of land tenure were distinguished: owned, cash-rented, share-cropped and mixed tenure holdings. For the first time data was provided separately for the southern, middle and northern parts of the area. The survey, the results of which are summarized in Table 4.5, showed that share-cropped holdings were, as in the 1961 study, the most numerous, followed by owner-occupied units, but that marked variations occurred in their distribution across the valley. Over the whole of the eastern valley 57 per cent of holdings were operated entirely on a share-cropping basis with a further 7 per cent partly share-cropped. The significance of this type of tenure seemed, however, to decrease northwards. Whereas 70 per cent of units were operated in this way in the south, the proportion fell to 60 per cent in the middle area and to only 47 per cent in the north.

Owner-occupied units were the second most common tenure type, as they had been in the 1961 survey, but in this study they assumed rather more importance, accounting for 34 per cent of all holdings. Unlike the pattern of distribution of share-cropper holdings, there were more owner-occupiers in the north than in the middle or southern areas. 39 per cent of holdings in the north were owner-occupied compared with only 28 per cent in the south. Mixed tenure and cash-rented farms were even less common than in the 1961 survey. Only 7 per cent of total holdings were classed as mixed tenure and 2.5 per cent as cash-rented with most of both of these types in the northern and central parts of the valley.

Whereas the 1961 survey suggested that, on average, owner-occupied farms were considerably larger than those of all other tenure types, the same conclusion cannot so clearly be drawn from the 1973 data for all parts of the valley. As Table 4.6 shows the 34 per cent of total holdings that were classed as owner-occupied took up nearly 36 per cent of the land suggesting that they were, on average,

TABLE (4.5) EAST JORDAN VALLEY:

DISTRIBUTION OF AGRICULTURAL HOLDING BY FORM OF TENURE, 1973

	Northern		Middle		Southern		Total Valley	
	No. of holdings	%	No. of holdings	%	No. of holdings	%	No. of holdings	%
Rented holdings								
Share-cropped	813	47.5	1349	60.7	380	70.2	2542	56.8
Cash-rented	76	4.4	31	1.4	4	0.7	111	2.5
Owned holdings	673	39.3	696	31.3	156	28.8	1525	34.1
Mixed tenure (owned and rented)	151	8.8	145	6.5	1	0.2	297	6.6
Total	1713	100.0	2221	100.0	541	100.0	4475	100.0

Source: Jordan, Department of Statistics (1973) Social and Economic Survey of The East Jordan Valley 1973, pp. 144-147. (compiled)

TABLE (4.6) EAST JORDAN VALLEY:

DISTRIBUTION OF AGRICULTURAL LANDS BY FORM OF TENURE, 1973

	Northern Valley		Middle Valley		Southern Valley		Total Valley	
	Area (dunums)	%	Area (dunums)	%	Area (dunums)	%	Area (dunums)	%
Rented Holdings:								
Share-cropped	36 198	46.1	38 047	48.5	11 524	47.0	85 769	47.2
Cash-rented	3 266	4.1	1 100	1.4	581	2.4	4 947	2.7
Owned Holdings	26 779	34.1	25 993	33.1	12 338	50.3	65 110	35.9
Mixed Tenure:								
Area Owned	3 985	5.1	7 076	9.0	57	0.2	11 118	6.1
Area Rented	8 346	10.6	6 233	7.9	10	0.0	14 589	8.0
Total	78 574	100.0	78 449	99.9	24 510	99.9	181 533	99.9

Source: Jordan, Department of Statistics (1973) Ibid, pp. 144-147 (compiled) little different from the mean size for all farms in the area. But this pattern varied between the three sections of the valley. In the north the 39 per cent of farms that were owner-occupied took up only 34 per cent of the land whereas in the south about half of all the land was occupied by the 29 per cent of farms classed as owner-operated, indicating the larger than average size of owner-occupied units.

Whilst owner-occupied farms tended, at least in the south, to be larger than average for all types of holdings, the other common type of holding - the share-cropped unit - tended to be smaller than average in the centre and south. Whereas, for example, share-cropped units made up 70 per cent of all farms in the south they took up only 47 per cent of the land. In the northern part of the valley, however, the data suggests that all farms, no matter their tenure status, were closer to a mean size.

A further set of data on tenure types in the three parts of the East Jordan Valley was provided only two years after the 1973 survey by the agricultural census of 1975.[12] Although a different system of classifying tenure was again adopted, the data largely confirms the patterns revealed by the 1973 results. Table 4.7 and 4.8 summarize the results. It can be seen that for the whole eastern valley area 93 per cent of the farms were held under single tenure arrangements. Of these renting was the most common (53 per cent) followed by owner-occupation (31 per cent). A further 7 per cent were held under mixed forms of tenure. Share-cropping accounted for over half of all rented holdings although in many cases this took the form of the landlord receiving a cash equivalent rather than a rent in kind. Actual cash renting on a fixed rent basis was much less common. As in 1973 tenanted units were much more frequent amongst southern and central valley farmers, accounting for nearly 80 per cent of farms in the south, whereas in the north they were approximately equal numbers of tenanted and owner-occupied farms. The fact that 42 per cent of farms in the north were owned, compared with only 17 per cent in the south, probably partly reflects the effects of the land redistribution laws which had more effect further north since the entire southern area, as defined in this survey, then lay outside of the project area where these laws applied.

TABLE (4.7) EAST JORDAN VALLEY:

DISTRIBUTION OF AGRICULTURAL HOLDINGS BY FORM OF TENURE, 1975

	North Ghors (Northern Valley)		Deir Alla (Middle Valley)		South Shuneh (Southern Valley)		TOTAL VALLEY	
	No.	%	No.	%	No.	%	No.	%
Holdings under one form of tenure:	2917	90.7	1637	93.2	1141	96.9	6151	93.1
Owned	1366	42.5	519	29.5	196	16.6	2081	31.5
Rented	1482	46.1	1106	63.0	940	79.8	3528	53.4
Occupied Free	67	2.1	12	0.7	5	0.4	84	1.3
Others	2		0	0.0	0	0.0	2	
Holdings under mixed form of tunure:	300	9.3	119	6.8	37	3.1	456	6.9
More than 50% of the area owned	102	3.2	43	2.4	11	0.9	156	2.4
More than 50% of the area rented	189	5.9	74	4.2	26	2.2	289	4.4
Others	9	0.2	2	0.1	0	0.0	11	0.1
Total Types	3217	100.0	1756	100.0	1178	100.0	6607	100.0

Source: Jordan, Department of Statistics (1977) General Results of the Agricultural Census 1975, pp. 49, 50, 54-55. (compiled)

TABLE (4.8) EAST JORDAN VALLEY:

DISTRIBUTION OF AGRICULTURAL LANDS BY FORM OF TENURE (1975)

	North Ghors (Northern Valley)		Deir Alla (Middle Valley)		South Shuneh (Southern Valley)		TOTAL VALLEY	
	Area in dunums	%	Area in dunums	%	Area in dunums	%	Area in dunums	%
Holdings under one form of tunure:	111662	84.2	52407	89.9	40928	88.3	204999	86.4
Rented	50637	38.2	32626	56.0	32060	69.2	115326	48.6
Owned	60107	45.3	19063	32.7	8754	18.9	87924	37.1
Occupied Free	871	6.6	716	1.2	114	0.2	1701	0.7
Others	48	0.1	0	0.0	0	0.0	48	
Holdings under mixed form of tenure:	20905	15.8	5896	10.1	5430	11.7	32151	13.6
More than 50% of the holding owned	7991	6.0	1954	3.4	2046	4.4	11991	5.1
More than 50% of the holding rented	12121	9.2	3813	6.5	3384	7.3	19318	8.1
Others	793	0.6	129	0.2	0	0.0	922	0.4
Total Types	132568	100.0	58304	100.0	46385	100.0	237230	100.0

Source: Jordan, Department of Statistics (1977) Ibid. pp. 49-50, 54-55 (compiled)

As was shown by the 1973 survey owner-occupied holdings appeared to be slightly larger than the average farm size whilst the rented ones were generally smaller, but in the 1975 data there was little regional variation in this pattern. The mean size of owner-occupied units was 42 dunums compared with 35 dunums for share-cropped and 33 dunums for cash-rented farms. What is of some interest is that in identifying mixed tenure holdings as a separate group the data also suggest that these were, on average, considerably larger units than many single-tenure units. Although mixed tenure units made up only 7 per cent of all holdings they occupied 13 per cent of the farmland. They were more common in the north where they formed 9 per cent of the farms and occupied 16 per cent of the land, whilst in the south they made up only 3 per cent of the units but took up 12 per cent of the land. As a result the mean size of mixed tenure farms was in excess of 70 dunums, rising to 77 dunums, on average, for units where over half of the land was owner-occupied.

The final and most recent source of data on land tenure amongst the east ghor farmers is available from the writer's own sample farm survey conducted in 1980, when he distinguished five main types of tenure in response to his questionnaire to 353 farmers within the four administrative sections of the project area. These five tenure types were owner, sharecropper, cash tenant, foreman and mixed tenure and Table 4.9 summarizes the results of this part of his survey. It can be seen that for the whole sample, owner-occupation was the most common form of tenure with 54 per cent (193 farmers) of the responses, followed by share-croppers who accounted for 31 per cent of the sample. Cash tenants were far less common and only a handful of farmers reported themselves as foreman-managers. Only one farmer responded that he operated under a system of mixed tenure.

With more farmers reported as owners than renters, these results, in some ways, do not correspond at all closely with those provided by earlier government and other semi-official surveys. There could be several reasons for this. These could include the effect of the size and distribution of the writer's sample which, unlike the earlier surveys, was entirely confined to farms in the project area. It could also result from inaccuracies in earlier surveys. It could also

TABLE (4.9) EAST GHOR CANAL PROJECT:

FORMS OF LAND TENURE, SAMPLE SURVEY, 1980

Land Tenure Status	SECTION I (North)		SECTION II (North-Central)		SECTION III (South Central)		SECTION IV (South)		TOTAL PROJECT	
	No. of Holdings	%	No. of Holdings	%	No. of Holdings	%	No. of Holdings	%	No. of Holdings	%
Owner	66	64.7	45	48.4	41	51.2	41	52.6	193	54.7
Share-Cropper	23	22.5	28	30.1	28	35.0	30	38.5	109	30.9
Cash-Tenant	9	8.8	18	19.4	9	11.2	6	7.7	42	11.9
Foreman	4	3.9	2	2.2	2	2.5	0	0	8	2.3
Mixed	0	0	0	0	0	0	1	1.3	1	0.3
Total	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

be caused by the recency of the writer's survey at a time when levels of farm ownership have been increasing. The low level of mixed tenure could be because farmers were unable or unprepared to explain to the interviewer the complexities of the legal status of their land.

In spite of the differences between the 1980 sample results and the results of the earlier surveys reviewed, it is clear from Table 4.9 that in several ways the 1980 results at least confirm the pattern of spatial variations of tenure type noted in earlier studies. Farm ownership appeared more common in the far north of the project area with 65 per cent of the sample reported as owner-occupying farmers in Section I, whilst this figure fell to around 50 per cent in the other three sections. In contrast share-cropping, the other common form of tenure accounting for 31 per cent of the respondents, appeared to be more common in the south as it had been in the other surveys. 38 per cent of farmers interviewed in Section IV were share-croppers compared with only 22 per cent in Section I. Cash-renting was everywhere the third most common tenure type, accounting for 12 per cent of the 353 farmers sampled, and was less frequently found than either owner-occupation or share-cropping. If one can assume from this sample that about half of all farmers in the project area were, in 1980, operating land which they owned, this represents a considerable change from the situation two decades earlier when the project got underway with only about one-quarter of the farmers owning their farm holdings. This would suggest that the land reform programme has probably had a considerable impact on landholding patterns and this point will be returned to later in this Chapter. But firstly it is worth summarizing what these survey results suggest and, secondly, to go on to consider changing landownership patterns.

Large variations in the relative importance of different farm tenure types from survey to survey is an over-riding impression one gains from reviewing the data collected between 1953 and 1980. A summary indication of this is given in Table 4.10 where the percentages of farmland held under various forms of tenure are listed by year of survey. Apart from noting that not all of the surveys included the same areas, it can also be seen that the proportion of land reported as share-cropped, cash rented or held in some other way tended to fluctuate more than the owner-occupied.

TABLE (4.10) EAST JORDAN VALLEY:

DISTRIBUTION OF AGRICULTURAL LAND BY FORM OF TENURE, 1953–1980

	1953	1960	1965	1973	1975	1978	1980*
Owned	54	32.5	56.3	35.9	37.1	47.1	57.0**
Sharecropped	31	39.0	11.0	47.2	26.1	16.7	30.9
Cash Rented		1.8	0.5	2.7	3.9	24.7	11.9
Mixed	15	23.7	32.2	14.1	13.6	11.4	0.3
Occupied free of rent	–	3.0	–	–	0.7	–	–
Mixed Rent	–	–	–	–	18.6	–	–

* The figures of 1980 are calculated from the author's sample survey of 1980, therefore it represents percentage of farm units rather than percentage of area.

** Thus figure includes the owned farm and those which are run by farm-manager operator.

Part of this fluctuation is probably the result of survey inaccuracies rather than tenure changes between surveys. That there should be such inaccuracies is not too surprising when one considers the conditions under which the surveys were made. For example there are no laws in Jordan to regulate the relationship between landlord and renter so that there is no legal definition of a cash renter or a share-cropper or anyone else who does not clearly own the land he is working. This would clearly reduce the accuracy of any census based on such information. Many farmers may not be clear themselves about their rental status. Sharab in 1975, for example, showed that 84 per cent of the tenants in the valley were operating entirely under a form of lease that had been agreed orally with their landlords.[13] A major reason for this is that landlords are concerned about any future land laws that may be passed which may give land rights to tenants with written agreements. Secondly, oral leases are generally thought to be adequate for short term rentals, often of no more than one year, and it is believed that most rentals are no longer than this. Sharab found in his survey that 87 per cent of his respondents who were renting land had one year agreements and a further 12 per cent had one season agreements. Longer agreements were very rare.

Surprisingly, short term leases seem to suit the majority of tenants as well as nearly all landlords. Not only did Sharab find that 92 per cent of landlords prefer them but so did 65 per cent of tenants, especially share-croppers. Not only did short leases give the landlord the opportunity of easily removing a tenant who could not, or would not, use the land to best advantages to get the largest harvest. The tenant also often wishes to have a landlord who will provide adequate financial or other assistance until the harvest is in and feels he is more likely to extract that assistance if he has the ability to get off the land quickly at the end of the year. Of course, longer term rentals based on cash renting, rather than share-cropping, might provide the conditions necessary for tenants to put more investment and care into the use of the land. But these matters were not dealt with by the land reform programme.

But the considerable variations in farm tenures suggested from survey to survey cannot be explained entirely by census inaccuracies, or differences in survey areas. It would be reasonable to suppose that the land reform programmes have had some effect on the size of units and their tenure so that these need to be examined as far as the data allows.

4.5 Land Ownership and the Size of Units

The few surveys made in the past in the Jordan Valley suggest that there was once much variation in the size of the units owned by farmers. An UNWRA survey which covered about 4650 landowners and 434,000 dunums on both ghors in 1955 showed (Table 4.11) that 35 per cent of the land was owned by only 54 persons, or 1.2 per cent of the farmers surveyed.[14] At the same time 84 per cent of the farmers owned less than 100 dunums each, or a total of 20.6 per cent of the land. Along with this went much joint ownership and fragmentation of holdings. Each farm on average contained 2.9 separate plots and 46 per cent of farms were individually owned, representing about a third of all the land.

The survey carried out by the Department of Statistics in 1960 covered a rather smaller part of the valley but revealed much the same pattern as the UNWRA study.[15] Being confined to about 158,000 dunums and 3668 farms in the northern part of the valley, from the Yarmouk River in the north to the El Masri Triangle in the south, it only covered about 36 per cent of the area of the earlier survey. Direct comparisons are not therefore possible between the two surveys but as the later study gave useful detail on farm sizes which largely confirms the results of the 1955 study, its main points are summarized in Table 4.12. Again it can be seen that there were many small farm owners as well as a few large ones. 92 per cent of all owners held no more than 100 dunums of land each which accounted for only 46 per cent of the land. At the same time only 10 (0.3 per cent) of the surveyed landowners held nearly 10 per cent of the land in units of over 1000 dunums. More than one third of the farmers had less than 10 dunums each. In view of the fact that the 1959 land reform law set the minimum size of holdings in the project area at 30 dunums it can be seen from the original data that about 65 per cent

TABLE (4.11) THE JORDAN VALLEY:

DISTRIBUTION OF LAND OWNERSHIP, 1955

Size of Ownership (dunums)	Owners		Area		Average size of Ownership (dunums)	Fragments	
	No.	%	No. in dunums	%		Total Fragments	Average per Ownership
Less than 5	1014	21.82	2113	0.49	2.1	1368	1.35
5 - 9	544	11.71	4004	0.92	7.4	951	1.75
10 - 19	728	15.67	10681	2.46	14.7	1397	1.92
20 - 49	1029	22.15	33046	7.61	32.1	2426	2.35
50 - 99	578	12.44	39771	9.16	68.8	1972	3.41
100 - 199	360	7.75	51226	11.78	142.3	1493	4.15
200 - 399	205	4.41	57386	13.22	279.9	1954	9.53
400 - 599	70	1.51	34666	7.98	495.2	848	12.11
600 - 799	40	0.86	27649	6.37	691.2	402	10.05
800 - 999	24	0.52	21812	5.02	908.8	265	11.04
1000 -1999	40	0.86	54188	12.47	1354.7	507	12.67
2000 -4999	6	0.13	17826	4.10	2971.0	85	14.16
5000 and over	8	0.17	80018	18.4	10002.3	8	1.0
Total	4646	100.00	434388	100.00	93.5	13676	2.94

Source: UNRWA, (1957) Jordan Valley Land Tenure Survey, Appendix A, p. 25

TABLE (4.12) EAST GHOR CANAL PROJECT:

DISTRIBUTION OF LAND OWNERSHIP, JULY, 1960

Size of Ownership (dunums)	Owners		Area		Average size of Ownership (dunums)
	No.	%	No.	%	
1 - 9	1309	35.68	5496	3.47	4.2
10 - 19	708	19.30	9935	6.28	14.0
20 - 29	378	10.31	9069	5.73	24.0
30 - 75	866	23.61	39086	24.69	45.1
76 - 100	113	3.08	9869	6.23	87.3
101 - 500	252	6.87	47815	30.21	189.7
501 - 1000	32	0.87	31782	13.76	680.7
Over 1000	10	0.28	15244	9.63	1524.3
Total*	3668	100.00	158296	100.00	43.1

* The total area does not include 46,811 dunums of land owned by the State.

Source: Jordan, Department of Statistics (1961) The East Jordan Valley: A Social and Economic Survey, p. 155

of all farms covered by this survey were below this minimum and many of these were far below this minimum.

Data on the amounts of land owned by farmers is more limited after the 1960 survey because later censuses reported little on the ownership of units, as distinct from enumerating landholdings which need not be wholly owned by the operators. A survey of the project area in 1971, however, by the Royal Scientific Society covered 5388 landowners on 130,000 dunums but only divided the units into broad size classes. These results are given in Table 4.13 where it is clear that there had been some narrowing of the previously large variation in the size of owned units, probably as a result of the land reform programme. No farmers were shown to own over 400 dunums (compared with at least 40 of them in 1960) and the percentage of farmers with over 100 dunums had also fallen. Although the two surveys are not strictly comparable this fall in the size of owned units is also suggested by the decline in the mean owned unit size - from 43 dunums in 1960 to only 24 dunums in 1971. Nor can the increase in the number of landowners surveyed in the project area - up from 3668 in 1960 to 5388 in 1971 - be explained entirely by a change in the areas covered by the two surveys although the later survey did reach further south as a result of the extension of the project area. Some of the increased number of landowners must reflect the impact of the land reform programme that created new small farms by removing some of the land from the larger owners.

4.6 The Size of Holdings

The data allows rather little to be said of the sizes of holdings in general except that, like ownerships, their average size appears to have fallen as land reform has taken effect. Holdings are also in general larger than ownerships because many farmers rent additional land to increase the size of the units they operate.

The first survey data on landholdings in the project area dates from 1960 and is summarized in Table 4.14.[16] It shows that generally farm holdings were, on average, larger than ownership units. Average holding size in the project area in 1960 was 62 dunums (compared with

TABLE (4.13) EAST GHOR CANAL PROJECT:

SUMMARY OF LAND OWNERSHIP, 1971

Size of Ownership (dunums)	Owners		Agricultural Units		Area		Average size of ownership (dunums)
	No.	%	No.	%	In Dunums	%	
0 - 19	0	0	0	0	0	0	0
20 - 49	3969	73.66	2110	62.19	72100	55.40	18.2
50 - 99	1106	20.53	904	26.64	39790	30.58	36.0
100 - 199	298	5.53	309	10.20	15414	11.85	52.7
200 - 399	15	0.28	70	2.06	2821	2.17	188.1
400 - 599	0	0	0	0	0	0	0
Total	5388	100.00	3393	100.00	130125	100.00	24.2

Source: Hezleton, J.E. (1974) Table 5, p. 32

After: Survey conducted by the Economic Research Department of the Royal Scientific Society in 1971.

TABLE (4.14) EAST GHOR CANAL PROJECT:

DISTRIBUTION OF LAND HOLDINGS, 1960*

Size of Holding (Dunums)	Holders Number	Holders %	Area Number (Dunum)	Area %
5 - 19	867	25.9	10 335	5.0
20 - 39	983	29.4	26 964	13.0
40 - 59	591	17.7	27 679	13.3
60 - 89	390	11.7	27 541	13.2
90 - 129	212	6.3	22 354	10.8
130 - 199	145	4.3	22 916	11.0
200 - 299	75	2.2	17 885	8.6
300 - 399	25	0.7	8 276	4.0
400 - 499	23	0.7	9 893	4.8
500 - 999	20	0.6	14 269	6.9
1000 and over	10	0.3	19 829	9.5
Total	3341	100.0	207 941	100.0

* The survey did not include 97 holdings of less than 5 dunums each, which totalled up to 223 dunums, in addition to the 2600 dunums at the Agricultural Research Stations at Al Baqura, Wadi Yabis and Deir Alla.

Source: Jordan, Department of Statistics (1961), The East Jordan Valley: A Social and Economic Survey, p. 159

43 dunums for mean ownership size). Because different class sizes were used to group holdings and ownerships, little comparison is possible between Table 4.14 and Table 4.12 but it is clear that there were far fewer very small farms than small ownerships. For example only 19 per cent of the landholdings were below 20 dunums in area in 1960 compared with 55 per cent of the land ownerships. As a result there were 9 per cent fewer landholdings than ownerships, clearly because some small owners did not operate their land but rented it out to others. Although mean holding size was, then, larger than the average size of ownerships, the pattern of landholdings in the project area in 1960 still revealed a wide size variation. For example, 26 per cent of landholdings were between 5 and 19 dunums but these occupied only 5 per cent of the farmed area. At the other extreme 5 per cent of the landholders held 200 dunums or more each or 33.7 per cent of the farmed area.

The 1973 socio-economic survey enumerated 4475 holdings spread across 181,533 dunums in the East Jordan Valley.[17] Because it covered areas further south than the 1960 survey, the two surveys are not strictly comparable. Furthermore although the 1973 survey enumerated more farms they in total covered a smaller area than did the 1960 survey, indicating that mean holding size had, like average ownership size, fallen from 62 dunums in 1960 to 40 dunums in 1973. The results of the 1973 survey are given in Table 4.15. Differences in the size classes used makes comparison between this and the 1960 survey difficult but it is clear that by 1973 there were fewer holdings above the 200 dunum maximum allowed under the land reform law and that there had probably been some increase in the number of farms just above the minimum required size. 29 per cent of the holdings were in the size class 31-50 dunums but the great majority of holdings (57.8 per cent) were still at or below the minimum allowable size.

The 1975 Agricultural Census reported on landholdings in the eastern valley but did not divide them by size classes and used subdivisions that are not entirely comparable with any of the earlier surveys. Nevertheless the results obtained, and given in Table 4.16 for the three districts of the valley are worthy of note because they cover a bigger area (223,000 dunums) and a larger number of holdings (5779 farms)

TABLE (4.15) EAST JORDAN VALLEY:

DISTRIBUTION OF AGRICULTURAL HOLDINGS, 1973

Holding size	No. of holdings		Area of holdings		Average size
	In. No	%	In No.	%	
30 dunums and less	2581	57.8	45564	25.1	17.65
31 - 50 dunums	1280	28.6	37309	20.6	29.14
51 - 100 dunums	621	13.9	43861	24.2	70.62
101 - 200 dunums	219	4.9	30395	16.7	138.80
Over 200 dunums	74	1.7	24404	13.4	329.80
Total Holdings	4475	99.9	181533	100.0	40.57

Source: Jordan, Department of Statistics (1973) Ibid. p. 144 (compiled)

TABLE (4.16) EAST JORDAN VALLEY:

DISTRIBUTION OF AGRICULTURAL HOLDINGS, 1975

	No. of Holdings	Area of Holdings (dunums)	No. of Parcels	Average Holding (dunums)	Fragmentation Ratio
Northern Valley (North Ghors)	2996	123 352	5025	41.17	1.7
Middle Valley (Deir Alla)	1688	57 087	2349	33.82	1.4
Southern Valley (South Shuneh)	1095	43 485	1716	39.71	1.6
Total Valley	5779	223 924	9135	38.74	1.58

Source: Jordan, Department of Statistics (1977) Ibid. pp. 3-4 (compiled) than any of the earlier surveys. They also reveal a little of the variation in mean holding size within the project area. While mean holding size had fallen from 40.5 dunums in the 1973 to 38.7 in this, the northern ghor had a larger mean holding size (41.2 dunums) than either the middle ghor (Deir Alla) or the south.

The writer's own survey of 353 sample farms in 1980 across the four sections of the project area shows that the pattern of landholdings was still dominated by small units. 65 per cent were in the size range 31 to 40 dunums, a much higher percentage than shown in the 1973 data for the whole eastern valley. Only 14 per cent of the farms enumerated in 1980 were larger than 50 dunums compared with 19 per cent in the 1973 survey so that the main changes since 1973, if the sample survey is reliable, were a further loss of the larger farms and a big increase in the number of farms rising just above the minimum allowable size. The results of the 1980 survey are shown in Table 4.17 where there was little apparent variation in farm sizes across the four sections of the project area, except that the smallest farms were more common in the northern section.

Since the project's land reform law linked the minimum farm size to the quality of the land involved, it is not surprising to find in the sample a strong correlation between holding size and the class of land occupied. Under the land law the minimum size of farm on the best land was set at 30 dunums and at 50 dunums for farms on poorer land classes. A chi-square test of farm size in relation to land class revealed a very significant correlation between these two variables with smaller farms generally occurring on the best land. This relationship, laid out in Table 4.18 can be summarized as:

a) 83.7 per cent of all units under 31 dunums lay entirely on Class 1 and 2 land with a further 11.2 per cent having more than nine tenths of their land in these classes. Only 4 farms in this size group (5 per cent of the sample) had less than this proportion of their land in these classes and none of these had less than half of their land in the better classes.

b) About two thirds (66.4 per cent) of the farms of 31-35 dunums - that is about the minimum recommended holding size on good land - were entirely on Class 1 and 2 and and a further 16.4 per cent had over nine-tenths of their land in these classes. Apart from 3 farms (2.1

TABLE (4.17) EAST GHOR CANAL PROJECT:

SIZE OF FARM UNITS, SAMPLE SURVEY, 1980

Farm Size Category (in dunums)	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
30 and less	18	17.6	10	10.8	3	3.7	8	10.3	39	11.0
31-35	53	52.0	46	49.5	49	61.2	39	50.0	187	53.0
36-40	11	10.8	12	12.9	12	15.0	10	12.8	45	12.7
41-50	9	8.8	9	9.7	7	8.7	7	9.0	32	9.1
Over 50	11	10.8	16	17.2	9	11.2	14	17.9	50	14.2
Total	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

TABLE (4.18) EAST GHOR CANAL PROJECT:

SIZE OF FARM UNITS AGAINST PERCENTAGE OF CLASS 1 AND 2 LAND

Count / Row % / Col %	Percentage of Class 1 & 2 in the Farm Unit: 50 & less	51-70	71-90	91-99	100	Row Total
Farm size (Dunums)						
30 and less	0	3	1	9	67	80
	0.0	3.7	1.2	11.2	83.7	
	0.0	7.5	2.0	19.6	37.6	22.7
31-35	3	4	18	24	97	146
	2.1	2.7	12.3	16.4	66.4	
	7.7	10.0	36.0	52.2	54.5	41.4
36-40	3	12	14	7	9	45
	6.7	26.7	31.1	15.6	20.0	
	7.7	30.0	28.0	15.2	5.1	12.7
40-50	6	8	12	6	0	32
	18.7	25.0	37.5	18.7	0.0	
	15.4	20.0	24.0	13.0	0.0	9.1
Over 50	27	13	5	0	5	50
	54.0	26.0	10.0	0.0	10.0	
	69.2	32.5	10.0	0.0	2.8	14.2
Column Total	39	40	50	46	178	353
	11.0	11.3	14.2	13.0	50.4	100.0

Chi Square = 249.68167 with 16 degrees of freedom Significance = 0.0000

per cent of this sample), all the rest had at least half of their land in the better classes.

c) As the size of farms increased throughout the sample, less of their land generally occurred in these better classes. 54.0 per cent of farms over 50 dunums had less than half of their land in these classes. Only 10.0 per cent of them lay entirely on Class 1 and 2 land.

4.7 Impact of Land Reform

These data indicate that the mean size of ownerships and of holdings has declined over the years and that the farms on the better land are often smaller. Much of this decrease in farm size is therefore, probably attributable to the effect of the land reforms especially as the number of large landowners and large farms had fallen so markedly over the years.

There are other data to support this view. The project authority has claimed to have altered the land areas owned by 5304 persons of which 1297, or 24.5 per cent, entirely gave up their land in the project area in return for compensation. With about 500 new farms created by the programme of land redistribution, the number of ownerships in the project area actually fell by 15 per cent as a result of the reforms but many more operating farms were up to or close to the minimum size laid down than was the case prior to the reforms.[18] Hezleton had argued that on the basis of the pattern of ownerships given in the 1960 survey there would not be sufficient land available from the break up of the larger farms to allow an increase of the many small units up to the minimum size of 30 dunums. He argued that for the farms below 30 dunums "merely to bring these holdings up to the minimum size would require the redistribution of 94,758 dunums". The 294 owned units of over 100 dunums only covered 94,841 dunums so that a "reduction of these holdings to an average of 100 dunums each would make available only 65,441 dunums for redistribution".[19] This would leave a shortfall of about 30,000 dunums. It is not clear, however, how Hezleton calculated that the 2395 owners with less than 30 dunums each needed as much as 95,000 dunums to bring them up to the minimum size required by the land reform programme. They already owned 24,500 dunums and so only required about 47,500 dunums to reach the minimum size. This could be achieved by redistribution without reducing the size of the largest farms right down to 100 dunums.

As Table 4.19 shows, by 1980 there were 3216 farm units in the project area and many of these had probably been affected by land redistribution in some form or other. 44 per cent were under single ownership but a further 19 per cent were held under joint ownerships involving two or three persons. Many of these were probably created by giving ownership rights to tenants or share croppers where the landowner held too little land to enforce its expropriation. 7 per cent of farms were held under multiple ownership as a result of inheritance since passage of the land reforms which prevented small farms from being broken up.

It is also worth noting that 949 farms (29.5 per cent of the total) were owned by persons who held more than one farm and in a few cases those persons owned as many as six farms or more. The data does not allow one to see whether each of these was a viable farm or whether this is an indication of continued fragmentation with some farmers considering their separate plots as separate farms.

The only survey to report in any detail on farm fragmentation was that for 1960 which showed that 27 per cent of holdings consisted of 2 parcels and 25 per cent had 3 or more parcels so that under half of all holdings consisted of only one piece of land. Furthermore this fragmentation was not restricted to the larger farms although might be thought more likely there. As Table 4.20 shows only 75 per cent of holdings of 19 dunums or less were made up of single parcels. As the size of holdings increased so did the proportion made up of two or more parcels. Holdings of 130 dunums or more were most commonly made up of four or more parcels.

Similarly detailed data is not available from any of the later surveys but it seems clear from the gross figures that levels of fragmentation had decreased as a result of the land reforms. By 1975, for example, the average holding consisted of 1.6 parcels (compared with 2.9 in 1955). This figure varied somewhat from north to south across the project area in line with mean farm size.

TABLE (4.19) EAST GHOR CANAL PROJECT:

OWNERSHIP OF FARM UNITS, 1980

No. of Farm Units owned by one person	No. of owners	Total Farm Units No.	%
8	2	16	0.5
7	6	42	1.3
6	4	24	0.7
5	9	45	1.4
4	19	76	2.4
3	74	222	6.9
2	262	524	16.3
1	1425	1425	44.3
½	910	455	14.1
⅓	486	162	5.0
*	5822	225	7.0

* 5822 owners inherited 225 farm units from their original owners.

Source: Jordan Valley Authority, records of Lands Department (May, 1980).

TABLE (4.20) EAST GHOR CANAL PROJECT:

SIZE OF AGRICULTURAL HOLDINGS AGAINST NUMBER OF PARCELS, 1960

Size of Holding (Dunums)	Total No. Holdings	Number of Parcels per Holding: One		Two		Three		Four & Over	
		No	%	No	%	No	%	No	%
5 - 19	867	647	74.6	170	19.6	45	5.2	5	0.6
20 - 39	983	534	54.3	290	29.5	120	12.2	39	4.0
40 - 59	591	216	36.5	217	36.7	98	16.6	60	10.2
60 - 89	390	91	23.3	131	33.6	101	25.9	67	17.2
90 - 129	212	39	18.4	65	30.7	57	26.9	51	24.0
130 - 199	145	17	11.7	28	19.3	41	28.3	59	40.7
200 - 299	75	5	6.7	14	18.7	16	21.3	40	53.3
300 - 499	48	3	6.2	8	16.7	8	16.7	29	60.4
500 and Over	30	0	0.0	3	10.0	4	13.3	23	76.7
All Holdings	3,341	1,552	46.4	926	27.7	490	14.7	373	11.2

Source: Jordan, Department of Statistics (1961) Ibid. p. 161 (compiled)

Clearly not only are small farms less likely to be viable but ones made up of several small and separate parcels are more difficult to operate efficiently because the farmers have to spend more time getting to and from each parcel and have often to waste more land on the edges of the plot. Higher costs are involved in the longer irrigation channels needed and the higher water losses that follow.

Later land reforms have therefore been as concerned to control fragmentation as to enlarge the smallest farms since subdivision of farms works in opposition to the programme attempting to create more viable units. As the 1977 land law states, for example: "Persons whose names are registered in one registration deed have no right to divide the unit into different divisions for the purpose of development of each part or parts of it by one or all from the rest of the unit and from the other holders of the unit."[20]

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17. Jordan, Department of Statistics (1973) supra.
18. In fact the IBRD mission had in 1955 reckoned that their proposed redistribution scheme on the east and west banks would increase the number of holdings from 3825 to as many as 15825.
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CHAPTER 5 SOME SOCIO-ECONOMIC CHARACTERISTICS OF EGCP FARMERS

5.1 Introduction

While the previous chapter has shown that it is possible to gather a reasonable amount of data on farm tenure patterns and trends over the years that the project has operated, the same cannot be said about changes in the farm population and their socio-economic conditions. There have been few population censuses in the valley and these have been very general.[1] As a result the writer thought it necessary to devote a considerable proportion of his 1980 questionnaire survey to obtaining basic data on the sample of 353 farmers he was interviewing. The results of this survey form a major part of this chapter. The questions asked in the questionnaire are listed in Appendix 2.

It is first possible, however, to note some trends and patterns in the population of the valley from the published census sources. With only limited irrigation in the valley before the late 1950s, the population until then was small. Around 1948 it numbered about 37,000 including many Palestinian refugees, but when the canal project got underway and as malaria was brought under control, the valley's population expanded rapidly although much out-migration occurred with the 1967 war and the unsettled years which followed it. The 1973 census showed there were 64,000 people in the valley giving an average annual growth rate of 2.8 per cent since 1961.[2] By 1979 it is estimated that the valley's population had grown to 83,559.[3] Even so this rapid expansion was less than the rate of natural increase because of continued out-migration.

Most of this burgeoning population - about 63,000 in 1979 - is settled in the project area, however, and this appears to have been an area of rather less rapid population increase in recent years.[4] For example by 1979 only 16 per cent of the houses in the Irbid district of the northern valley were built since 1973, compared with 31 per cent around Deir Alla to the south where rapid population expansion has occurred more recently.[5] Further expansion of the irrigation potential of the valley is intended to allow considerably greater population growth.

The valley's population lives in some 50 villages, 47 of which are in the project area or close to it above the main canal.[6] These settlements vary in size from a few thousand people like North Shuneh and Mashar'h, each with about 8000 population, down to others with less than a hundred inhabitants. Most of these settlements, as can be seen in Fig. 5.1, tend to cluster along the main north-south valley road, a pattern that reflects the need for accessibility and to keep under farming the good quality land which is mainly located west of the road and main canal (Plates 5 and 6).

About two-thirds of the population living in the project area is dependent on farming but only about 29 per cent of the farm workforce was made up of farm proprietors, so that the majority employed in farming are labourers or farming helpers. A quarter of the workforce is female almost all of which form the bulk of the farm family labour. Only 2 per cent of farm proprietors are female. But more numerous than the women helpers are paid farm workers. These include small farmers who partly work for others to increase their small income, and those who are totally landless, some of whom are refugees and foreign workers.

Because the available census data is unable to specify further the characteristics of the farm population, it is now necessary to turn to the author's sample survey for further detail. As this survey covered about 10 per cent of the farmers in the project it is felt that it can also give a useful view of the wider population.

5.2 The Social Characteristics

5.2.1 Farmers' Origins

The results of that part of the questionnaire which asked farmers where they had come from are summarized in Table 5.1. The largest single group (51.3 per cent) of the farmers sampled had originated from the ghor but 30.6 per cent of the sample were Palestinians who had moved into the valley as refugees on the establishment of the State of Israel. Jordanians who had come in from the other East Bank parts of the country made up another 11.0 per cent of the sample. A further

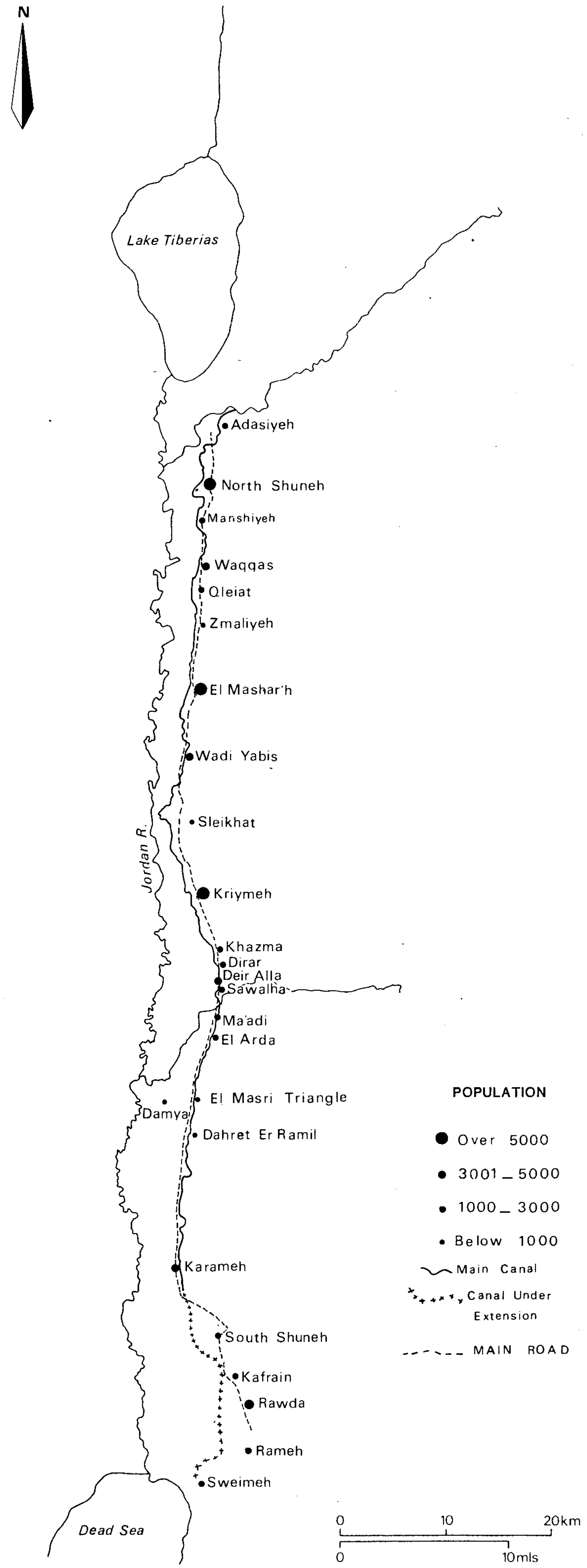

Fig. 5.1 EAST JORDAN VALLEY: DISTRIBUTION OF SETTLEMENTS

Plate 5. Scattered houses on the valley foothills in part of Wadi Yabis village

Plate 6. The settlement of North Shuneh located on the foothills above the irrigable land

TABLE (5.1) EAST GHOR CANAL PROJECT: FARMERS' ORIGINS, SAMPLE SURVEY, 1980

Origin of Farmer	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
El-Ghor	50	49.0	27	29.0	42	52.5	62	79.5	181	51.3
Palestine	37	36.3	46	49.5	18	22.5	7	9.0	108	30.6
East Bank	8	7.8	14	15.1	11	13.7	6	7.7	39	11.0
West Bank	2	2.0	6	6.5	9	11.2	3	3.8	20	5.7
Others	5	4.9	0	0	0	0	0	0	5	1.4
Total	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

20 of the farmers interviewed (5.7 per cent of the total sample) had come from the West Bank of Jordan at about the time of the 1967 war when Israel occupied that area. Another five farmers (1.4 per cent) had come from other countries, mainly Iran and Egypt.

The local population, as the majority population throughout the whole project area, was not evenly distributed across the sampled areas. Only 29.0 per cent of those sampled in Section II had originated from the ghor mainly because there were so many Palestinians and East Bankers in this part of the sample. As a result only 14.9 per cent of all the ghor people interviewed were actually found in this section. In contrast farmers who said they had originated in the ghor formed nearly 90 per cent of the sample in Section IV. Nor were the various immigrant groups found evenly distributed across the sampled areas in the project. The Palestinians were mainly concentrated in Section II where they formed nearly half (49.5 per cent) of the farmers sampled. The concentration decreased slightly northwards where they formed 36.3 per cent of the sample in Section I, but fell markedly southwards forming only 22.5 and 9.0 per cent respectively in Sections III and IV. The farmers attracted to the project from the East Bank areas also tended to concentrate, like the Palestinians, in Section II where 35.9 per cent of them were found, and in Section III. The much smaller group of farmers who had come from the West Bank were also more commonly settled in the middle two sections. Most were to be seen in Section III where more land was being developed for settlement in the late 1960s when many of them were leaving the West Bank. All five of the sampled farmers who had come from other countries, apart from Palestine, were found in the northern section.

In summary then one can conclude that, in respect of farmer origins, the samples taken from each section varied markedly from Section II where there is a Palestinian dominance. In Sections I and III the local ghor people were balanced by a mixed non-ghor group of farmers whilst Section IV is predominantly settled by farmers who have originated locally.

5.2.2 Age, Experience and Length of Residence in the Valley

The ages of the 353 farmers ranged from 24 to 75 years but the middle-aged character of much of the sample should be noted with the largest category questioned being in the age group 41 to 50. This made up 31.7 per cent of the total sample. The next most common groups were those of 31 to 40 years (29.7 per cent of the sample) and 51 to 60 years (23.0 per cent of the sample). Clearly the smallest age group, making up only 4.3 per cent of the sample, were farmers under 31 years of age and these were easily outnumbered by those over 60 years of age. The pattern of age groups within the sampled farmers in each section of the project area is summarized in Table 5.2. The sections show only limited variation from one to another with the exception of Section III where the age group 31-40 was larger and the 41-50 age group smaller than in other sections.

Chi-square tests were carried out to seek for, and test, significant relationships between the age of farmers and other variables in their make-up but only two of these proved significantly related. These were the links between farmers' ages and their length of residence in the ghor and their length of experience in farming. Not surprisingly it was found that the older farmers had lived, and farmed, for the greater number of years in the ghor. Another relationship for which significant positive correlation had been expected, between farmers' age and educational levels, proved invalid.[7]

Table 5.3 summarizes the results of the survey of farmers' ages subdivided accordingly to length of residence in the ghor where it can be noted that most of the sampled farmers in all age groups reported that they had lived most or all of their lives in the ghor. Thus two-thirds of those within the age group of 30 years and under reported that they had lived in the ghor for a period ranging between 21 and 30 years while a slightly smaller percentage of those aged from 31 to 40 years claimed to have lived in the ghor for that number of years. Over half of the farmers in the 41-50 age group stated that they had been in the ghor for over 40 years and this proportion varied little for the older age groups. For all age groups over 30 years the percentage that reported living in the ghor for less than 20 years was no more than 20 per cent. Not only do these figures confirm an earlier conclusion of the sample survey (Table 5.1) which showed that local people outnumbered immigrants, but they also show that many

TABLE (5.2) EAST GHOR CANAL PROJECT: FARMERS' AGE, SAMPLE SURVEY, 1980

Age Category (in years)	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
30 and less	3	2.9	4	4.3	3	3.7	5	6.4	15	4.3
31-40	27	26.5	28	30.1	31	38.7	19	24.4	105	29.7
41-50	33	32.4	31	33.3	18	22.5	30	38.5	112	31.7
51-60	27	26.5	20	21.5	17	21.2	17	21.5	81	23.0
Over 60	12	11.8	10	10.8	11	13.7	7	9.0	40	11.3
Total	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

TABLE (5.3) EAST GHOR CANAL PROJECT: FARMERS' AGE AGAINST FARMERS RESIDENCE IN THE VALLEY

Count / Row % / Col %	Farmer Residence in the Valley (in years)				
	20 & less	21-30	31-40	Over 40	Row Total
Farmer's Age (in years)					
30 and under	5	9	0	1	15
	33.3	60.0	0.0	6.7	
	8.9	11.5	0.0	0.8	4.2
31-40	18	23	64	0	105
	17.1	21.0	61.0	0.0	
	32.1	29.5	63.4	0.0	29.7
41-50	16	21	17	58	112
	14.3	18.7	15.2	51.8	
	28.6	26.9	16.8	49.2	31.7
51-60	9	18	15	39	81
	11.1	22.2	18.5	48.1	
	16.1	23.1	14.9	33.1	22.9
Over 60	8	7	5	20	40
	20.0	17.5	12.5	50.0	
	14.3	9.0	5.0	16.9	11.3
Column Total	56	78	101	118	353
	15.9	22.1	28.6	33.4	100.0

Chi Square = 129.85262 with 12 degrees of freedom Significance = 0.0000

immigrants, like most of the Palestinians, have now been in the ghor for several years.

Table 5.4 summarizes the pattern of farmers' age groups in relation to their length of farming experience. As in the previous table the expected pattern is again found with the younger farmers having fewer years of farm experience. Two-thirds of the sampled farmers of 30 years of age or less reported 10 years or less of farming experience and 56 per cent of those aged between 31 and 40 reported between 11 and 20 years of farming. It should be noted, however, that considerable numbers of farmers in the older age groups reported lengths of farm experience which were less than the number of their adult years. This was often as a result of their arrival in the ghor from Palestine and other parts of Jordan when the project developed in the 1960s. Many of these may well have not been farming before they settled here. For example, the farmers in the over 60 age group who reported that they had had under 20 years of farming experience were almost as numerous as those who claimed over 30 years' experience.

Because the length of time over which a farmer has resided in an area might be, apart from his age and experience, a good general guide to his familiarity with farming conditions, the results of the writer's survey of farmers' residence time in each section of the project area are summarized in Table 5.5. This immediately confirms that most of the sampled farmers had lived for many years in the ghor, partly because most of them were middle aged and partly because the local ghor folk and long-time immigrants predominated over more recent arrivals. Thus 84.1 per cent of the sampled farmers had lived in the ghor for over 20 years and 33.4 per cent had been there for over 40 years. Only 15.9 per cent had been there for 20 years or under.

But the spatial distribution of these farmers in each residence-time group varied considerably between the sections even though we earlier found only limited variation in their age distribution. Section IV, for example, contained many more farmers who had lived in the ghor for over 40 years even though the farmers sampled there were not, on average, the oldest in the project area. 55.2 per cent of the farmers sampled in that section had lived there for 41 years or more. In contrast Section II contained many more farmers who had lived in the

TABLE (5.4) EAST GHOR CANAL PROJECT: FARMERS' AGE AGAINST FARMING EXPERIENCE

Farmer's Age (in years)	Count / Row % / Col %	Farmer's Experience (in years): 10 & less	11-20	21-30	Over 30	Row Total
30 and under		10	5	0	0	15
		66.7	33.3	0.0	0.0	
		18.5	3.5	0.0	0.0	4.2
31-40		31	59	15	0	105
		29.5	56.2	14.3	0.0	
		57.4	41.0	14.9	0.0	29.7
41-50		9	46	50	7	112
		8.0	41.1	44.6	5.2	
		16.7	31.9	49.5	13.0	31.7
51-60		4	19	27	31	81
		4.9	23.5	33.3	38.3	
		7.4	13.2	26.7	57.4	22.9
Over 60		0	15	9	16	40
		0.0	37.5	22.5	40.0	
		0.0	10.4	8.9	29.6	11.3
	Column Total	54	144	101	54	353
		15.3	40.8	28.6	15.3	100.0

Chi Square = 159.10208 with 12 degrees of freedom Significance = 0.0000

TABLE (5.5) EAST GHOR CANAL PROJECT: FARMERS' RESIDENCE IN THE VALLEY, SAMPLE SURVEY, 1980

No. of years the farmer has spent in the Valley	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
20 and under	12	11.8	24	25.8	14	17.5	6	7.7	56	15.9
21-30	28	27.5	18	19.4	17	21.3	15	19.2	78	22.1
31-40	33	32.4	28	30.1	26	32.3	14	17.9	101	28.6
41 and over	29	28.4	23	24.7	23	28.8	43	55.1	118	33.4
Total	102	100.1	93	100.0	80	99.9	78	99.9	353	100.0

project area for a shorter time. 42.9 per cent of all sampled farmers who had resided in the ghor for no more than 20 years were found in this section where they made up over a quarter of all farmers interviewed in that section. This concentration of shorter-residence farmers in Section II undoubtedly relates to the strong Palestinian presence already referred to. In contrast only 11.7, 17.4 and 7.7 per cent of sampled farmers in Sections I, III and IV fell into this shorter-residence category.

In summary, Section II had a more balanced distribution of farmers by residence time than any other part of the project area and the Section IV sample was dominated by long-term residents. Both Sections I and III had distributions where farmers who had resided in the area for between 21 and 40 years predominated. All of this suggest the considerable experience that most sampled farmers have had. If one correlates length of farmer residence in the ghor against location, the results are little different. Again one finds that a greater proportion of more experienced farmers are actually found in Section IV, the most recently settled area, where 25.6 per cent of the sample farmers, for example, claimed to have over 30 years of farm experience. 17.6 per cent of farmers in Section I, the earliest settled area, also made this claim with under 10 per cent in the other two sections. Table 5.6 gives detail on this pattern and clearly shows that Sections I and IV of the project, the oldest and the most recently developed sections, have the highest proportion of more experienced farmers in their samples, although the most striking feature remains the considerable body of experienced farmers in all sections.

There was also a significant relationship between length of farmer's residence and farm size. 65 per cent of the sampled farms were in the size range of 31 to 40 dunums with those of between 31 and 35 dunums being easily the most common. Only 14.1 per cent of all the farms were over 50 dunums and only 7 farms of the 353 (2.0 per cent of the sample) were over 100 dunums, some of these the result of areas of non-cultivable land being attached to a holding. The pattern of farm sizes in the sample showed little variation between the sections of the project area although there were rather more small farms in Section I.

Although one would expect farm size to be almost entirely conditioned by the imposed land law and the related factor of land

TABLE (5.6) EAST GHOR CANAL PROJECT: FARMERS' RESIDENCE IN THE VALLEY AGAINST LOCATION

Count Row % Col %	Farmers' Location Section I	Section II	Section III	Section IV	Row Total
Farmers' residence in the Valley (in years)					
20 and under	12	24	14	6	56
	21.4	42.9	25.0	10.7	
	11.8	25.8	17.5	7.7	15.9
21-30	28	18	17	15	78
	35.9	23.1	21.8	19.2	
	27.5	19.4	21.2	19.2	22.1
31-40	33	28	26	14	101
	32.7	27.7	25.7	13.9	
	32.4	30.1	32.5	17.9	28.6
Over 40	29	23	23	43	118
	24.6	19.5	19.5	36.4	
	28.4	24.7	28.7	55.1	33.4
Column Total	102	93	80	78	353
	28.9	26.3	22.7	22.1	100.0

Chi Square = 30.72108 with 9 degrees of freedom Significance = 0.0003

quality, a strong relationship in the sample was also detected by chi-square between the number of year of experience the farmers had had in farming and the sizes of their holdings. The older farmers generally operated larger farms. Table 5.7 summarizes this relationship. It shows, for example, that 35.2 per cent of farmers with over 30 years of farm experience held over 40 dunums of land each whereas only 18.6 per cent of farmers with 10 years or less of such experience held farms of that size. At the other extreme 70.4 per cent of farmers with 10 years or less experience had units of 35 dunums or less compared with 59.2 per cent of the farmers with over 30 years' experience.

5.2.3 Farm Labour and Family Help

Work on the farm by members of the farmer's family, apart from the landholder, is not as common as one might at first expect. As Table 5.8 shows only 136 farmers, or 38.5 per cent of those interviewed in the writer's 1980 survey, stated that they used family help although there were marked variations in the proportions of farmers reporting the use of this source of labour from section to section. Nearly half (47.3 per cent) of farmers sampled in Section II stated that they used family labour whereas in Section I this proportion fell to a little above a quarter (28.4 per cent). Figures between these two extremes were found in the other two sections.

Assessing the actual amount of work done on the sampled farms by family labour as against hired help was difficult but the writer asked farmers if they depended mainly on the one or the other. It is clear from Table 5.8B, which summarizes these results for the whole sample as well as for the sections, that family labour is of even more restricted importance than is suggested by the figures reported in Table 5.8A. Only 13.6 per cent of sampled farmers claimed to depend mainly on family help whereas 83.3 per cent said that hired labour was more important to them. Even though the use of family labour assumed more importance in Section IV where a quarter of farmers reported it was their main source of help, this was only just over half of those farmers in that section who had reported that they used family help. As one moves northwards the percentage of farmers reporting a

TABLE (5.7) EAST GHOR CANAL PROJECT: FARM SIZE AGAINST FARMERS' EXPERIENCE IN AGRICULTURE

Count / Row % / Col %	Farmer's Experience in Agriculture (in Years) 10 & less	11-20	21-30	Over 30	Row Total
Farm size (Dunums)					
30 and less	10	35	19	16	80
	12.5	43.7	23.7	20.0	
	18.5	24.3	18.8	29.6	22.7
31-35	28	68	34	16	146
	19.2	46.6	23.3	11.0	
	51.9	47.2	33.7	29.6	41.4
36-40	6	17	19	3	45
	13.3	37.8	42.2	6.7	
	11.1	11.8	18.8	5.6	12.7
40-50	3	9	11	9	32
	9.4	28.1	34.4	28.1	
	5.6	6.2	10.9	16.7	9.1
Over 50	7	15	18	10	50
	14.0	30.0	36.0	20.0	
	13.0	10.4	17.8	18.5	14.2
Column	54	144	101	54	353
Total	15.3	40.8	28.6	15.3	100.0

Chi Square = 22.55905 with 12 degrees of freedom Significance = 0.0317

TABLE (5.8) EAST GHOR CANAL PROJECT: FARM LABOUR AND FAMILY HELP, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
A. Family help on the Farm:-										
Farmers receiving family help	29	28.4	44	47.3	28	35.0	35	44.9	136	38.5
Farmers receiving <u>no</u> family help	73	71.6	49	52.7	52	65.0	43	55.1	217	61.5
Total	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0
B. Most work carried out by:-										
Family labour	7	6.8	8	8.6	13	16.3	20	25.6	48	13.6
Hired labour	93	91.2	80	86.0	65	81.2	56	71.8	194	83.3
No answer	2	2.0	5	5.4	2	2.5	2	2.6	11	3.1
Total	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

reliance on family labour falls even more rapidly. Hence by the time one has reached Section I in the north only 28.4 per cent of farmers reported that they used family help and less than a quarter of these, or only 6.8 per cent of all the farmers sampled in that section, claimed that family labour was more important to them than hired help.

Not only, then, is it noteworthy that hired labour is much more widely used than family help but that the family help, where it is used, often only takes a secondary role. This is more clearly seen in Section II. Here 44 farmers, or 47 per cent of the sample in that section, reported that they used family help, the highest figure for any part of the project. On the other hand only 8 of those farmers, or 8.6 per cent of the total sample in that section, claimed that their family provided most of their labour needs, clearly indicating the important role of paid labour for most farmers.

5.2.4 Farmers' Educational Levels

Lastly in this section, reference should be made to the educational levels of the sampled farmers. They were asked about their levels of formal education and these were then grouped into illiterate, those with elementary schooling (up to 6 years), those with up to preparatory schooling (7-9 years), those with up to secondary schooling (10-12 years) and graduates (diploma or a university degree). Table 5.9 summarizes the results of this part of the survey where it can be seen that nearly 44 per cent of the sample reported that they were illiterate and a further 35.1 per cent only had an elementary education, leaving only 21 per cent with more schooling than this. Most of these had had only an extra three years of schooling up to preparatory level. Only 4.5 per cent of the total sample claimed to be graduates.

Few useful conclusions can be drawn from the variations in those levels of schooling reported for farmers in different sections of the project although one can note that the proportion of illiterate farmers rose southwards from 37.3 per cent of the sample in Section I to 43.8 per cent of those interviewed in Section IV where a higher proportion of local people were found. Farmers with a secondary level of education and graduates were much more common in the northern two sections

TABLE (5.9) EAST GHOR CANAL PROJECT: FARMERS' EDUCATIONAL LEVEL, SAMPLE SURVEY, 1980

Education Status	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Illiterate	38	37.3	40	43.0	35	43.7	42	53.8	155	43.9
Elementary	39	38.2	30	32.3	29	36.2	26	33.3	124	35.1
Preparatory	10	9.8	10	10.8	10	12.5	8	10.3	38	10.8
Secondary	7	6.9	8	8.6	4	5.0	1	1.3	20	5.7
Graduate	8	7.8	5	5.4	2	2.5	1	1.3	16	4.5
Total	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

of the project area where they made up nearly 15 per cent of the samples in contrast to the most southerly section where they made up less than 3 per cent of the sample.

Relationships were sought and tested by chi-square between the reported levels of formal education of the interviewees and 30 other variables. In most cases correlations at or above the statistically significant .05 level were not found or the tests were invalidated by not meeting the test conditions. In a few cases, as for example in the use of Amman, Irbid and Sawalha produce markets, the tests showed that the better educated farmers tended more often to use these but the reason for this is not clear.

Two relationships between farmer education levels and their other activities were statistically significant and are worth noting. The chi-square test showed a very strong relationship (0.00 significance level) between higher educational levels and sources of additional income. Whereas only 10.3 per cent of illiterate farmers reported that they had additional income sources to that from their farming, 18.5 per cent of those with an elementary or preparatory schooling reported additional income sources. This level kept rising for those with a secondary or graduate level of education where 40.0 per cent and 62.5 per cent respectively reported other income sources.

A strong relationship (.016 significance level) was also demonstrated by the chi-square test between farmer educational level and obtaining cash loans for farming where these were more common amongst groups up to and including the secondary level, with graduates and, to a lesser extent, those with a preparatory level of schooling seeming to take fewer loans. There appear to be few clear reasons, however, for this pattern. 56, 59 and 65 per cent respectively of illiterate, elementary-schooled and secondary-schooled farmers had taken cash loans whereas only 34 per cent of those with a preparatory education reported that they had taken a loan. In the case of graduates only 31 per cent had obtained such a loan and this low figure may reflect the greater likelihood of their having other income sources to support their farming activities.

5.3 The Living Conditions in the Jordan Valley

The writer did not attempt to survey housing conditions, as an aspect of the socio-economic conditions of his farmer sample, but some indication of these can be found from previous surveys. It is not intended here to provide a detailed account of these conditions because many of them have little bearing on the farming and land use characteristics. Furthermore the official data on the socio-economic characteristics of the population are limited and do not generally distinguish between the farm and non-farm population. Generally surveys have considered the whole area of the East Jordan Valley rather than the project area and its constituent sections. Since agriculture, however, was reported as the occupation of 74 per cent of the population in the East Jordan Valley in 1973 (ranging from 70 per cent in the north to 77 per cent in the south), and since almost no data is available on the socio-economic character of the farmers alone, some attempt is here made to summarize the main features of the social conditions in the whole valley to indicate something of the background against which to assess the farming situation.[8]

The first socio-economic survey of that part of the East Jordan Valley included within the East Ghor Canal Project area was carried out by the Department of Statistics in 1960 at a time when the East Ghor Canal Project was still under construction.[9] This covered the area from Adasiyeh to El Masri Triangle. The social part of the survey examined the quality of living in the area as seen in the housing conditions and recorded such features as house size, age, tenure, construction materials and the availability within households of various facilities like kitchens, bathrooms, toilets, water supply and lighting.

The survey covered 7258 households and showed, overall, that housing conditions were very poor in the area, often because there were many new settlers in the area and these were living in makeshift accommodation. Almost half of the households surveyed had lived in their homes for less than five years previously and many neither owned nor paid a rent for these homes, both facts reflecting the significant influx of new "squatter" settlers that had come into the area just before the survey was made.[10]

The predominance of poor quality housing in the area was indicated by the survey in several ways. 84 per cent of the homes were of mud construction, providing cheap but small and very basic shelters. Most of these simple houses not only had mud walls but roofs made of rushes or reeds and mud, supported on poles. Another 11 per cent of households reported that they were living in tents, in some cases because they were Bedouins, sometimes because they stated that they were only temporarily working in the valley, their main homes being elsewhere. Only 5 per cent of homes were the more substantial ones constructed of a mixture of mud and stone, cement block or stone.

Significantly most houses were very small so that household overcrowding was common. The average household had only 1.31 rooms available to it and with an average household size of 5.08 persons, mean room occupancy stood at 3.88 persons. 117 households (1.6 per cent of the total) stated that they had 10 or more members but these occupied only 1 room per family. Under conditions like these it is not surprising that most houses in the project area were poorly equipped. Only 34 per cent had a separate kitchen for food preparation purposes. Bathrooms were even more scarce, being found in only 2.6 per cent of all households, nearly all of these being in the two northern villages of Mashrou' and Adasiyeh where the population had been longer settled and were a little better off. Only 1.9 per cent of households reported having their own indoor toilet with another 12.5 having their own toilet outdoors. Another 14 per cent of households shared a toilet with other households. 71 per cent reported no toilet facilities at all. The provision of safe, convenient water supplies for domestic purposes was also very unsatisfactory. Only 2 per cent of homes had water on tap, a half of these taps being outside the house. 1.3 per cent had wells and 18.4 per cent used local spring sources but most of these sources were over 50 metres from the house. The great majority of homes (78.4 per cent) relied on taking water from the river or irrigation ditches where pollution was a constant danger, especially for those living downstream and especially in the flood season. Since the people were generally aware of this pollution threat, most collected their daily water needs early in the mornings when they believed the pollution threat was lowest.

For lighting only 0.5 per cent of homes had electricity and virtually all of these were in Adasiyeh and Deir Alla, the remainder relying on kerosene lamps.

A second socio-economic survey of the area was made by the Department of Statistics in 1973 but this one covered the whole of the East Jordan Valley from Adasiyeh in the north to Sweimeh (on the north shore of the Dead Sea) in the south. As a result it is not possible to consider conditions in the project area separately from the rest of the valley. Again as in the 1960 survey, housing conditions formed the main focus for the examination of the social characteristics of the population although the housing features considered were not in all cases comparable to those used in the previous survey.[11] 11,213 households were included in the enumeration, 55 per cent more than in the 1960 survey.

In some respects there appeared to have been considerable improvement in housing conditions since 1960 but other data suggests much less change. Data on house size is not strictly comparable between the two surveys but it appears that little change had occurred in this. While houses with two or more rooms were more common, accounting for 43 per cent of all homes, household overcrowding was still severe. The data shows that houses were still small, at an average 35.6 square metres, but that larger families tended, on average, to occupy rather larger homes than did the smaller families. But this did little to obviate the problem. 72 per cent of homes only had one bedroom; 24 per cent had two and only 4 per cent had more bedrooms than this. With average household size still above 5 persons (5.7 persons) the mean bedroom occupancy rate was 4.3 persons. Households with 10 or more members still reported a mean of less than two bedrooms. In households of this size, which formed 10.5 per cent of all households in the valley, there were only 5.6 square metres available for each member of the household, whereas at the other end of the scale - the one person units which formed 5.2 per cent of all households - there was 22.6 square metres available per person.

A major change appeared to have occurred since the 1960 survey, however, in the tenure conditions of many households. By 1973 many of the rent-free squatter housing arrangements seem to have disappeared as farmers and farm labourers either acquired ownership to the land on which their homes stood or paid rent to the landowner. 77.8 per cent of households in the eastern valley by 1973 owned their homes and another 14.2 per cent rented them. Only 7.6 per cent of families lived in houses they neither owned nor paid rent for, these mostly being dwellings occupied by farm managers or workers as part of their arrangement with the farm owner. If anything, housing had become more concentrated since 1960 into villages as the number of makeshift shelters had declined. In 1973, 89.2 per cent of all homes were in villages, offering the advantages of some services, and only 7.2 per cent were located actually on farms. These offered the advantage of closeness to the main place of work for the farmers or farmworkers who occupied them.

Also suggesting rather limited improvement in housing standards was the fact that 76.3 per cent of houses were reported as made of mud bricks (compared with 84 per cent in 1960). 11 per cent, the same proportion of families as in 1960, still lived in tents. Some of these were Bedouin but other households had been forced into tents because of the unsettled conditions created by Israeli attacks in the years after 1967, resulting in the complete destruction of the valley village of Karameh in 1968, and the loss of many other houses. Only 10 per cent of houses were built of cement block, generally the better quality newer homes, and homes made of other materials such as mud and stone, zinc, wood and dressed stone totalled only 2 per cent of all houses.

While housing improvement appeared to have been rather limited between the two surveys it is clear that much housing had been constructed during the years between the two surveys, partly as a result of house losses in the 1967 war.[12] Unfortunately much of this was often little better than what it replaced. 45 per cent of houses in the area had been built in the 11 year period 1955-66 and another 33.1 per cent had been constructed in the 6 years from 1967 to 1973. Even so in 1973 only 41.6 per cent of houses in the valley had separate kitchens (compared with 34 per cent in the project area in 1960); only 8.6 per cent had separate bathrooms (compared with 2.6 per cent in 1960), although this figure appeared to be a little higher for houses located on farms where some better-off families lived.

Similarly houses in the northern older-settled part of the valley were, on average, better than those in the more recently-settled southern areas. In the northern valley there were bathrooms in 13 per cent of the homes in 1973 compared with only 3 per cent in the middle valley covering the southern project area. Kitchens were also much more common in northern homes (58 per cent) than in areas to the south (33 per cent), suggesting that home improvements were related to a number of factors including levels of farm income and length of settlement in the area.

Although the Department of Statistics conducted a further socio-economic survey of the East Jordan Valley in 1978, the results of this enumeration were still not available in early 1983 at the time of writing. Some very limited data, based on that survey, has appeared in other government-sponsored reports produced since 1978 but most of these refer to the needs to provide the improvements in the socio-economic conditions in the valley rather than reporting on the conditions prevailing in the late 1970s or early 1980s.

It is clear that considerable governmental effort has been made in the years since the 1967 war and its aftermath to improve housing conditions in the valley but in some cases the results of these efforts have been limited. Housing programmes include low cost mortgages especially for lower income families wishing to improve, extend or replace their existing homes in the project area.[13] A second scheme of home development has proved more successful. Under it the Jordan Valley Authority (JVA) has contracted with two firms to build nearly 1900 homes of a good standard to be made available for purchase by valley people at JD 3000 each on 20 year mortgages. Another 300 homes were also built for government employees in the valley and made available on a rental basis. Dajani noted that rather more were provided in the north even though housing problems appeared to be most acute in the south.

Since 1973 considerable improvements have been made to the provision of domestic water supply. Several villages in the middle valley between Dahret Er Ramil and Khazma; five in the south, around Karameh; and 10 villages north of Sleikhat have been connected by pipe networks to a chlorinated supply. Although the main source of domestic water in 1980 for 55 per cent of the population was still by tankers, 35 per cent enjoyed a piped system and this was being extended. Far fewer now relied on streams or springs for their domestic water needs. By 1980, 30 villages, where nearly 80 per cent of the valley's population live, were connected up by rural electrification schemes, leaving only six villages to which power supplies are planned to go, still to be connected up. Other village services such as a telephone, and a clinic, are now becoming relatively common.

5.4 The Economic Characteristics

Having examined some of the social characteristics of the population of the valley in general and the sampled farm population in particular, it is appropriate to consider some of the economic features of the farmers. After this, some attention will be given to evidence of their adoption of more modern techniques needed for successful farming in the project.

5.4.1 Farm Expenditure

As little reliance can be based on income data, emphasis is here placed on answers to questions put to farmers on their expenditure. The farm expenditure data is discussed under seven sub-headings which represent the basic elements of farm production. These are: wages for labour, generally non-family labour; fertilizers; marketing and transport costs; pesticides and herbicides; seeds and seedlings; irrigation water and ploughing costs. Land rent forms an eighth cost element for some farmers, but is considered separately because only one-eighth of the surveyed farmers reported they made rent payments. Rent is also omitted to make comparison possible between the rented and non-rented farms. The total expenditure profile of farmers is briefly discussed at the end of this section along with income.

Labour wages

Wages for farm work seems to take up the largest share of farm expenditure, and reflect the important role of paid labour in the ghor farms, already referred to. Wages accounted on average for about a third of all farm outlays, but this proportion varied widely on many farms from 5 per cent to 80 per cent, or between JD 45 per year to as much as JD 7600 depending on the size of the farm and the degree to which outside labour is employed (Table 5.10). The mean outlay on wages for the sampled farms was JD 586 for the 1978/79 year which represented 34.4 per cent of their total farm expenditure. There appeared to be little indication of any meaningful spatial variations in the wage outlays across the different sections of the project area with Section I farmers using 37.2 per cent of their outlay on wages at one extreme and Section IV farmers using 31.2 per cent at the other. Virtually all farmers reported expenditure on wages.

Whilst note should be taken of the high average outlay on wages, too much should not be read into the detail of the figures which can only be, at best, approximations to the actual situation. Apart from the fact that individual farmers probably spent widely different amounts on wages because of their varying labour needs, it should also be pointed out that, in the survey, farmers were being asked about their previous year's expenditure.[14] Farmers in the valley seldom keep records of expenditure or income and could not be expected to remember their precise expenditure.[15] Furthermore, even where reporting their expenditure honestly there was a common tendency to over-estimate farming costs and to underestimate income. If one also considers that the individual circumstances and activities of farmers greatly affects their wage labour requirements, it is not surprising that much variation was reported on their wage outlays. Some farmers have more family assistance, so greatly reducing their need for wage labour. Not only would larger farms or farmers with two separate holdings often need more outside labour but this also depended on crops grown and techniques used. Vegetable production generally has the highest labour input followed by fruit and then cereals, but drip irrigation, for example, can greatly reduce labour needs compared with surface watering where ditches need to be kept clear, more hoeing is needed and fertilizer has to be applied separately. Share-cropping farmers generally use least outside labour because they can least afford to.

TABLE (5.10) EAST GHOR CANAL PROJECT:

MEAN FARM EXPENDITURE, INCOME AND RATIO OF INVESTMENT, SAMPLE SURVEY, 1978/79

	SECTION I		SECTION II		SECTION III		SECTION IV		TOTAL EGCP	
	JD	%	JD	%	JD	%	JD	%	JD	%
Labour wages	590	37.2	557	33.2	641	35.7	558	31.2	586	34.4
Fertilizers	354	22.3	392	23.4	423	23.5	447	24.9	400	23.5
Marketing and transport	195	12.3	267	15.9	209	11.6	168	9.4	212	12.5
Pesticides and herbicides	104	6.5	118	7.0	207	11.5	233	13.0	153	9.0
Seeds and seedling	96	6.0	127	7.6	131	7.3	207	11.6	141	8.3
Irrigation water	152	9.6	115	6.9	93	5.2	83	4.6	114	6.7
Ploughing	97	6.1	100	6.0	93	5.2	95	5.3	96	5.6
Total expenses	1588		1676		1797		1791		1702	
Gross income	3391		4256		4883		3366		3952	
Net Income	1803		2580		3086		1575		2250	
Investment ratio (%)	46.8		39.4		36.8		53.2		43.1	

Fertilizers

The cost of fertilizers formed the second largest item of expenditure on most farms. On average this was JD 400 in 1978/79 or 23.5 per cent of total outlays although this varied between 18 and 34 per cent on individual farms. Virtually all farmers reported spending part of their income on fertilizers but the level of spending seemed to increase both in actual and proportionate terms southwards across the project. As Table 5.10 shows, these outlays rose from JD 354 or 22.3 per cent of total expenditure amongst Section I farmers, to JD 447 (24.9 per cent) in Section IV. Even accepting the imprecision of the responses provided by farmers, the limited diversity of reported outlays and their tendency to increase southwards tends to confirm their value since it could be expected that fertilizer use would be greater on the larger southern farms with their poorer soils.

Marketing and Transport

Only 271 of the 353 farmers sampled reported expenditure on marketing and transport and their mean estimated costs gave an annual expenditure of JD 212, making it on average the third largest item, accounting for 12.5 per cent of average outlays. Much variation occurred in these costs reported by farmers, however, as might be expected in view of differences in types and volumes of crops grown by individual farmers and their varied distances from markets. On average farmers in Section II spend 15.9 per cent of their outgoings under this heading compared with 9.4 per cent amongst farmers in Section IV.

Pesticides and Herbicides

Virtually all farmers reported using pesticides and most used herbicides. Average expenditure on these two items was JD 153 per year or 9.0 per cent of average expenditure but this figure varied markedly from JD 50 to JD 3000 on individual farms, depending on several factors such as farm size and crops grown. As Table 5.10 shows, about twice as much was spent by farmers on these chemicals in the southern parts of the project as in the north, again not an unexpected pattern. In Section I these items cost farmers on average JD 104 in 1978/79 (or 6.5 per cent of their total expenditure) but in

Section IV these figures rose to JD 233 and 13.0 per cent of total outlays. The sections in between had intermediate expenditure levels on these items.

Seeds and Seedlings

Average expenditure per sampled farm on seeds and young plants, like fruit trees, was JD 141 in 1978/79, representing 8.3 per cent of total expenditure. Considerable variation was found in the estimated costs of this element of the farming bill by different farmers and it is also noted in Table 5.10 that farmers in the southern sections of the project spent, on average, twice as much on this as those in the north. About a fifth of the farmers reported no expenditure on this. The increased spending in the south would partly reflect the larger size of southern farms and the greater preponderance of perennial crops in the north needing less annual outlay on replacements.

Irrigation Water

On average the sampled farmers spent JD 114 in 1978/79, or 6.7 per cent of their total expenditure, on irrigation water. On the eve of the implementation of the project in 1960 it was estimated that they were spending 3.3 per cent of their outlay on this but the rise is not surprising in view of the greatly increased amounts of water used in recent years. It was also due to the fact that many pre-project farmers did not have to pay for the water which they obtained from the wadis and rivers where they had water rights. Indeed the figure is not higher only because water is available relatively cheaply at 3 fils per m^3 (about one half penny). Table 5.10 shows that, contrary to the other costs that tend to be higher amongst southern farmers, the northern farmers tend to spend more on water than those in the south. This largely reflects the greater water demands on the northern farms, growing perennial crops like banana and citrus, even though it is the southern farmers who face the greatest water deficits because of very low rainfall receipts. Southern farmers tend to grow less water-demanding crops or to more often employ water-conserving methods like drip irrigation to reduce water shortages. Furthermore, southern farmers have often found they faced shortages of irrigation water which also limits their expenditure on this item.

Ploughing

The smallest and perhaps least reliable estimate of expenditure made by farmers was for ploughing. This is because some farmers employ someone to do it for them with their own tractors; others made a crude estimate of the part of the cost of owning a tractor for this particular task. On average farmers spent JD 96, or 5.6 per cent of their total expenditure, on this item and these figures varied little between the farmers in the four sections. In 1960 it was estimated that farmers spent 16.0 per cent of their outlays on ploughing but this was at a time when few farmers had their own tractors, cereals were a major crop, and spending on other production elements was less.

Land Rent

The land rent paid by farm operators to owners has not been considered as part of the total expenditure profile of farmers in the sample because most farmers, being owners themselves or share-croppers, paid no monetary rent. Only 44 of the 353 farmers sampled, or 12.5 per cent, reported paying rent. For this small number it was clear that rents varied widely from under JD 50 per year to several thousand JD depending on farm size, land quality and location, and supplementary equipment, such as drip irrigation, installed on the land. The average cash rent for these 44 farmers was JD 793 per year but this varied from JD 489 in Section I to JD 950 in Section III.

5.4.2 Annual Farm Budget

Total Annual Farm Expenditure

Some indication of total farm expenditure can be obtained by adding together and averaging the seven expenditure elements, excluding land rent, that have just been considered. These can then be related to the income data obtained from the same questionnaire survey and considered next. On average the sampled farmers spent JD 1702 on their main farming needs in 1978/79 although the actual amounts spent varied widely from this. In general farmers questioned in the two southern sections spent rather more than those in the north. This is to be expected in view of the larger size of farms in the south and the longer time that most northern farmers have been established.[16]

Total Annual Farm Income

Table 5.10 also shows the mean gross incomes of the sampled farmers in each section of the project area with the net income figure obtained by deducting the average expenditure from the average gross income. Little can be safely concluded from these income figures partly because as averages they hide a large degree of variability and partly because farmers were often either unable or unwilling to accurately estimate their previous year's income. That incomes varied considerably in relation to such factors as farm size and type of farming is seen in the fact that one farmer in Block 20 using drip irrigation and plastic greenhouses estimated his previous year's gross income at JD 50,000 whereas another in Block 6 estimated his gross income at only JD 700.

Farm Investment

A further and possibly more useful way of expressing the expenditure/income relationship is by the investment ratio shown in Table 5.10. This is derived by dividing the average expenditure in the section by the average gross income of the same farmers, expressing the result as a percentage. This indicates that on average the sampled project farmers in three sections spent less than half of their income on farm outlays with rather more being spent in the more recently developed Section IV and the more intensively farmed Section I in the north.

5.4.3 Farmers' Additional Income

The extent to which EGCP farmers can rely on sources of income additional to their agriculture is very limited. The writer's 1980 survey showed only 18.1 per cent of the sampled farmers reported that they had additional sources of income and the figure would not have reached this level but for the fact that over one third of those questioned in Section I reported these extra incomes. In the other three sections the proportions of farmers with extra income sources were lower, ranging between 14 percent in Section II and 10 per cent for the two southern sections.

No attempt was made in the survey to determine the nature of these additional income sources, probably wages for occasional work on the farms of others, transporting neighbours' goods to market as well as various non-farm jobs. Nor was it possible to assess the degree to which those farmers rely on this additional money. But various correlations were tested by chi-square between several characteristics of farmers reporting additional income sources. In particular it can be noted that statistically significant relationships were found between the receipt of additional income and the following characteristics of farmers and their farms: tenure status, farm income level, level of education, the production of certain crops and the use of certain markets.

Owner-operated farms and those occupied by cash tenants were more likely to have extra income sources than share-croppers. This seems to result from the fact that farm owners more often have transport, farm machines or surplus land they can rent out to other farmers for an extra cash return. Some cash tenants are only part-time farmers and are dependent on another wage source than their farm income. The survey shows that 22.8 per cent of owner operators and 19.0 per cent of cash tenants reported an additional income compared with only 9.2 per cent of share-croppers. The chi-square test on these data gave a .0317 degree of significance.

A strong relationship was also proved (.0183 degree of significance) between the level of farm income and additional income sources. Whereas farmers with a farm income of less than JD 2000 a year or JD 2001 to 3000 reported that they had other incomes in only 17.1 and 11.1 per cent of cases respectively, 20.5 per cent of those with a farm income of between JD 3001 and 5000 reported they had another income. 30.9 per cent of those with an even larger farm income reported that they also had no other money source. A strongly significant relationship was also found between the educational level of sampled farmers and the likelihood that they enjoy an additional income. Whereas few of the illiterate or poorly-schooled farmers reported another income source, those with a secondary or graduate education much more frequently claimed that they had an income, in addition to that from their farming, which could have resulted from farmers with higher education taking governmental part-time jobs.

Whereas fruit tree growers were more likely to have extra income sources than other farmers, those that concentrated on vegetable production were less likely to. 39.2 per cent of those sampled farmers who relied entirely on fruit trees reported additional incomes possibly because they are part-time farmers, compared with 12.6 per cent of non-fruit producing farmers. Generally as the proportion of a farmer's land given over to fruit trees increases so does the likelihood that he enjoys an additional income. This correlation was proved at the .0002 level of significance. In contrast vegetable producers are less likely than other farmers to have other sources of income, probably because it is often, unlike some methods of farming, a full-time occupation. Chi-square tests showed significant correlations between farmers who reported an additional income and those who marketed their crops at Irbid and Sawalha, and to a lesser extent North Shuneh, close to Section I where many farmers with extra income sources were concentrated.

5.5 Farmers' Adoption of Machines and Advanced Techniques

In this final section of the chapter it seemed sensible to consider the degree to which farmers in the project area have begun to use more modern farming techniques, often essential for crop intensification and for the production of better quality produce. As it was not possible to consider all these techniques, anymore than the writer could examine all aspects of farm income and expenditure, he decided to focus on the presence of various machines on farms and the adoption of plastic covers for crops. Some mention is made of drip irrigation although this was largely dealt with, along with other watering techniques, in Chapter 3.

5.5.1 Machine Ownership

The typical farm in the project area is very small and often no more than 50 dunums (5 hectares) in area. With much of the farm work on these tiny farms still done by hand by the farmer and his helpers, it might not seem sensible or necessary to consider the level of ownership of machines by project farmers. But the author had noticed that some farm jobs such as ploughing, spraying and pumping now inevitably involve the use of machines while transport of goods to and from market generally involves the farmer in the use of motor vehicles. There is virtually no official data on machine use in the project area so that the author in his 1980 sample survey decided to ask farmers about their machine ownership as an indication of the introduction of more modern techniques. His survey enquired into the ownership of six items: a pick-up truck, lorry, tractor and trailer, automatic sprayer, rotary hoe and water pump. Because pickups and lorries perform much the same tasks those two groups were eventually joined together.

Motor vehicles

89 pick-up trucks were reported amongst the 353 sampled farmers, approximately one to every four farmers. The relatively large number of these trucks that have appeared in the area in recent years reflects their versatility in that they can perform most marketing jobs as well as acting as a family car and performing some basic farm jobs. Only 17 lorries were reported amongst the sampled farmers. As Table 5.11 shows, this gave some form of truck transport to just under a third of all farmers although there was some variation in levels of provision between sections, with more vehicles being available amongst sampled farmers in Section III. 72 tractors were also reported, with Section III again better provided for than other sections. 32 trailers, generally for use behind tractors, were also in use. Their relative infrequency probably results from a rapid decline following the widespread use of pickups.

Farm equipment

The survey revealed 117 automatic sprayers, giving one to every three farms (Table 5.11). Many more were found in the southern two sections where there was one sprayer on average to each 1.8 farms compared with less than 1 to every 6 farms in the north. In contrast the 51 rotary hoes found amongst the sampled farmers showed a distribution which made them much more common in the north than the south. They are most commonly used for cultivating between citrus and other fruit trees which are much more commonly found in the northern

TABLE (5.11) EAST GHOR CANAL PROJECT

DISTRIBUTION OF MACHINES AND THEIR RELATION TO THE NUMBER OF FARMS

	SECTION I		SECTION II		SECTION III		SECTION IV		TOTAL PROJECT	
	No. of Farms	No. of farms per machine	No. of	No. of farms per machine	No. of farms	No. of farms per machine	No. of farms	No. of farms per machine	No. of farms	No. of farms per machine
Pickup/Lorry	26	3.9	30	3.1	33	2.4	17	4.6	106	3.3
Tractor	22	4.6	15	6.2	19	4.2	16	4.9	72	4.9
Trailer	11	9.3	5	18.6	9	8.9	7	11.1	32	11.0
Sprayer	14	7.2	15	6.2	45	1.8	43	1.8	117	3.0
Rotary hoe	26	3.9	14	6.6	10	8.0	1	78.0	51	6.9
Water pump	7	14.6	18	5.2	13	6.1	6	13.0	44	8.0

sections of the project. Whereas there was one rotary hoe to each 3.9 farms in Section I, only one was found between 78 farms in Section IV. Hoes can be used for some other farm work such as tanker towing but would not be purchased just for this purpose. Lastly 44 water pumps were reported in the survey giving one pump to every 8 farms. These appeared to be most common in Sections II and III and are sometimes associated with drip irrigation installations.

5.5.2 The Adoption of Advanced Techniques

The recent introduction of two advanced farming techniques into the project area has also been examined in order to gain some further insight into the conditions under which farming methods are changing in the area. The two farming techniques selected for study were the use of plastic covers, either in the form of cloches or actual "houses" to protect the crops, and the use of drip irrigation in place of other more traditional methods of watering.[17]

5.5.2.1 General Characteristics of the Plastic Culture

The principal advantages of crop cultivation under plastic covers are to allow crops to mature earlier in the season when prices are higher and to increase crop yield per dunum, particularly by protecting crops from damage by frost, wind and rainstorms. Additional advantages include the possibility of timing the harvest and spreading out the harvest period to suit both market and farm labour conditions; to make it possible to tend the crops under all weather conditions without interruption and improving the quality of the harvested crop in the competitive and high value export markets. To set against these advantages are the cost of installing plastic covers, which can be as much as JD 1800 (£3,000) per dunum for plastic houses, and the possibility of increased crop disease owing to the high levels of humidity of plastic culture. These costs are much lower in the case of cloches but the advantages of cloches, in terms of raising crop yields and making farm work easier, are also far more limited.[18]

Generally the plastic houses consist of units of about 400 to 500 m^2 but can range in area from as small as 120 m^2 up to 800 m^2, depending on the length of the house.[19] Most provide a cover 7 or 8 metres wide and about 3 metres high in the centre, being made up of steel-framed arches on which polythene covers are fixed. Ventilation is provided by leaving gaps in the plastic when required while some types have built-in ventilators. The covers are high enough to allow nearly all of the soil they protect to be cropped and the crops are generally laid out in rows, possibly with supporting strings to give a greater density of crop cover for higher yields. Surface or drip irrigation systems can be used (Plates 7 and 8).

The much smaller plastic cloches or "tunnels" give the same sort of protected environment as the houses but are far smaller and less elaborate. They consist of sheets of polythene supported above the rows of crops on bent wire frames staked out at about 1 metre intervals and each giving protection to a strip of land about 1.4 metres wide. Most cloches cover rows of 40-50 metres in length. While being far less costly than plastic houses they have two major disadvantages. Because they stand only a metre or so high the strip of land that can actually be cropped under each is only about a metre wide, so wasting some bordering soil space. Tending the crop also involves extra labour in removing the polythene and putting it back after every agricultural operation apart from watering (Plates 9 & 10). That both the cloche and the plastic house can improve crop yields quite markedly is suggested by the results of two studies by Steitieh carried out in the East Jordan Valley in 1978 and 1980.[20] Using cucumber as the test crop since it is the crop most commonly used in plastic culture, Steitieh showed that plastic houses with drip irrigation gave cucumber yields of over eight tons per dunum, or about 10 times the yield given by traditional open field methods with surface irrigation. Plastic houses with surface irrigation produced yields seven times those of traditional methods but below those obtained with plastic houses and drip irrigation. Cloches and drip irrigation gave yields over 2½ times as good as open field methods, and cloches with surface irrigation were not far below these.

Plate 7.   Tomato cropped in a plastic house and irrigated by drip irrigation

Plate 8.   Cucumber cropped in a plastic house and watered by the drip method

Plate 9. Cucumber cropped under a cloche and watered by the drip irrigation technique

Plate 10. Cultivation under plastic cloches

With the considerable increase in crop yield, and hence profitability, obtained by these methods, they appear to have been rapidly adopted by a proportion of farmers in the East Jordan Valley and in the project area itself. Because much of the data on the spread and extent of this technique is limited in detail, the writer attempted to find out more about this in his sample survey. Data on the use of plastic houses and cloches was previously limited to surveys by the staff of the Faculty of Agriculture at the University of Jordan in 1978/9 and 1979/80.[21] These covered the whole East Jordan Valley and provided little detail on the use of the technique within the various parts of the project area.

5.5.2.2 The Crops Grown under Plastic

According to a survey made in the 1978/79 crop season by Steitieh, 11 different crops were observed in production under plastic covers although one of them, cucumber, was far more common than the rest but it is useful to differentiate crops grown under plastic houses and cloches. 90.6 per cent of all land then cropped under plastic houses was given over to cucumber with tomato, pepper and sweetmelon each accounting for only 3.7, 2.6 and 1.2 per cent respectively. Other crops occupying less than one per cent of the cropped area under plastic were eggplant, greenbeans, flowers, watermelon, marrow, jew's mallow and strawberries. Whereas Steitieh found about 670 dunums of land under plastic houses, there was about nine times that amount under cloches. Here 10 crops were observed in production. Again cucumber was easily the most dominant accounting for 80.4 per cent of the area with sweetmelon, marrow, pepper, eggplant and watermelon each taking up 5.0, 4.6, 2.9, 2.4 and 2.0 per cent of the area. Smaller areas of jew's mallow, green beans and okra were also found.

5.5.2.3 Geographical Distribution of the Plastic Culture

The first survey showed that a total of 6756 dunums of land in the East Jordan Valley was cultivated in 1978/9 under plastic (Table 5.12). 89 per cent of this was under cloches and only 11 per cent was under the more effective, but more costly, plastic houses. 56 per cent

TABLE (5.12) EAST JORDAN VALLEY:

DISTRIBUTION OF PLASTIC CULTURE BY TYPE OF IRRIGATION (IN DUNUMS) 1978/79

Type of Irrigation	East Ghor Canal Project (Stage I) Block 1-20	Block 21-24	Total Project	Southern Valley (Stage II)	Total East Jordan Valley
A. Plastic Houses	102.4	525.6	628.0	116.6	744.6
Drip	19.0	241.0	260.0	63.9	323.9
Surface	83.4	284.6	368.0	52.7	420.7
B. Cloches	22.0	346.0	368.0	5647.0	6015.0
Drip	-	67.0	67.0	1528.0	1595.0
Surface	22.0	279.0	301.0	4119.0	4420.0
Total	124.4	871.6	996.0	5763.6	6756.2

Source:- Compiled from Steitieh, A. (1980) pp. 26-27 of the land used under plastic was still irrigated by traditional surface methods. The two types of plastic covers had rather different patterns of distribution, however, within the valley. Cloches tended to be most common in the far south, beyond the limits of the project area whereas 84 per cent of the plastic houses were found within the project area, although most of these were in the southern parts of the project. That is, whereas there were 525 dunums of land under plastic houses in the southern blocks 21-24, representing 84 per cent of all the houses in the project area and 71 per cent of the entire valley, there were only 102 dunums in the areas to the north. These represented 16 per cent of the EGCP houses and 14 per cent in the whole valley. Drip irrigation was also less commonly in use with the plastic houses in the northern blocks than to the south.

Whilst cloches were far more commonly employed in the area of the valley to the south of the project area, the 368 dunums found in the project area - equal to only 6.1 per cent of the area of plastic cloches in the entire valley - were almost entirely in the southern blocks. As Table 5.12 shows only 22 dunums (6 per cent) of the cloches in the project area were reported in blocks 1-20 compared with 346 dunums (94 per cent) in blocks 21-24. Surface irrigation methods were much more common than drip methods with cloches.

In the 1979/80 crop season some 171 farms (or 4.6 per cent of all farms) in the project area were reported as making some use of plastic covers and Fig. 5.2 again shows the predominance of the southern blocks in their distribution. Block 24 had 31 per cent of all these farms in the project area and another 19 per cent were found in Block 20. Sections III and IV had many more of these farms than either of the northern sections.

In his sample survey in 1980 the writer collected some further data on the use of plastic covers and the spread of their use. While he found that 11.6 per cent of his sample (41 farms) reported the use of this technique, it is worth noting that the marked concentration of this technique in the more southerly parts of the project was again found.

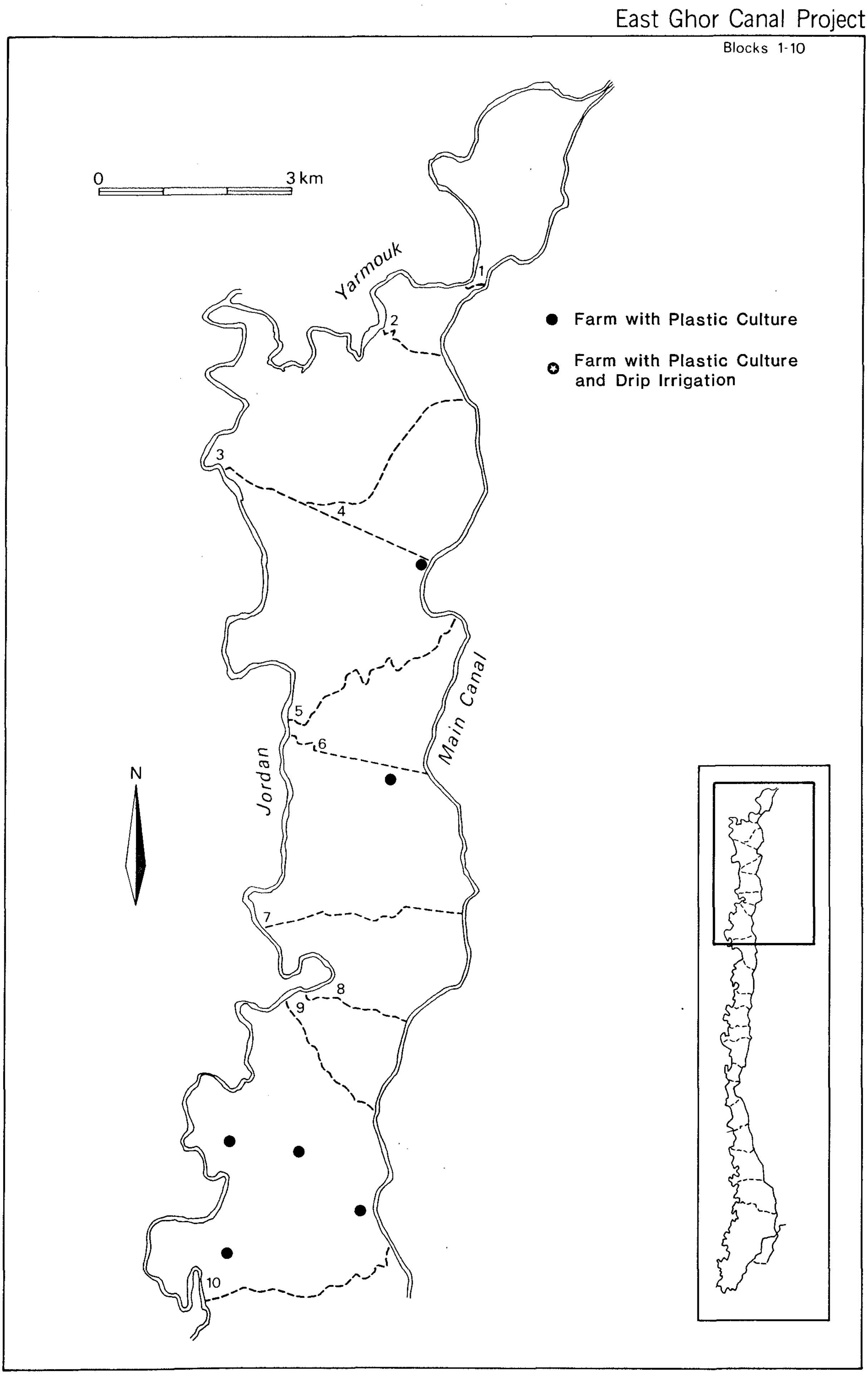

Fig. 5.2 EAST GHOR CANAL PROJECT: DISTRIBUTION OF FARMS WITH PLASTIC CULTURE, 1979/80

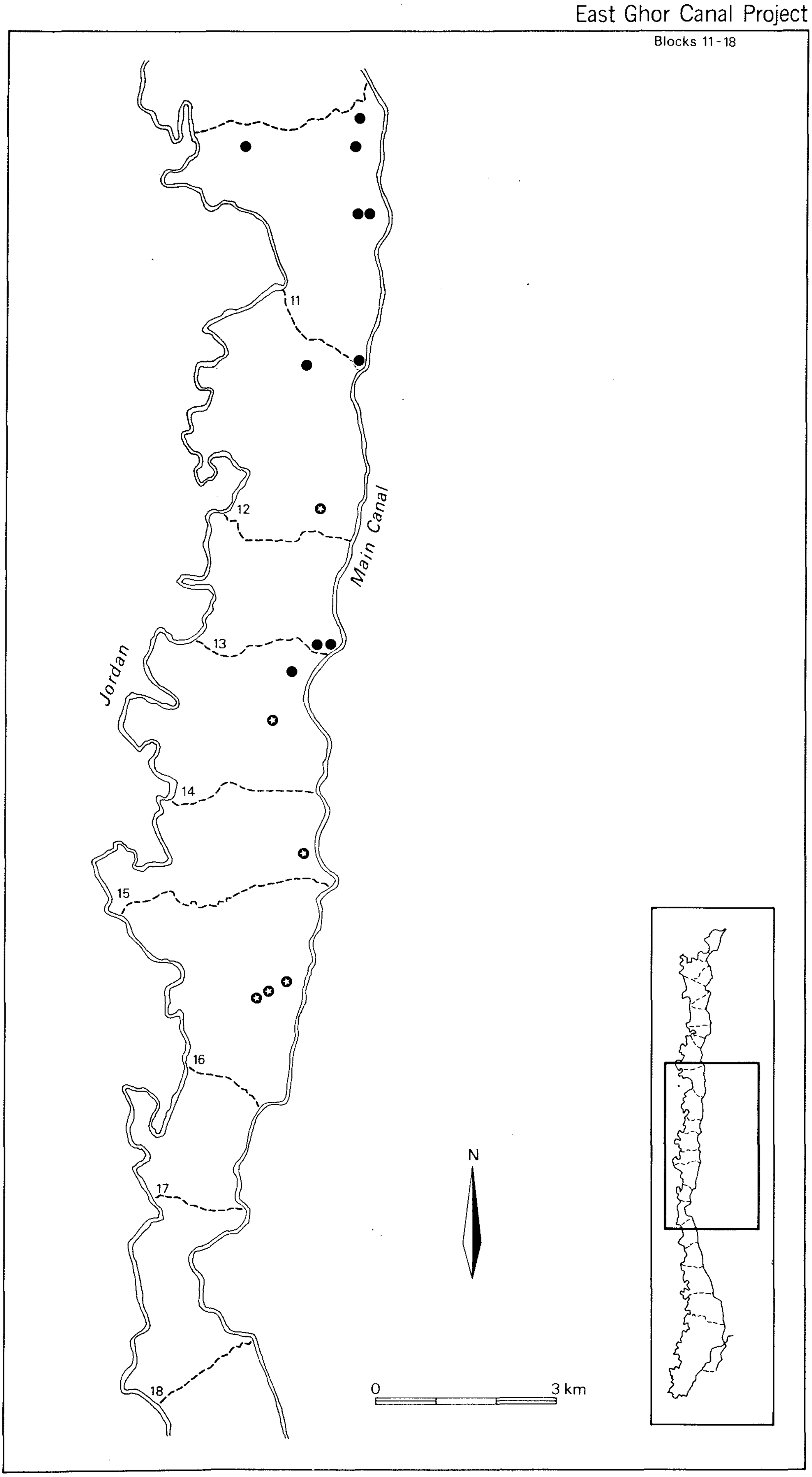

Fig. 5.2 continued

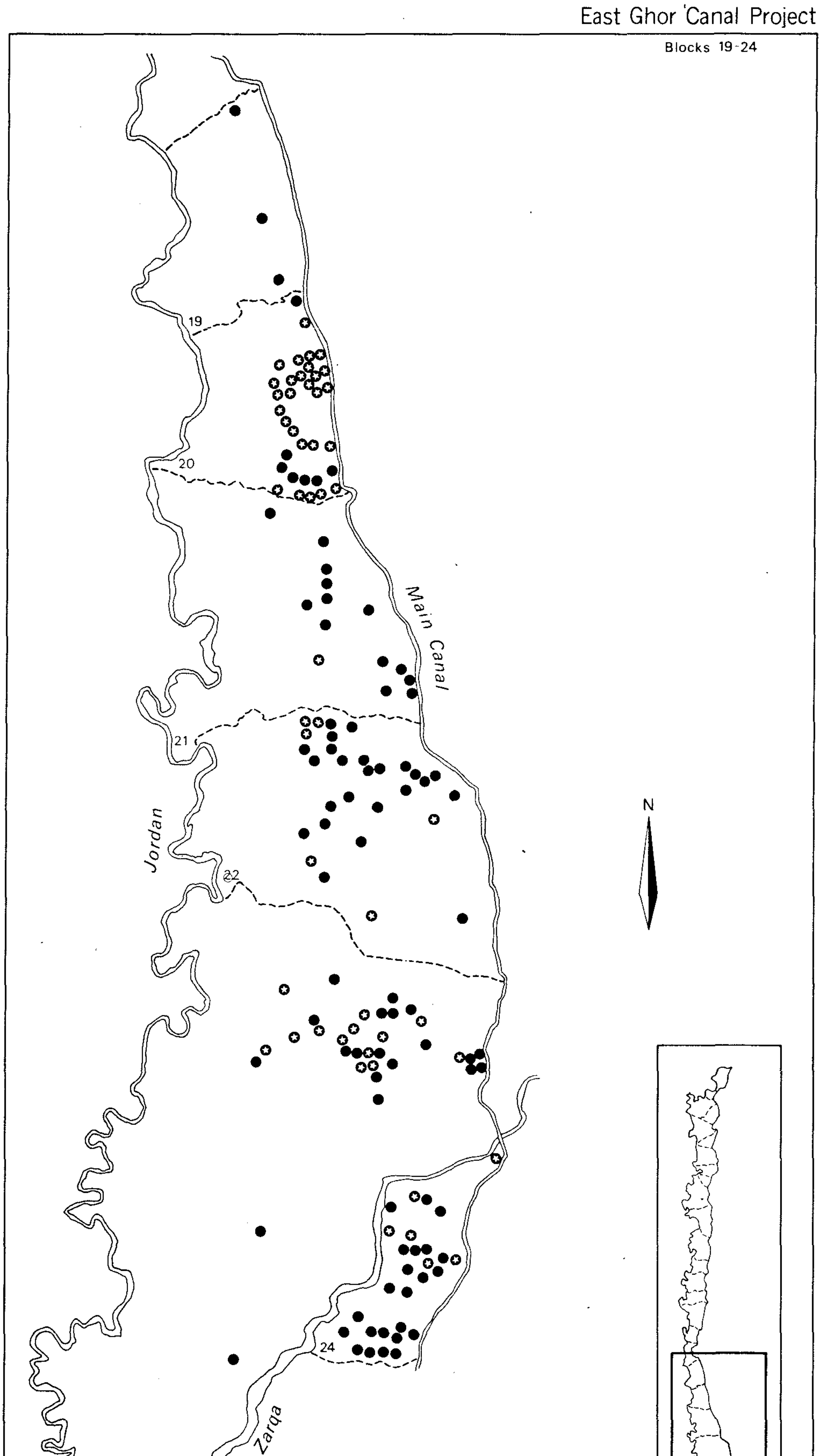

Fig. 5.2 continued

About half of the 41 farmers in the sample reporting the use of plastic covers were found in Section IV with the second highest number in Section III. As in the other surveys,drip irrigation was much less commonly used than plastic covers but was most often found in the southern section where the cost of water required greater economy in its use. Relatively few farmers throughout the project, however, used both plastic covers and drip irrigation but the use of both techniques together was more common in the southern than the northern sections as it can be seen in Fig. 5.2. No farms sampled in Section I used both techniques compared with 7.5 per cent and 9.0 per cent in Sections III and IV.

5.5.2.4 Diffusion of Plastic Culture

In his sample survey the writer also attempted to determine the rate at which the adoption of plastic covers had spread through the project area and what the farmers perceived as their advantages. The results showed that most farmers had adopted the technique very recently even though the first reported use of plastic covers in the project area dates from 1968 when the extension services established two plastic houses for cucumber and tomato production.[22] Even so 85.5 per cent of the author's sample of farmers who used plastic in 1980 reported that they had used the technique for only three years or less and half of them for only one year. Only four of the 41 farms had used plastic covers for five years and one farmer claimed he had started using them seven years before. Nearly all (92.7 per cent) of those sampled using the technique claimed that its chief attraction to them was the higher prices they could get from crops that yielded earlier in the season and a similar proportion (87.8 per cent) favoured the advantage of a higher income from crops that yield more abundantly under plastic. Ten farmers (24.4 per cent of users) stated that they had adopted it because it seemed to be fashionable. Other reasons given by a few farmers were that the crops benefited from the protection from the weather.

While many farmers considered they had learnt of the techniques from several places,82.9 per cent of the farmers said they were introduced to the technique by seeing other farms where it was in use. Only five farmers (12.5 per cent of the sample) stated that they had been introduced to it by the extension services but seven other farmers (17.1 per cent of the sample) claimed that they had learnt of the technique from the local research station which is run by the extension services. Two had heard of the technique from their agricultural supply companies and two others through their training as agronomists.

In terms of the further extension of the technique, 68 per cent of the 41 farmers using the technique expected to expand their area under plastic and 22 per cent had no such plans beyond keeping what they had. Two farmers had no views and two others expected to give up the technique.

5.5.2.5 Advanced Techniques in Relation to other Farmer Characteristics

The relationship between the application of these advanced techniques and 30 other variables was examined using the chi square test but significant relationships at the 95 per cent level of confidence (0.050) were found in the case of only five of the variables. These were:

	Level of significance
Co-operative membership	.0158
Crop marketing at Amman	.0047
Crop marketing at Wadi Yabis	.0021
Taking cash loans	.0010
Crop marketing at Sawalha	.0005

In some cases the statistical test was invalidated because the chi-square test conditions could not be met. Positive correlations were found between the use of advanced techniques and the taking of cash loans and membership of a co-operative. Such relationships are to be expected because farmers who adopt such techniques, often involving a high capital outlay, are also likely to take advantage of loan facilities and co-operative membership. Whereas 54 per cent of the total sample of farmers reported that they took cash loans, 78 per cent of those using an advanced technique were loan-takers. 84 per cent of those that used both techniques were using cash loans (see Table 9.11). Similarly whereas only 47 per cent of the sampled farmers were co-operative members 62 per cent of those that used either of the two advanced techniques claimed this membership. No less than 10 of the 13 farmers (77 per cent) that used both techniques said they were members of co-operatives as it can be seen in Table 10.20.

Positive and significant correlations were found between farmers who employed the advanced techniques and those that used the three markets of Amman, Wadi Yabis and Sawalha. The only reason for this seems to be that the use of advanced techniques is much more common in the southern parts of the project area where the farmers most often use those markets.

This chapter has covered a wide range of features related to the social and economic characteristics of the farm population of the valley, focusing particularly on the 10 per cent of the project farmers used in the writer's sample. From these data sources it is clear that there is considerable diversity amongst this group of small farmers both in terms of their social background, the income and expenditure levels, and their farming methods. Some of these variations appear to operate spatially. It seems appropriate, then, to continue the examination of several aspects of the farms and the farmers' behaviour beginning, in the next chapter, with the crop patterns.

Notes and References

1. The socio economic surveys containing data on the project area were:
   Jordan, Department of Statistics (1961) The East Jordan Valley: A Social and Economic Survey, Amman, Department of Statistics.
   Jordan, Department of Statistics (1973) Social and Economic Survey of the East Jordan Valley, Amman, Department of Statistics.
2. Dajani, J. et al (1980) An Interim Evaluation of the Jordan Valley Development Effort: 1973-1980, US-AID, Project No. Evaluation 278-0181.
3. Jordan, Department of Statistics (1982) Housing and Population Censuses, 1979, Summary Results for Localities in the East Bank, Amman, Jordan, 56, 60-61.
4. Ibid.
5. Dajani, J. et al (1980).
6. Jordan, Department of Statistics (1982) Ibid.
7. The chi-square test would not be valid if the number of cells with expected frequencies less than 5 are above 20 per cent.
8. Department of Statistics, Jordan (1973) supra.
9. Department of Statistics, Jordan (1961) supra.
10. Less than 5 per cent of households reported that they had lived in their houses for more than 15 years and over one third of respondents stated that they neither rented nor owned the homes they occupied.
11. No data was collected, for example, on toilets, water supply or lighting whereas more data was collected under other headings.
12. Dajani estimates that a half of all valley homes were lost in the 1967 war and the following skirmishes in the area, Dajani, J. (1980) 166.
13. To qualify for these a family had to prove title to the land it occupied, which many were unable to do and any new home planned had to include a kitchen and a bathroom which raised the cost above what many could afford. As a result only 19 loans had been provided under this fund by 1980.

14. Because the cropping season was not yet over when the author conducted his survey in April 1980 it seemed sensible to collect this expenditure data for the previous year.
15. During the first fieldwork study carried out by the author in the Autumn of 1978, he noted that only one farmer out of 156 interviewed had kept records of farm income and expenditure.
16. The application of plastic culture and drip irrigation, which are concentrated in the southern two sections, may be responsible at least partly for higher farm expenditures.
17. Further details on the drip irrigation technique were given, alongside those for other watering systems, in Chapter 3.
18. Al-Taji, N. (undated) The Protected Agriculture: Vegetable Production under Plastic Cover, Jordan, Ministry of Agriculture, Dept. of Research and Agriculture Advisory (in Arabic).
19. Steitieh, A. and Musa, A.H. (1980) Vegetables Grown under Plastic Covers and Drip Irrigation Systems in the East Jordan Valley, Amman, Faculty of Agriculture, The University of Jordan, 28.
20. The two studies are:
    Steitieh, A. and Musa, A.H. (1980), supra and
    Steitieh, A. and others (1978) A Manual for the Main Vegetable Crops Grown in the East Jordan Valley, Amman, Faculty of Agriculture, University of Jordan.
21. Ibid.
22. Al Taji, N. (undated) Ibid.

CHAPTER 6 ANALYSIS OF LAND USE AT THE BLOCK LEVEL

6.1 Data Collection and Description

Earlier visits to the area had suggested that the pattern of cropland use was varied across the East Ghor Canal Project area and has shifted significantly from year to year since the inception of the scheme in 1962. It therefore seemed sensible to try to make some measurement and assessment of these spatial and temporal variations.

At the broadest scale the crop data contained in the agricultural censuses of the ghors, which have been carried out annually since 1971 by the Department of Statistics, could provide some indication of these trends. But as these only divided the East Jordan Valley up into two broad units, the northern and middle ghors, no detailed analysis of the spatial pattern of crops is possible from this source. Furthermore only certain major crops are recorded in these surveys. Also as each annual census has only been based on a random sample, which varied from year to year, doubt must be cast on the value of this data for year by year comparisons.

More detailed analysis of crop patterns is, however, possible by using the crop data records of the East Ghor Canal Authority which have been collected monthly since 1965 to give the Authority some indication of water needs, particularly in the summer when irrigation demand often exceeds supply. Monitoring crop trends from such data allows the Authority to estimate likely water requirements within each of the 23 blocks of the scheme and in theory to control the crop pattern in keeping with the Authority's plan, by requiring farmers to obtain a license to grow certain crops (notably citrus, banana and alfalfa) which have high water requirements.[1]

These crop data are collected each month by the Authority's 140 water-distributors, who, being responsible for the supply of irrigation water to individual holdings, are familiar with the farmers in their area and can therefore obtain accurate records of the area of their land under each crop. On extracting the data from the files at the Authority's head office at Deir Alla, the writer did, however, find a number of deficiencies in these records. Data for some months and some blocks were occasionally missing and the totals given for some blocks did not always agree with their component farm units. Since many of the records had been written up in the field, some entries were unclear. Several of these data problems could be dealt with by cross-checking and re-totalling but data for certain months had to be discarded because it was incomplete. In addition because it took seven weeks to extract only part of this data it was decided to concentrate on four representative months in each of the 15 years (1965-79) for which records were available. The data for January was collected and analysed since it represents a period of the year when conditions, including a plentiful supply of irrigation water, are favourable for more intensive land use. Data for July represents the dry period when crop land use is least intensive and irrigation water is in short supply. The April and October data were selected to represent the transitional seasons.

These data have been used to provide the basis for an examination of the spatial and temporal variations in land use across the Project area for the 15 year period (1965-79) by two main approaches:-

1) an analysis of crop combinations,
2) an analysis of the patterns and changes in the areal dominance of individual major crops.

Because of the manner in which the original crop areas were recorded it was decided to use the data as already grouped within the existing blocks rather than regroup the farm data into new areas for the purpose of this part of the study. It will be noted, however, in Table 6.1 that the blocks vary greatly in size. For example Block 23 covers 41,593 dunums and includes 744 farms in contrast to block 2 with only 1054 dunums and 30 farms. Table 6.1 also gives the area and number of farm units in each block and section. Although 24 blocks are listed Block 3 is unused so that data only exists for 23 blocks.[2]

6.2 Method of Analysis

Crop combination analysis can be used to indicate more clearly the nature of the agricultural land use pattern in an area. It can be assumed that since farmers in a relatively small and uniform area, like

TABLE (6.1) EAST GHOR CANAL PROJECT

VARIATION OF BLOCK SIZES AND NUMBER OF FARMS

BLOCK NO.	TOTAL FARMS	AREA OF FARMS (dunums)	AV. AREA OF FARMS (dunums)
Section I	985	37204.567	37.77
1	101	3515.158	34.88
2	30	1054.660	35.15
4	97	2997.676	30.90
5	152	6321.465	41.59
6	81	2739.295	33.82
7	157	5789.748	36.88
8	92	3308.226	35.96
9	37	1752.357	47.36
10	238	9725.982	40.86
Section II	991	45327.003	45.73
11	218	7813.754	35.84
12	192	7983.855	41.58
13	96	3940.413	41.05
14	126	6448.301	51.18
15	116	5009.647	43.18
16	151	6777.161	44.88
17	59	3378.076	57.25
18	33	3975.796	120.48
Section III	852	40114.083	47.08
19	105	6525.864	62.15
20	120	6602.322	55.02
21	282	12103.380	42.92
22	345	14882.517	43.14
Section IV	845	46044.697	54.49
23	744	41593.029	55.90
24	101	4451.668	44.08

Source:- East Ghor Canal Project Records (compiled).

the blocks in the project will tend to concentrate on certain crops suitable to the particular conditions, then the combination derived from the common crops in that area will reflect the general character of the crop range found in that area. A combination can be stated in terms of the main individual crops or in terms of classes of crops such as fruits, vegetables and field crops. In this study combinations have been determined on individual crops since the number of such crops is limited, but at a later point in the study crop classes are used.[3]

A numerical method for crop combination analysis was first devised by Weaver in 1954 to analyse variations across the agricultural regions of the American Middle West.[4] To derive the actual combination in each area he compared the percentages of the cultivated land under various major crops in the area with an abstract set of percentages related to the number of crops in the combination. For instance, theoretically in a 5 crop combination 20 per cent of the land could be given over to each of the 5 crops, 33.3 per cent in a 3 crop combination, and so on. Although such equal shares would not exist in the real world, the actual percentage crop areas in an area could be compared with these theoretical percentages as a means of defining the number of crops that make up the combination as well as stating what crops they are. Making this comparison between theoretical and actual percentages involves the application of the statistical variance given in the formula:

$$\sigma^2 = \frac{\sum d^2}{n} = \frac{\sum (Xi-\bar{X})^2}{N}$$

where d = the difference between the theoretical and the actual percentage under each crop.

$\bar{X}$ = the actual percentage under the crop

Xi = the theoretical percentage under the crop

N = total crops in the area being studied.

The variance of the actual percentages from the theoretical is calculated for each possible combination (1 crop, 2 crop, 3 crop etc.) and the actual combination which exhibits the least variance from the theoretical defines the length of the combination for that geographic area. The particular crops in that combination can then be noted and ranked according to their importance.

Three other geographers have made modifications to the Weaver approach which had to be considered in the development of a method appropriate to the present study. In 1957 Scott, in a survey of crop and livestock combinations in Tasmania, established combination regions in a way that differed from Weaver in the application of the procedure for the definition of the major crops.[5] In particular Scott gave speciality crops, which might represent only a small percentage of cropped area but a larger proportion of farm income, more prominence in the analysis. This could have been of relevance to the present study area where small areas of high income crops, like vegetables, often share land with large areas of lower income crops, like cereals, but, unfortunately, Scott did not sufficiently specify how he weighted data for these speciality crops whilst retaining crop area as the basic means of ranking crops. It was therefore decided not to attempt crop weightings in the present study. In a similar modification of the Weaver method, Coppock applied crop combination analysis to United Kingdom data.[6] He developed a modification of the Weaver method in order to consider a wider spectrum of agricultural activities, notably livestock keeping, as well as cropping. He did this by reducing crops and livestock to a common set of units and also differentiating between various intensities of production introducing weighting factors based on the labour requirements of different activities. In the present analysis, however, it has not been found possible or worthwhile to adopt any of the Coppock modifications because livestock form only a very minor part of the farm enterprises in the Project area and because there is an insufficient data base on which to apply satisfactory weightings to allow for variations in labour or other inputs.

A third modification of the Weaver approach by Thomas did seem more relevant, however, to the present study and has been applied to the data. Essentially the Thomas method tries to make fuller use of the available data.[7] As Thomas has pointed out in comparing his form of analysis with Weaver's, if one had an area where the 5 principal crops occupy 47, 19, 15, 9 and 8 per cent of the cropped area, the Weaver method for assessing this, as a possible 2 crop combination, would be based on the measurement of variance of the two main crop areas

(47 and 19) from the 50 per cent area that each would occupy in a theoretical two crop combination. Hence the Weaver method would calculate the result as

$$\frac{(50 - 47)^2 + (50 - 19)^2}{2} = 485$$

The score of 485 would then be compared with scores obtained for a 3, 4 and 5 crop combination in a similar manner to find which combination gave the smallest variance from the theoretical. This would then define the appropriate combination for that area. In contrast using the Thomas method in testing for a 2 crop combination on the same data, one would compare the variance between the actual areal percentages of the 5 crops and a set of 5 theoretical percentages of 50, 50, 0, 0 and 0. The result is therefore:

$$\frac{(50 - 47)^2 + (50 - 19)^2 + (0 - 15)^2 + (0 - 9)^2 + (0 - 8)^2}{5} = 268$$

Because the Thomas method would seem to give more meaningful results in areas with fairly complex crop combinations, as in the ghor, it has been applied to the analysis of the data in this part of the study.

Initial inspection of the data showed considerable variation in cropping characteristics from year to year, over the 15 years so that it was decided to use data for all years rather than for a sample which might not be representative of those years on either side of the selected years. This again contrasts the present study with the handling of data for crop combination analysis by the other workers mentioned. Thomas only analysed crop combinations in Wales for one year and made no attempt to establish temporal trends from it, while Weaver chose one year each decade between 1919 and 1949 to represent the changes in combinations in the Middle West over that period.

Analysing and presenting land use data on a crop combination basis for each of the 23 blocks of the project area over a run of 15 years has also created problems of presentation. After a pilot study, conducted before the complete data set was available and based on a few selected years, it was decided:

1) to compute the crop combinations by the Thomas method for each of the 23 blocks and for each of the years between 1965 and 1979. To do this the author developed a computer programme to handle the mass

of data. A list of the programme and its method can be found in Appendix 3.

2) to divide the 15 year run of data into three periods, each of 5 years, in order to provide a convenient aid to discussing the trends revealed in the analysis. These were 1965-9 (the late 1960's); 1970-4 (the early 1970's); and, 1975-9 (the late 1970's).

6.3 Results of Crop Combination Analysis at the Block Level

The results derived from the crop combination analysis can be examined in a number of ways in order to detail and interpret both the spatial patterns and the trends over time which they reveal. There are not only the crops in the combinations but the length of the combinations to consider.

The length of the crop combinations can be usefully considered as a measure of crop diversification. Variations in combination length between different blocks of the project area can reflect a number of factors influencing local farming conditions, such as differing land quality and water availability. Changes in combination length from year to year and from season to season are also of interest but need careful analysis. Combination lengths can sometimes change as certain crops become more or less important in an area without any variation in the number of crops grown. Similarly, variations in the availability of irrigation water can mean that in summer perennial crops, like citrus, appear dominant in very short combinations when little land may be given over to vegetables or other annual crops. In winter, however, without any change in the area devoted to it, citrus can appear with many more vegetables alongside it. As a result the calculated combination can lengthen without any change in the area devoted to the main citrus crop.

Trends in combination lengths over the space of several years will often reflect major factors of changing farm techniques or changing market value of different crops. The relative success or failure that farmers had with a crop in one year may help determine if the crop is planted the following year, or is replaced by another, and left out of the crop pattern altogether, hence shortening the combination. Outside factors can play a part. The disruption to farming in the ghor following the 1967 Arab-Israeli war and the subsequent border incursions was followed by much shorter crop combinations in much of the project area between 1967-71 because farmers were less able to plant and maintain annual crops and relied instead on a restricted range of perennials.

The crops that make up most of the combinations include staples like cereals, notably wheat, a range of perennial fruit crops, notably citrus and banana, and a wide range of annual vegetables. These combinations can also be examined to determine the common groupings across the project area in order to further recognise the main types of farm enterprises. It must be made clear, however, that just because a number of crops make up the combination in a block they do not necessarily occur together on most of the farms in that block. That is, combinations of crops are not the same as farm enterprises which are discussed in Chapter 7. But given the wide range of combinations that could exist in the valley, compared with the limited range that has been shown to exist, it is reasonable to assume that there is considerable similarity between the crop combination of a block and the actual farm enterprises that operate in that block. Data for selected blocks, referred to later, based on crop areas on individual farms would tend to confirm that the crop combination of a block is a good guide to what group of crops most farmers in that block are growing, rather than being some abstract statistical summary with little real relevance to what is happening on the ground.

6.3.1 Crop Combination Length

It has already been noted that the length of crop combinations can be usefully examined for variations in several ways: spatially across the project area, as a result of various geographical influences upon the range of crops grown; temporally because, during the 15 year period under review, one might expect changes in cropping emphasis; and, seasonally because, while a year-long growth season allows some farmers to double-crop, others are much more restricted by water shortages to the winter season cropping. For this latter reason it is convenient to treat each main season separately and to consider the winter pattern first as the time of more intensive cropping, taking data for January as representative for this. Temporal changes in crop combination length for the project area over the winters of 1965-79 will be considered first.

6.3.1.1 The Winter Pattern

January crop combinations generally lengthened over those 15 years indicating a trend towards more cropping diversity and less reliance placed by many farmers upon a few dominant crops. Table 6.2 summarizes those crop combination lengths and shows a general trend towards longer combinations over the study period. Combinations were generally short in 1965 but in the late 1960's 3 or 4 crop combinations became more common. This was followed by a partial retreat in the early 1970s. Some new shorter combinations appeared in the last few years of the period alongside blocks with long combinations. In 1965 at the start of the study period 5 of the 22 blocks had just one crop as their "combination". 12 other blocks had only 2 crops each. Only 5 blocks had combinations of 3 or more crops although it should be noted that 3 of these blocks ran combinations with 5 crops apiece. As Table 6.2 shows in no year since 1965 have as many as 5 blocks again recorded single crop combinations while the number with dual crop combinations fell rapidly after 1967 and again in 1975. By then single crop combinations disappeared entirely. Although it can be noted that 2 blocks returned to single crops in 1978, and in 1979 more blocks again returned to dual crops, this seems to represent a new trend rather than a return to the previous situation because the blocks that have recorded these shorter combinations in recent years - mainly in the northern part of the project - appear to be undergoing a new phase of crop specialisation mainly focused on intensive citrus production.

As a result of this trend away from shorter crop combinations, with the exception of the final 3 years noted above, more blocks have adopted multi-crop combinations, in some cases of a complex form. In 1965 5 of the 22 data blocks had combinations of 3 or more crops.

TABLE (6.2) EAST GHOR CANAL PROJECT: CROP COMBINATION LENGTH BY BLOCK, JANUARY, 1965–1979

Crop Combinations Length in January, 1965–1979

Year / Block No	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	2	2	2	2	2	2	2	2	2	2	3	2	1	1	1
2	2	1	2	1	3	1	1	2	3	5	4	4	2	1	1
4	5	6	5	6	5	3	4	3	4	5	4	3	2	2	3
5	5	4	4	3	4	3	3	5	5	5	4	3	3	3	4
6	5	5	3	5	3	4	4	4	3	4	3	3	3	3	2
7	3	3	3	2	2	3	3	3	3	4	3	7	3	2	3
8	2	3	2	2	4	4	5	3	2	2	4	4	5	5	5
9	1	1	1	1	4	3	3	1	1	1	3	5	6	7	6
10	2	2	2	3	3	2	2	2	2	2	2	2	2	2	2
11	1	2	5	2	3	5	1	1	1	2	4	4	3	5	5
12	2	2	2	2	2	1	2	2	2	2	3	3	2	2	2
13	2	2	2	4	5	6	3	1	1	3	3	4	5	4	5
14	2	1	2	3	5	2	3	3	2	4	3	3	3	4	5
15	1	2	4	4	3	2	2	4	4	6	4	4	4	4	4
16	1	2	2	3	4	2	4	3	5	4	5	5	3	4	4
17	1	2	2	3	3	1	2	2	4	2	3	3	2	2	3
18	2	6	4	4	2	1	2	2	5	4	4	3	4	4	3
19	2	2	2	3	*	3	4	4	4	5	7	6	5	6	5
20	3	2	3	3	*	3	3	3	3	4	4	6	6	4	3
21	2	2	2	2	*	2	2	2	2	2	2	5	5	6	4
22	2	2	2	2	*	2	2	2	2	2	2	3	8	8	8
23	2	2	2	2	*	2	2	2	*	2	2	2	2	2	5
24	*	*	2	1	*	3	3	3	3	3	4	4	3	5	6

* No data available

By 1968 this had risen to 12 blocks. 1976 was the peak year for crop diversification with 20 blocks having combinations of 3 or more crops, some of them of considerable length. A 7 crop combination appeared for the first time in 1975 and an 8 crop pattern in 1977. Since 1977, as had been indicated, there has been some retreat towards shorter combinations in some blocks although in others long and diverse combinations have continued. In 1979, the last year of the study period, 9 of the 23 blocks had combinations of 5 or more crops, the highest number of any year in the 15 years and three times the number of blocks of this type in the first year of the date period.

This trend towards more diverse cropping reflects, as will be seen in more detail later, the more widespread adoption of a range of specialist vegetable crops being grown alongside the dominant citrus crop. This is in marked contrast to the combinations found in the early years which were shorter because they were essentially based on one or more of three crops - banana, citrus and cereals. A later part of this chapter will consider how this switch from a standard set of crops to a much wider range occurred.

When one considers spatial aspects of the January crop combinations it can be seen that the trend towards more diverse cropping did not occur uniformally over the whole area. Similarly the move towards shorter, specialist combinations noted in recent years has only occurred in a few northern blocks. Fig. 6.1 summarises the main patterns and trends for the alternate years between 1965 and 1979. It can be seen that in the early years when longer crop combinations were less usual, they were largely confined to four blocks (Nos. 4-7) in the north, where the greater availability of water supplies made crop diversification both possible and advisable, and where farmers had had sufficient farming experience in the scheme to allow several crops to be grown. Even so the two most northerly blocks did not diversify from their specialisation in banana in the early years and citrus in later years.

The more patchy occurrence of longer combinations in various central and southern blocks in the years up to 1971 largely reflected relatively small changes in the area devoted to particular crops so that some blocks were shifting from one length of combination to another almost

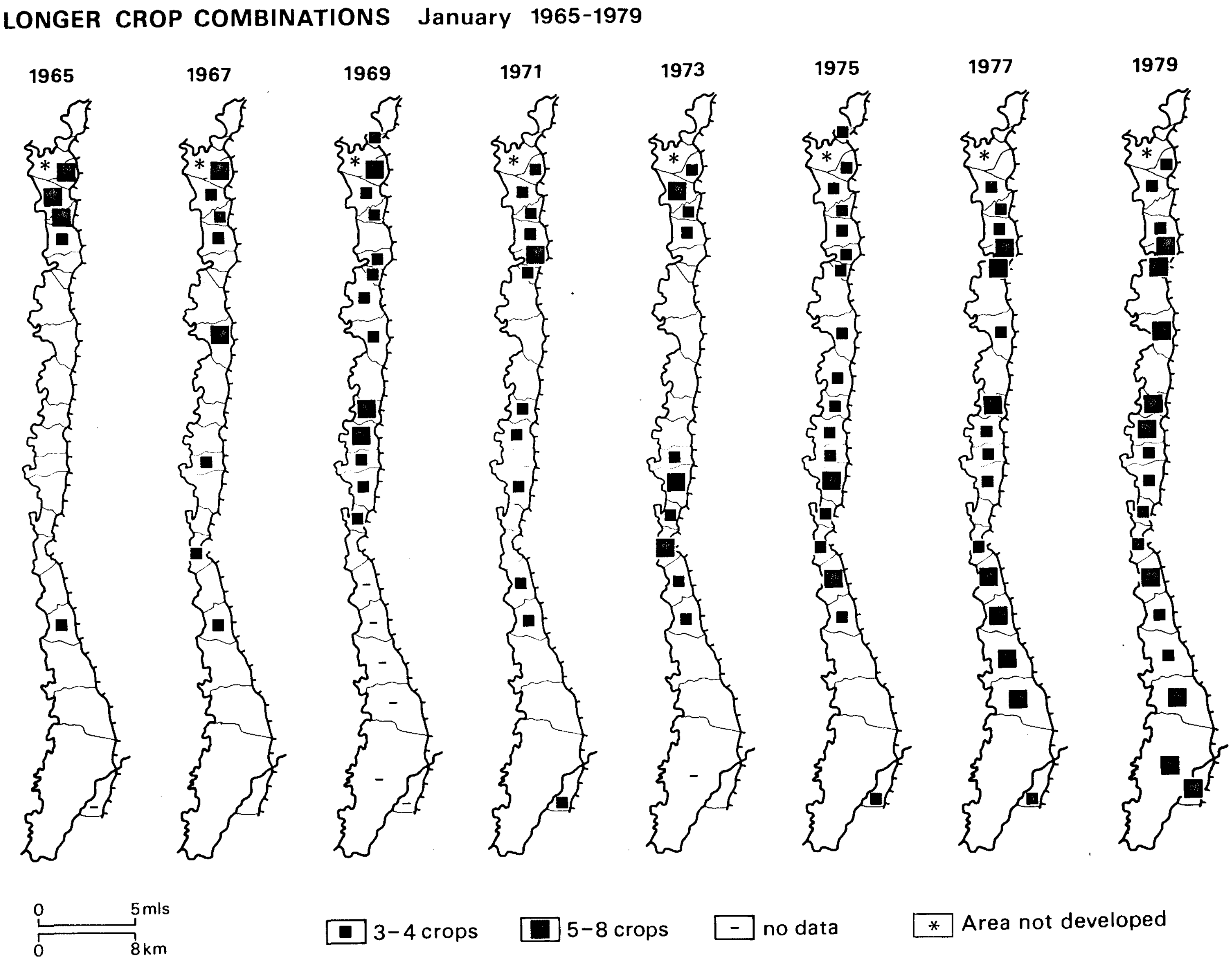

Fig. 6.1 EAST GHOR CANAL PROJECT: CROP COMBINATION LENGTH, JANUARY, 1965-1979

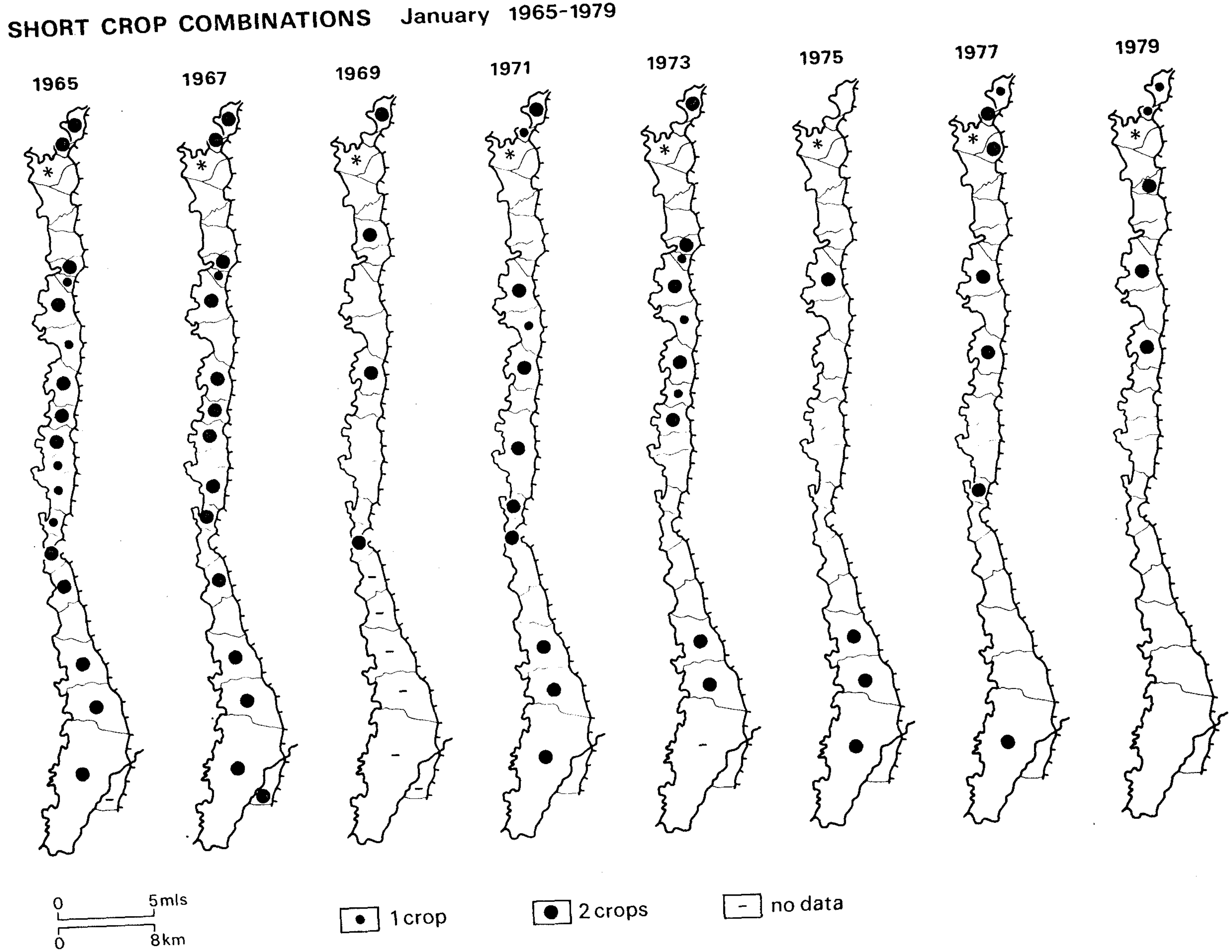

Fig. 6.1 continued

every year. It is noticeable (Fig. 6.1) that from the early 1970s a small but growing group of southern blocks, centred on Blocks 19 and 20, underwent a more permanent change towards longer combinations. In time blocks neighbouring these, first to the north and then to the south adopted more crop diversity. As a result, then, one can see that longer crop combinations evolved in two areas of the project, first in the north, and more recently in the south. Certain central blocks notably 12 and 17, only shifted towards slightly more diverse cropping much later in the study period while Block 23, in the far south retained its short combinations until towards the end of the period, while Blocks 1 and 2 in the far north have never really diversified.

It can also be noted that there have not only been spatial variations in this general trend towards longer crop combinations, but the rate of lengthening has also varied from block to block. Some northern blocks which had longer combinations right at the start of the data period have not increased the length of their combinations and in some cases have decreased them, although the crops involved have been changed. In contrast some southern blocks, like 19 and 20, progressively lengthened theirs as additional crops were introduced into their farms.

Table 6.3 attempts to summarize these spatial changes in combination lengths by comparing for each block the average combination length of each 5 years of the data period. From this it is clear that average combination lengths were shorter in the early run of years than in the last 5 years, with only two groups of blocks (nos. 1, 4-6, and 10-11) having longer combinations in the January months of earlier years. The northern group had longer combinations than the southern group. In all other cases mean values for combinations for 1975-9 were higher than for the earlier years, with certain blocks, like 22 having a very high mean in 1975-9 compared with its mean for the earlier years. In nearly all cases, as has been noted, this lengthening of crop combinations reflects the introduction of a wider range of vegetable crops into the farm regimes whereas, in these few cases where crop combinations have shortened, this results from an increased specialisation focused on

TABLE (6.3) EAST GHOR CANAL PROJECT:

SUMMARY OF CROP COMBINATION LENGTH TRENDS, 1965-1979

	JANUARY				APRIL				JULY				OCTOBER			
Blocks	1965-69	1970-74	1975-79	1965-79	1965-69	1970-74	1975-79	1965-79	1965-69	1970-74	1975-79	1965-79	1965-69	1970-74	1975-79	1965-79
1	2.0	2.0	1.6	1.9	2.0	2.0	1.4	1.8	2.0	1.8	1.0	1.6	2.2	2.2	1.2	1.9
2	1.8	2.4	2.4	2.2	1.4	2.6	3.0	2.3	1.0	1.2	1.2	1.1	1.4	2.8	1.6	1.9
4	5.4	3.8	2.8	4.0	4.6	3.2	3.2	3.7	3.2	3.2	2.2	2.9	4.2	3.8	3.0	3.7
5	4.0	4.2	3.4	3.9	4.0	4.0	3.4	3.8	2.0	3.0	2.2	2.4	3.6	3.8	3.4	3.6
6	4.2	3.8	2.8	3.6	4.2	4.4	3.6	4.1	3.6	3.2	2.0	2.9	3.4	3.4	2.0	2.9
7	2.6	3.2	3.6	3.1	2.8	4.4	2.6	3.3	2.2	3.2	1.6	2.3	2.2	3.0	2.0	2.4
8	2.6	3.2	4.6	3.5	2.2	3.4	3.8	3.1	2.8	3.4	3.2	3.1	3.2	4.0	2.8	3.3
9	1.6	1.8	5.4	2.9	1.0	1.6	5.2	2.6	3.8	4.0	4.2	4.0	4.0	3.6	3.6	3.7
10	2.4	2.0	2.0	2.1	2.0	1.8	2.8	2.2	3.0	2.6	1.2	2.3	3.4	1.8	1.4	2.2
11	2.6	2.0	2.4	2.9	1.4	2.0	4.5	2.5	4.0	3.6	2.8	3.5	5.8	5.8	3.6	5.1
12	2.0	1.8	2.4	2.1	2.0	2.2	2.5	2.2	1.6	1.8	1.4	1.6	1.8	2.8	2.0	2.2
13	3.0	2.8	4.2	3.3	2.2	4.2	4.5	3.6	2.2	2.6	2.2	2.3	4.0	3.0	4.4	3.8
14	3.3	2.8	3.6	3.0	2.6	2.8	3.3	2.9	2.4	2.0	1.8	2.1	3.8	3.4	3.4	3.5
15	2.8	3.6	4.0	3.5	3.8	3.4	3.2	3.5	2.0	2.2	1.4	1.9	3.2	3.0	2.2	2.8
16	2.4	3.6	4.2	3.4	2.2	3.6	3.0	2.9	3.4	2.0	2.2	2.5	3.4	2.4	2.4	2.7
17	2.2	2.2	2.6	2.3	2.0	1.8	1.3	1.7	2.6	1.8	2.0	2.1	2.6	1.4	2.2	2.1
18	3.6	2.8	3.6	3.3	3.8	2.2	1.8	2.6	2.8	1.6	2.2	2.2	3.0	4.5	4.6	4.0
19	1.8	4.0	5.8	4.1	3.0	4.2	4.8	4.0	2.6	2.4	2.2	2.4	3.2	5.2	6.4	4.9
20	2.2	3.2	4.6	3.6	3.0	4.0	3.8	3.6	1.2	1.2	1.2	1.2	2.2	4.4	4.0	3.5
21	2.0	2.0	4.4	2.9	2.0	3.0	3.4	2.8	2.6	2.6	2.2	2.5	1.6	2.4	5.6	3.2
22	2.0	2.0	5.8	3.4	2.0	3.5	5.6	3.7	3.4	2.4	2.6	2.8	1.6	4.0	5.3	3.4
23	2.0	2.0	2.6	2.2	2.0	2.3	3.6	2.6	2.8	2.0	2.8	2.5	1.0	1.5	3.8	2.1
24	1.5	3.0	4.4	3.3	2.3	5.2	4.3	4.2	1.0	2.4	2.3	2.0	1.8	3.8	3.0	2.8

one or two main crops such as citrus or tomato. The details of these crop patterns will be considered later.

6.3.1.2 The Summer Pattern

The July pattern of crop combinations provides a marked contrast in several wasy to the January pattern. First and not unexpectedly, the combinations were generally shorter because of the limitations imposed by water supply upon more varied cropping and more intensive land use. Shorter combinations were most common, as will be seen, in the more hot and arid central and southern parts which are most restricted by shortages of irrigation water supplies. Second and rather less easy to explain, one finds a considerable and rather haphazard pattern of variation in the length of crop combinations over the data period.

In general, as can be seen in Tables 6.3 and 6.4, there has been a trend towards shorter combinations in recent years which is the reverse of the trend shown for winter cropping. This trend speeded up in the last few years of the period. Whereas 8 of the blocks recorded combinations of only 1 or 2 crops in 1965, in 1979 no less than 20 blocks were in this category. In every year except 1965, the first year in the data set, blocks with only 1 or 2 crop combinations have been more numerous than those with 3 or more crop combinations. 3, 4 and 5 crop combinations which were found in some blocks at the start of the study period had virtually disappeared by its end. Indeed the crop pattern in the project area in general in 1965 was more diverse, with more longer crop combinations, in summer than it had been in winter. Whereas there were only 5 blocks with combinations of 3 or more crops in January 1965, there were 13 blocks with that type of combination in July. Yet the situation changed completely soon after with the winter cropping pattern becoming more diverse and the summer pattern becoming more and more dependent on one or two main crops. This reduction in length of summer crop combinations was most marked in particular years, notably 1968-70, 1974-5 and 1978-9.

TABLE (6.4) EAST GHOR CANAL PROJECT: CROP COMBINATION LENGTH BY BLOCK, JULY, 1965-1979

Block No.	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	2	2	3	2	2	2	2	2	2	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1
4	4	4	3	3	2	3	3	3	4	3	2	2	2	3	2
5	2	2	2	2	2	3	3	3	4	2	2	2	3	2	2
6	3	4	4	4	3	3	3	3	4	3	2	2	1	3	2
7	2	3	2	2	2	2	4	3	4	3	2	1	1	2	2
8	3	2	3	2	4	3	5	3	2	4	3	4	4	3	2
9	*	1	6	4	4	3	5	4	4	4	4	4	5	4	4
10	4	2	5	1	3	1	4	3	3	2	1	2	1	1	1
11	6	2	5	4	3	4	4	4	3	3	4	3	3	2	2
12	2	2	2	1	1	1	2	2	2	2	2	2	1	1	1
13	3	2	2	3	1	2	3	3	3	2	2	3	2	2	2
14	3	3	3	2	1	2	2	2	2	2	2	2	2	1	2
15	2	2	2	2	2	2	2	2	3	2	1	3	1	1	1
16	7	5	2	2	1	2	2	2	2	2	3	3	1	2	2
17	6	3	2	1	1	1	2	1	3	2	1	3	2	1	3
18	4	4	2	2	2	1	2	2	2	1	2	2	3	1	3
19	3	4	2	2	2	2	3	2	2	3	2	3	2	2	2
20	1	2	1	1	1	1	2	1	1	1	1	2	1	1	1
21	5	3	2	2	1	2	2	2	4	3	2	4	3	1	1
22	6	3	4	2	2	2	2	5	2	1	4	3	3	1	2
23	2	2	3	4	3	2	2	4	1	1	1	5	3	3	2
24	*	*	1	1	1	1	6	2	2	1	3	2	*	2	2

* No data available

Within this overall trend, the pattern of single and dual crops in the combinations has fluctuated markedly from year to year. For example single crop combinations were more common in 1978 than in any other year in the data period yet a year later in 1979 dual crop combinations reached their peak. Dual crop combinations have, overall, been more common than any other but this may not be significant at this level of crop specialisation because a block can be grouped in one or other combination as a result of a relatively small percentage change in crop area. This may simply depend on whether farmers decide, on the basis of previous experience, to risk a summer cash crop in one year and not in another.

Unlike the pattern of change already considered for the January data where major shifts seemed to occur in particular sets of years, none are apparent here which may suggest other influences have been at work. Overall, however, as Table 6.3 indicates, most blocks showed a low mean combination length for the first 10 years and an even lower mean for the last 5 years. Just as with the temporal pattern little clear pattern can be seen spatially in these changes apart from the fact that shorter combinations have been more characteristic of the drier centre and south. At the same time certain blocks consistently had short crop combinations throughout the 15 years. These included some blocks in the south like Block 20 but also included Blocks 1 and 2 in the far north which, it was noted, often differed in their winter combinations from the other northern blocks. Yet some blocks in the central part of the project such as 8 and 9 generally had more diverse crop patterns and, therefore, longer crop combinations. Fig. 6.2 shows the July pattern of crop combination lengths.

6.3.1.3 The Spring and Autumn Patterns

Analysis of the crop combinations at the other two seasons of the year, as seen in the April and October data, add little, at this stage, to the emerging patterns. As Table 6.5 for the April combinations shows, they were similar to the January pattern since many of the winter crops would still be in the ground in April. In some blocks the April combination was longer than the January one

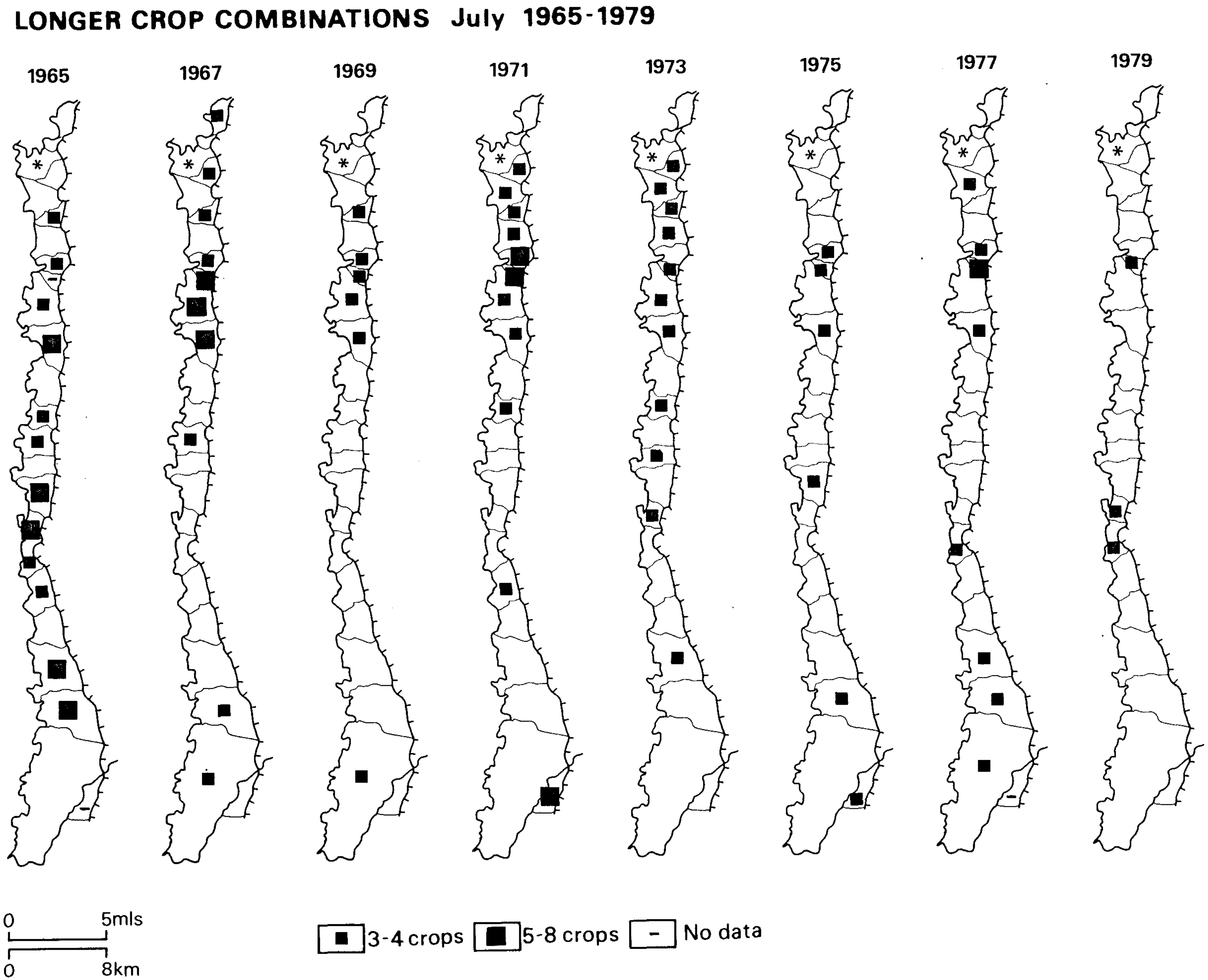

Fig. 6.2 EAST GHOR CANAL PROJECT: CROP COMBINATION LENGTH, JULY, 1965-1979

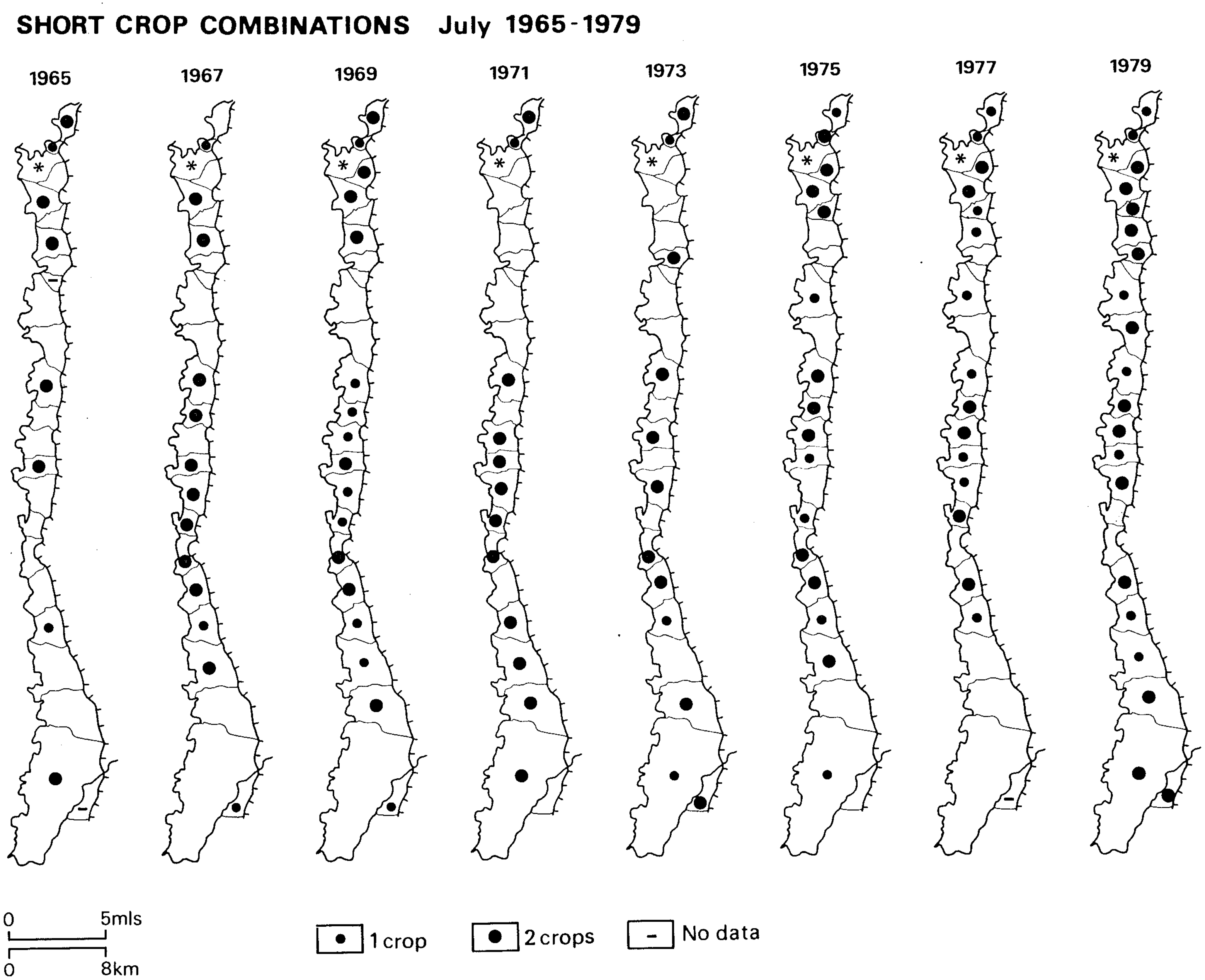

Fig. 6.2 continued

TABLE (6.5) EAST GHOR CANAL PROJECT: CROP COMBINATION LENGTH BY BLOCK, APRIL, 1965–1979

Block No.	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
2	1	2	2	1	1	1	1	4	3	4	5	3	3	2	2
4	6	4	5	4	4	2	3	4	4	3	3	3	3	3	4
5	4	4	5	4	3	3	4	4	5	4	4	4	3	3	3
6	3	4	5	5	4	4	6	4	3	5	4	4	4	3	3
7	3	3	3	3	2	3	6	4	4	5	2	3	3	3	2
8	1	1	2	2	5	4	6	3	2	2	3	3	4	5	4
9	1	1	1	1	1	1	2	1	1	3	5	4	5	8	4
10	2	2	2	2	2	1	2	2	2	2	2	2	2	6	2
11	1	1	1	1	3	4	1	1	1	3	6	5	4	*	3
12	2	2	2	2	2	1	2	2	2	4	3	2	3	*	2
13	1	3	1	2	4	4	5	3	4	5	4	5	4	*	5
14	2	3	2	4	2	2	3	3	3	3	3	4	4	*	2
15	1	4	4	4	6	2	3	3	4	5	4	3	4	*	2
16	1	2	2	3	3	2	4	5	3	4	4	3	3	*	2
17	1	2	2	2	3	1	1	2	3	2	1	1	2	*	1
18	3	3	6	4	3	1	1	3	3	3	2	2	2	*	1
19	2	2	3	4	4	3	3	5	5	5	6	6	3	4	5
20	3	3	3	3	3	2	4	5	5	4	5	4	3	5	2
21	2	2	3	1	2	2	2	3	4	4	4	4	4	2	3
22	2	2	2	2	2	5	3	2	*	4	3	3	8	8	6
23	2	2	2	2	2	3	2	2	*	2	2	3	3	4	6
24	*	*	2	2	3	7	3	6	7	3	4	4	3	6	*

* No data available

because some of the summer crops had also been planted; in other cases they were shorter because winter crops had been harvested. This seemed to be more commonly the case in the southern blocks where, by April, crops would be ripe and would suffer drought if left in longer. Generally, however, just as the winter combinations lengthened over the run of the years so also did the combinations that appeared in April because they were closely tied to the main winter crops. The October pattern was more complex in that longer crop combinations, as Table 6.6 shows, were generally dominant throughout the whole period so that they neither shared the narrow crop ranges of the summer pattern nor the switch from short to long combinations seen in the winter data. These longer combinations largely result from the overlap of summer and winter crops.

Having briefly considered these trends in length of crop combinations it is appropriate to consider the crops that make them up, starting again with the more important winter season. For the sake of clarity this discussion is confined to the leading crops in each block, that is the one that takes up the largest area. A complete list of crops in the combinations of each block are given in Appendix 4.

6.3.2 The Leading Crops

6.3.2.1 The Leading Crops in January

Over the 15 year period for which crop combinations have been calculated for the 23 blocks of the project area, nine leading crops have been recognised, a leading crop being one that takes up most area in a block. These were cereals, tomato, citrus, banana, eggplant, broad bean, cauliflower, marrow and cucumber. In any one year no more than four or five of these crops appeared as leaders across the 23 blocks although some of them led for many more years, or in more blocks, than did others. Fig. 6.3 shows the pattern of some of these leader crops in January for the 15 years and the 23 blocks.

It would be possible to classify these crops according to their importance into four major groups: crops such as cereals and tomato

TABLE (6.6) EAST GHOR CANAL PROJECT: CROP COMBINATION LENGTH BY BLOCK, OCTOBER, 1965-1979

Block No.	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	3	2	2	2	2	2	2	2	2	3	2	1	1	1	1
2	2	1	2	1	1	1	2	3	5	3	3	1	1	1	2
4	5	5	5	4	2	3	4	4	4	4	4	2	3	3	3
5	3	4	4	4	3	3	4	4	4	4	4	2	3	4	4
6	4	3	4	3	3	4	4	3	3	3	2	2	2	2	2
7	3	2	2	2	2	3	3	3	3	3	2	2	2	2	2
8	4	3	3	3	3	4	3	3	6	4	2	3	3	2	4
9	3	5	5	5	2	2	3	5	4	4	3	4	4	4	3
10	5	5	4	2	1	1	2	2	2	2	1	2	1	2	1
11	7	5	6	6	5	4	8	6	5	4	4	3	4	3	4
12	2	2	3	1	1	1	2	3	5	3	2	2	2	2	2
13	7	1	4	5	3	3	3	2	3	4	5	4	4	5	4
14	7	3	3	4	2	2	4	4	3	4	3	3	3	4	4
15	4	2	6	2	2	1	3	3	6	2	2	2	2	2	3
16	4	4	5	3	1	2	2	3	2	3	3	2	2	2	3
17	5	1	2	3	2	1	1	3	1	1	1	1	1	3	5
18	4	4	4	2	1	*	2	5	6	5	4	2	5	7	5
19	5	5	1	3	2	2	5	7	5	7	6	7	8	7	4
28	2	3	2	3	1	2	4	5	6	5	5	6	3	4	2
21	2	1	1	1	3	2	2	2	2	4	6	6	6	6	4
22	1	1	1	1	4	4	*	*	*	4	3	7	*	6	5
23	1	1	1	1	1	1	*	*	*	2	2	2	*	5	6
24	*	4	1	1	1	4	3	5	*	3	3	2	3	4	*

* No data available

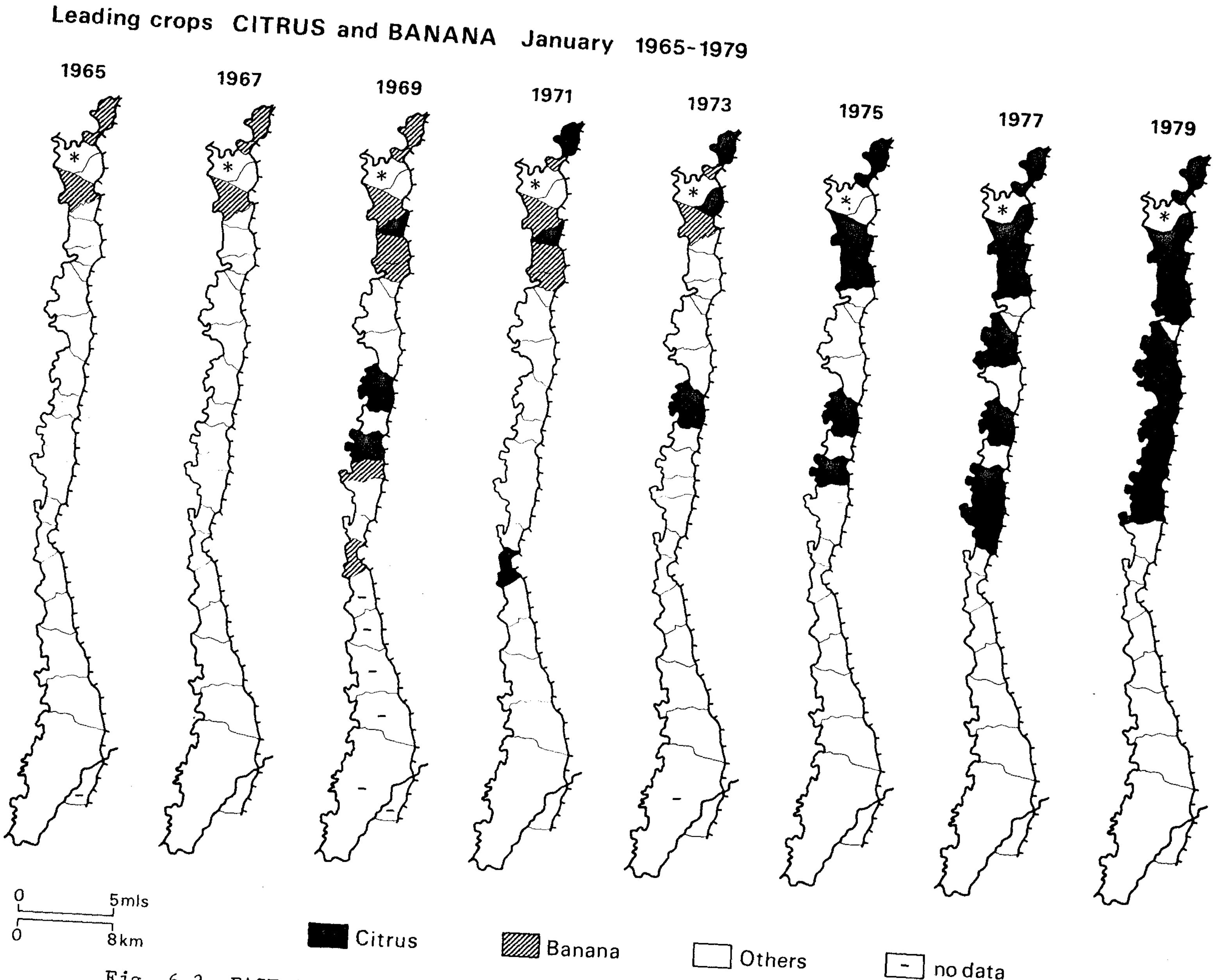

Fig. 6.3 EAST GHOR CANAL PROJECT: PATTERN OF LEADING CROPS, JANUARY, 1965-1979

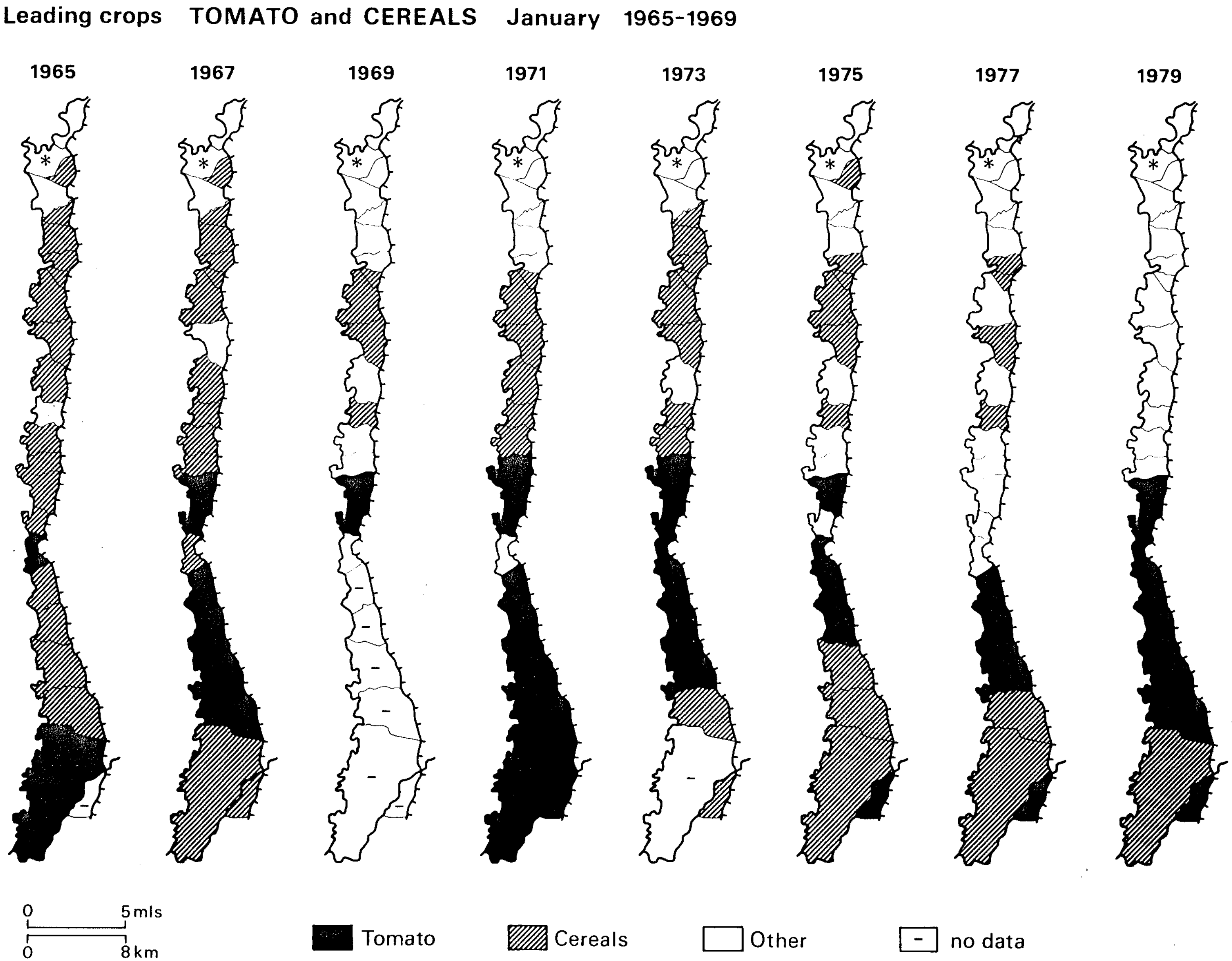

Fig. 6.3 continued

which appeared as leaders in some part of the project area in everyone of the years in the study period; crops that were leaders in the majority of the years. These included citrus and banana which occupied a leading position in one or more blocks for 10 and 13 years respectively; crops such as broad beans and eggplant which were only leaders for 5 or 6 years; and crops like cucumber and cauliflower which led in a few blocks for no more than one or two years.

This approach to the analysis of the pattern over-simplifies, however, since it ignores the differing size and importance of the blocks on which the various crops were dominant. Hence two main criteria - the leading crop in each block and year, and the relative extent of each block - have been used by means of also calculating the percentage of the total project area, represented by the blocks, on which each crop led in each year. Table 6.7 summarizes the results of this calculation as a mean for each of the three 5-year periods between 1965 and 1979 as well as for the total study period. On this basis it is possible to consider the trend of each crop across the project and the study period according to whether it has declined, expanded or showed mixed trends. Declining crops will be considered first.

Leading Crops in Decline

The most noticeable case of winter crop decline is demonstrated by the banana since 1971. As can be seen in Fig. 6.3 for the first four years of the study period banana was the leading crop in Blocks 1, 2 and 5 in the north which made up 8 per cent of the project area. By 1969 it led over 14 per cent of the project area when banana also dominated in a number of other northern and central blocks. Yet by 1972 (not shown in Fig. 6.3) it was a leading crop in only Block 5 representing under 4 per cent of the project area, and by 1975 it was no longer the leading crop even there. At the same time as banana lost its leading position, it was also of declining importance as a second or third most important crop in other blocks. In average terms, as Table 6.7 shows, banana fell from a leading crop over 7.7 per cent of the project area in the late 1960s to 7 per cent in the early 1970s but was leader in none of the project area in the later 1970s. Cereals have shown a different pattern of decline both because they decreased in importance earlier than did banana (and then enjoyed a partial, if unstable, recovery), and also because cereals have always been much more widespread than banana. Grains were the leading crop in no less than 16 of the 22 blocks in 1965 (Fig. 6.3) or 62 per cent of the project area, at the start of the study period. In contrast during the last two years of the study period, cereals were the leading crop in only 1 block, number 23, which, as the most southernly, was also the largest single block, representing 25 per cent of the total project area.

But the decline in cereals in the middle years of the study period, at the same time as their centre of importance shifted southwards, was marked by major fluctuations from year to year. 1967, for example, rivalled 1965 when 59 per cent of the project area had cereals as the leading crop. Yet by 1969 and 1970 only 14 per cent of the project area (only three or four scattered blocks) had cereals as a leading crop. In 1971, 22 per cent and in 1972 50 per cent of the project area was back under cereal dominance and although similar levels were also obtained in 1974-77, the last two years of the study period saw cereals dominant only in the single largest block in the south of the project area. Because the pattern of cereals decline has been marked by these frequent peaks and troughs that did not co-incide with the 3-fold division of the study period, the figures given in Table 6.7 may be a little misleading although it is clear that cereals still were more important in 1978-9 than they had been in 1969-70, indicating the partial recovery that seemed to have occured back to their important position in the project area.

Tomato was the third winter crop to display a decline in areal dominance although in this case the crop enjoyed a peak in the middle years of the study period when about 40 per cent of the project area had tomato as its leading crop. In the late 1970s less than a quarter of the project area had tomato as its leading crop. It should be noted, however, that missing data for the 1960s, and especially for 1969, probably greatly affects the reliability of this analysis since the blocks concerned were probably important ones for the tomato crop. In the late 1960s (excluding 1969) tomato dominance varied between 27 and 55 per cent of the project area, with much of this being in the

TABLE (6.7) EAST GHOR CANAL PROJECT: SUMMARY TRENDS OF LEADING CROPS, JANUARY, 1965–1979

	Late 1960s 1965–1969	Early 1970s 1970–1974	Late 1970s 1975–1979	Average 1965–1979
Cereals	42.64	33.74	39.38	38.60
Tomato	32.94	39.16	23.11	31.74
Citrus	2.80	12.13	32.73	15.90
Banana	7.70	6.99	0	4.90
Broad Bean	0	0.80	3.46	1.43
Eggplant	0.72	2.25	0.21	1.05
Cauliflower	1.40	0	0	0.46
Marrow	0	0	0.59	0.20
Cucumber	0	0	0.52	0.20
No data	11.8	4.93	0	5.40
Total	100.0	100.0	100.0	99.88

southern parts. For the early 1970s the figure varied between 26 and 60 per cent. In the late 1970s no year reached above 32 per cent mainly because the largest single block in the project, Block 23 in the far south, switched from tomato as its leading crop to cereals, and a number of smaller southern blocks also shifted to other crops.

Citrus as an Expanding Crop

It is not difficult to see from Fig. 6.3 and Table 6.7 that citrus is the one crop to have shown a major expansion in areal dominance over the 15 year study period. Whereas it dominated in no blocks in either 1965 or 1967 at the start of the period, it was the leading crop in no less than 13 blocks by 1979. All of these were in the north-central part of the project area. As a result whereas in the late 1960s citrus on average was the leading crop over less than 3 per cent of the project area, it had become the leader over 12 per cent of the area in the early 1970s and in no less than a third of the project area in the late 1970s. There was, however, considerable fluctuation in this citrus expansion from year to year with, for example, 24 per cent of the project under the leadership of citrus as early as 1970 even though the year before, and the years immediately after, never had more than 10 per cent of the project area under citrus leadership. After 1975, however, no year occurred when less than 20 per cent of the project had citrus as the leading crop and this figure rose to 48 per cent in 1978. As a result citrus rose from the fourth leading crop within the project in 1965-9 to the second crop in 1975-9, as both banana and tomato declined. Of course this analysis takes no account of the relative value of a dunum of cereals to a dunum of citrus. This would greatly reduce the importance here given to cereals.

Mixed Trends

A number of crops that were leaders sporadically in one or two blocks also need a brief mention, but because of their very limited occurrence it is not possible to categorize their trends. Cauliflower, for example, appeared as a leading crop in the early part of the study period in two central blocks and has not reappeared since then as a leading crop. In contrast, eggplant assumed some limited importance as a leading crop, mainly in more northerly blocks in the years 1968-71 and again in 1979. Broad bean has been a leading crop only since 1974 in one or two central blocks. Cucumber only made one brief appearance as a leading crop in 1979 in one southern block.

6.3.2.2 The Leading Crops in July

When we turn to the summer pattern of leading crops, where the data can be analysed in the same way as for January, one finds that there are more leading crops involved and more undergoing decline or expansion over the study period. This is inspite of the lower intensity of summer land use.

Ten crops acted as leaders in some part of the project area and over some period of years under review, although some of these crops were much more commonly represented than others. The crops were citrus, jew's mallow, banana, melon, corn, eggplant, pepper, cucumber, tomato and sesame. They might be grouped into four types according to their relative importance as leader crops. Citrus and jew's mallow led in some part of the project area throughout virtually the whole study period. Secondly, one can pick out crops which acted as leaders in some blocks within the area for most of the years. These included banana (11 years), eggplant (10 years) and corn (9 years). Cucumber, melon and tomato were leading crops for between 6 and 4 years in some part of the area. Pepper and sesame were leading crops for only one or 2 years at the start of the study period in only 1 block each.

Leading Crops in Decline

Because it was felt sensible in the January pattern to consider the patterns of declining lead crops before those of expansion - mainly as citrus became more important as other crops declined - it is convenient to follow the same approach here even though just as many crops expanded their area in the summer as suffered a decline.

Three summer crops showed clear patterns of decline. These were banana, cucumber and corn although cucumber underwent some re-establishment in the late 1970s. The general pattern of leading crop change is shown in Table 6.8. As for January the banana area

TABLE (6.8) EAST GHOR CANAL PROJECT: SUMMARY TRENDS OF LEADING CROPS, JULY, 1965–1979

	Late 1960s 1965–1969	Early 1970s 1970–1974	Late 1970s 1975–1979	Average 1965–1979
Citrus	39.58	53.48	60.97	51.34
Jew's Mallow	13.39	26.78	26.62	22.26
Banana	21.05	8.13	0.47	9.88
Melon	4.93	1.76	4.96	3.88
Corn	6.26	3.94	0.88	3.70
Eggplant	1.23	4.17	3.07	2.83
Pepper	6.69	0	0	2.23
Cucumber	3.41	0.40	1.90	1.90
Tomato	0.77	1.34	0.60	0.90
Sesame	1.43	0	0	0.48
No data	1.26	0	0.53	0.60
Total	100.0	100.0	100.0	100.0

has declined markedly over the study period. While it was the leading crop for the 15 years, on average, over 10 per cent of the project area, in the summers of the late 1960s it held leadership over 21 per cent of the area. This figure dropped to 8 per cent in the early 1970s and to under 1 per cent in the later years of the study period. In effect it fell from the second leading crop at the start of the period to the ninth crop at the end.

As can be seen from Fig. 6.4 this pattern of decline has shown some variation in the blocks where the crop was dominant, with the northern blocks being major areas for banana in the early years along with some southern areas. The peak area for banana leadership occurred in 1969 when no less than 34 per cent of the project area had banana as its main crop. In the last four years, except for 1978, no block showed banana as its main crop.

The other two crops that have declined were both far less important and less widespread than banana. Corn was a leading crop in some parts of the project for 10 of the 15 years but it led on average over only 3.7 per cent of the area for the whole study period. Nevertheless in its peak year (1966) it was the leader over 15 per cent of the project area but had virtually disappeared as a leader by the late 1970s when it was dominant over less than 1 per cent of the project area. It had been most commonly an important crop in the middle blocks of the study area.

Cucumber, a far less common crop, in that it only appeared as a leader in 5 of the 15 years of the study period, has also suffered decline, more especially in the early 1970s from which it partly recovered in the last five years of the study period. Whereas on average it was a leader across 3 per cent of the project area in the south in the late 1960s, it disappeared from the map of leading crops between 1970-4 (except for 1 year) and only returned intermittently after.

Leading Crops in Expansion

Just as with the January pattern, citrus is the main crop that has undergone marked expansion as a summer landuse, partly because so many other crops that might rival it - notably vegetables and cereal crops - disappear almost entirely in summer. This has particularly been the case in more recent years when farmers have tended to leave

Leading crops CITRUS and BANANA July 1965-1979

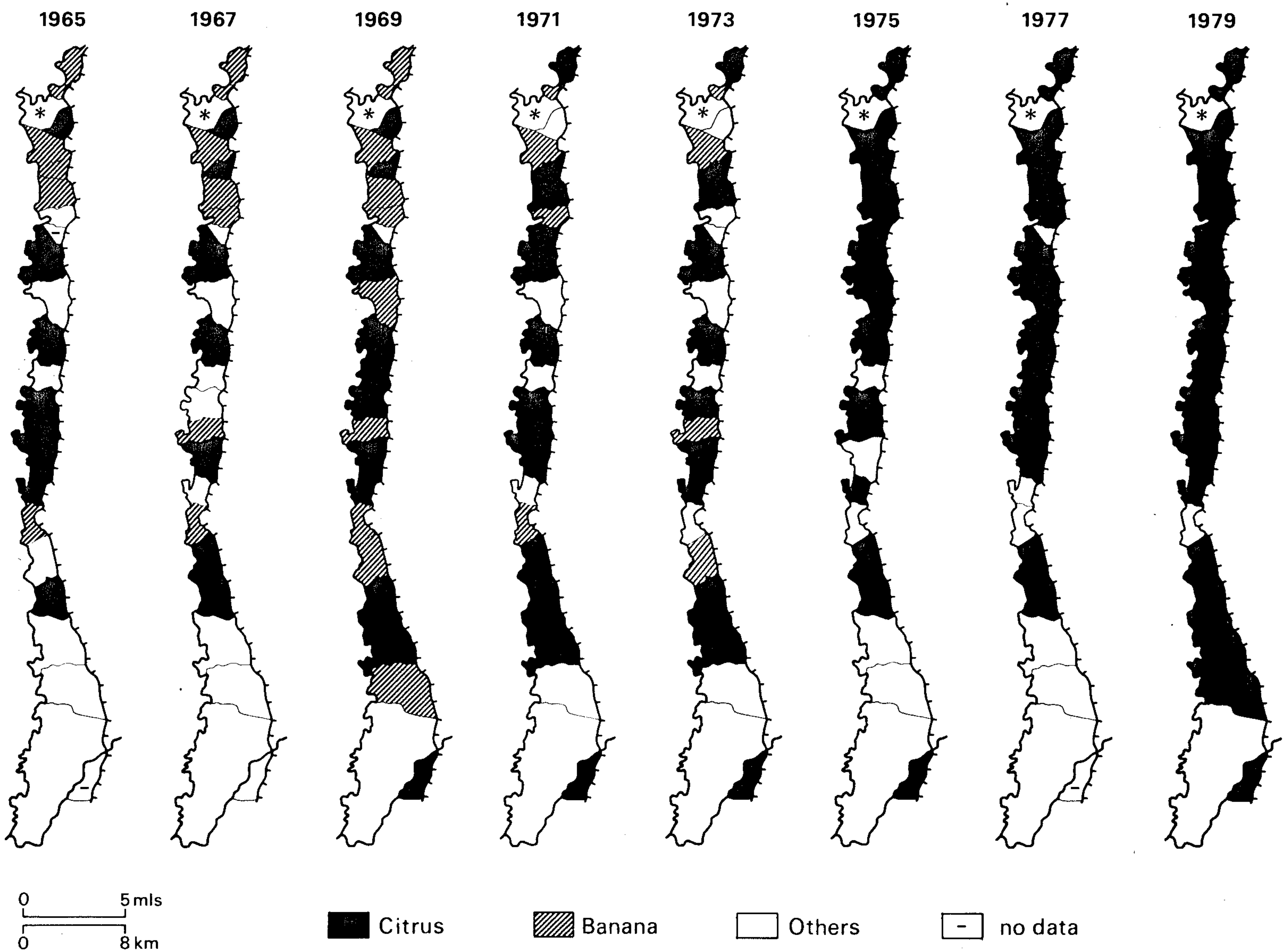

Fig. 6.4 EAST GHOR CANAL PROJECT: PATTERN OF LEADING CROPS, JULY, 1965-1979

more of their land fallow through the summer months because of uncertainties over water supplies. Unlike the January pattern, there are, however, a number of other summer crops that have held their own against citrus.

Citrus was, on average the leading crop over more than half of the project area for the years under study and generally this area of dominance tended to increase with time. Table 6.8 shows that whereas citrus represented the leading crop over nearly 40 per cent of the project in the late 1960s, this had risen to 53 per cent in the early 1970s and 61 per cent in the late 1970s. The peak year was 1979 when no less than 73 per cent of the area had citrus as its leading crop, compared with 27 per cent in the first year of the study period. Fig. 6.4 shows that this expansion has affected all parts of the study area as citrus spread from out of the more central blocks.

In fact the only blocks where citrus did not spread in more recent years were those where other expanding crops were found. Where banana or corn was the leading crop citrus soon took over; where jew's mallow or eggplant was the leading crop this less often happened. Jew's mallow was, on average, a leading crop over 22 per cent of the project area and doubled its area between the late 1960s and early 1970s, principally by becoming firmly established as the leading crop in Block 23, the most southerly and largest blocks in the project area. In some years in the early 1970s it was also the leader in Block 22 as well, giving it leadership over a third of the project area, virtually all of it in the far south.

Eggplant was the third crop to experience some expansion over the study period but this has been for a crop that was not widespread as a leader, and most of this expansion occurred in the early 1970s. Eggplant only acted as a crop leader in any block in 10 years of the 15 and only led, on average, over 3 per cent of the project, but this rose as high as 8 per cent in 1971. When it appeared as a leader this was in the central blocks.

Mixed Trends

A number of minor crops which were dominant occasionally in one or two blocks, also deserve a mention to complete this analysis of summer patterns. In some cases because of their very occasional occurrence as leaders, it is not possible to suggest a clear trend for them. These included pepper which was a leading crop in the far south in only 1966 and 1967 and has never appeared as a leader since; sesame, which did the same in 1965; and tomato, usually a winter crop but which also was a leading summer crop in some central blocks for four years in the early 1970s.

Of the minor crops only melon behaved rather differently. Although it only appeared as a leader in 5 of the 15 years, it did so in Block 23 and other large southern blocks mainly in the mid 1970s, giving an average 4 per cent occurrence over the whole study period.

6.3.2.3 Leading Crops in Spring and Autumn

Less space need be given to the consideration of the pattern and changing importance of the leading crops in the spring and autumn seasons for the 15 years under study, because these largely reflect the trends already noted for the main winter and summer seasons. The April and October crop records have, however, been calculated and the results for each summarized in Tables 6.9 and 6.10.

The April Pattern

Eight principal crops led in different parts of the project area at various times in spring. These ranged from some, like cereals, citrus and tomato, which led in some part of the area for most years, through to others like eggplant, and other vegetables, which were very infrequent crop leaders. It might also be noticed that a rather greater variety of leading crops occurred in the project area in several of the early years whereas in the later years these narrowed down to only three or four, partly, no doubt, as farmers better adjusted the growing period of their crop to the seasonal weather conditions.

As has already been seen in the analysis of the January data, banana and cereals declined in importance as citrus and to some extent tomato increased. In the April data cereals showed the most drastic decline from being the leading crop over 90 per cent of the project area in 1965 to only 25 per cent in 1979, although the decline was not a steady one. Whereas cereals occurred in all parts of the project area in the early years they were largely restricted to the most southerly

TABLE (6.9) EAST GHOR CANAL PROJECT: SUMMARY TRENDS OF LEADING CROPS, APRIL, 1965-1979

	Late 1960s 1965-1969	Early 1970s 1970-1974	Late 1970s 1975-1979	Average 1965-1979
Cereals	71.26	53.87	46.39	57.18
Tomato	12.31	22.85	21.09	18.75
Citrus	4.31	9.70	25.78	13.26
Banana	8.59	5.61	0	4.73
Eggplant	0.71	0.35	0	0.35
Corn	0	0.93	0	0.31
Jew's Mallow	0	0	0.32	0.11
Cucumber	0	0	0.53	0.18
Melon	1.67	0	0	0.59
No data	1.05	6.69	5.89	4.54
Total	100.0	100.0	100.0	100.0

areas after 1975 as citrus, tomato and some other crops became more important and cereals were harvested earlier. Similarly banana declined from being the leading crop in three blocks in the first four years of the study period and, after a sudden increase in importance in 1969, when it was the lead crop over 19 per cent of the project, it slumped to a point where it led in no blocks after 1975.

In contrast tomatoes showed a pattern of rapid expansion. Whereas it was a leading crop in none of the blocks in 1965 it suddenly became prominent thereafter in the south-central blocks and was the main crop over a third of the project in 1979. It might be recalled that it was of declining importance as a winter crop because, presumably, farmers found spring tomatoes more profitable. Table 6.9 tends to underestimate the rise in importance of tomatoes in the late 1970s because data for blocks 11-18, in which tomato was an important crop, was missing for the April of 1978. Citrus was, as expected, the other crop that expanded over the 15 years. Whereas no block had citrus as its leading crop in the first two years, it became the leader over 2 per cent of the project in 1967, rising to 23 per cent in 1970. Although a marked decline followed in 1972-3, further expansion occurred in the citrus areas after 1973 so that it was the leading crop over 40 per cent of the area in 1979. These citrus areas were mainly in the northern blocks so that by the late 1970s one had much of the northern project area characterised by citrus dominance in the spring. To the south tomatoes and cereals dominated.

Five other crops - eggplant, corn, jew's mallow, melon and cucumber - also occurred spasmodically as leading crops in April but since some of these had been harvested by April their prominence is much more muted in the April pattern than in that for January. Hence no trend is clear for these crops from the spring data to support the slim evidence of their increasing importance seen in the January data.

The October Pattern

The October pattern with 13 principal crops listed in Table 6.10 is the most complex of the four months considered. These crops ranged from citrus and tomato which were leading crops in some part of the project area every year of the study period; others like banana, broad

TABLE (6.10) EAST GHOR CANAL PROJECT: SUMMARY TRENDS OF LEADING CROPS, OCTOBER, 1965-1979

	Late 1960s 1965-1969	Early 1970s 1970-1974	Late 1970s 1975-1979	Average 1965-1979
Citrus	20.98	30.78	52.75	34.84
Tomato	49.10	25.47	26.64	33.74
Banana	15.69	7.70	0	7.80
Broad Bean	1.41	8.60	9.54	6.52
Eggplant	5.15	5.01	0.62	3.59
Cauliflower	2.32	0.77	0	1.03
Pepper	0	0	2.87	0.96
Marrow	0.80	0	0	0.27
Cereals	3.21	0	0	1.07
Beans	0	0.59	0	0.20
Corn	0.41	0	0	0.14
Cucumber	0.40	0	0	0.13
Cabbage	0	0	0.35	0.12
No data	0.53	21.08	7.22	9.60
Total	100.0	100.0	100.0	100.0

bean and eggplant which were frequent but discontinuous leaders; and several others that occurred spasmodically as leaders in one or two blocks. These included cauliflower, corn, pepper, marrow, cucumber, beans, cabbage and cereals. Cereals, a major crop in the other three seasons, are generally not in the ground in October and so appear as unimportant at this time of the year.

Three crops were of declining importance in the October figures for the study period. These were banana which as a perennial has shown a general decline at all seasons; tomato which has shown a decline in importance in January but an increased importance in the spring; and eggplant which appeared to be a more stable crop in January throughout the study period. Little more need be said of banana's universal decline which had seen it as the third leading crop, after tomato and citrus, in the autumn data for the late 1960s, but which found it in leading in no block in that month in the late 1970s. Because tomato tended to increase as a spring crop and decline as a winter crop, it has shown a decline in October as well. In 1965, 48 per cent of the project area, especially in the south, had tomato as its leading crop but this area had been halved by 1978-9. The lack of data for various southern blocks in certain years in the 1970s makes it difficult to further analyse these trends, but it appears that Block 23 in the far south of the project, has retained its importance for autumn tomatoes whereas the blocks to the north of it have switched progressively to spring tomato production.

Eggplant has been a far less important crop, leading over 7.8 per cent of the project area in 1965 in three blocks. Various blocks in the central part of the project had the crop as its leader in the late 1960s and early 1970s, but by the late 1970s only Block 9 remained as the focus for this crop. It has already been noted, however, that eggplant appeared to become rather more important as a summer crop in more recent years suggesting that, as with tomato, farmers may not have rejected the crop so much as modified its growing season.

With these crops in decline in October, others inevitably must rise to replace them since crop combinations are based on the relative, rather than the absolute, importance of various crops. The two crops which have shown clear evidence of expansion have been citrus, which as a perennial has expanded at all seasons, and broad beans which also showed a little evidence of increase as a winter crop in the 1970s. Little more need be said of the marked increase in the citrus dominance, which took it to a leading position over two-thirds of the project area by October 1979.

Broad beans only occurred as a leading crop in the early part of the study period in 1967 when it emerged as the main crop in two blocks in the central part of the project area. Since 1970, however, the crop appeared as the leader each year not only in those two blocks, but often in one or two other neighbouring ones, a set of blocks also characterised by spring time tomato production, and forming part of the very distinctive zone of emphasis upon vegetable production in the southern part of the project area.

Trends for another eight leading crops - cauliflower, corn, pepper, marrow, cucumber, cereals, cabbage and beans - cannot be specified because they dominated too infrequently, although it does appear that most of them - cauliflower, marrow, corn, cucumber and cereals - declined in overall importance through the study period.

6.4 Analysis of Land Use Intensity

Having shown that over the data period winter cropping has generally become more diverse, whereas summer cropping has become less so, it is appropriate to end this chapter with some examination of the variations in intensity of land use over these years. This will confirm much of what has been concluded already about the change in the character of cropping within the project.

Any indication of land use intensity is only available on the basis of relating the cropped area recorded for each block in a season to the total area of that block. Because of double cropping in some blocks very high intensity figures are sometimes obtained and these may be rather misleading. Figures 6.5 and 6.6 show the January and July patterns of intensity based on 3 percentage classes, while Tables 6.11 and 6.12 give average intensity figures for each block for each group of 5 years of the data period. Full annual data are given in Appendix 5.

It is immediately clear that land use intensity has varied enormously across the project area both spatially and temporally during the 15 year study period. In all cases July land use intensities were lower than January ones, as is to be expected, but the relationships between summer and winter varied from block to block. For example, in some blocks farmers used land very intensively in the winter to let it lie idle in the summer, whereas in other blocks land appeared to be used at a more moderate level of intensity in both seasons.

6.4.1 The January Pattern

Temporal trends in land use intensity are immediately noticeable in the January data in Fig. 6.5 with the years 1969-71 representing a trough of low intensity followed by a recovery by 1974 although it is difficult to more fully specify this because of lack of data for 1969. Taking the whole 15 year period data set for all blocks, the median January land use intensity was 55 per cent and it is clear that most blocks at the start and the end of the study period exceeded this whereas fewer did in the middle years.

The years of lower intensity in the middle of the period co-incided with the time of Israeli raids into the valley following Palestinian raids in the West Bank so that farmers were unable or unwilling to use their land so intensively. This trough of lower intensities also co-incides with the shift away from certain crop specialisations in the early years towards greater diversification in the later years, already referred to in the crop combination analysis.

There is also some indication of a spatial pattern in these variations in land use intensity partly seen in Table 6.11. In the early years land use was generally more intensive in winter in the northern blocks. Virtually all northern blocks had above median intensities whereas many southern blocks were below the median. This pattern was largely maintained throughout the 15 years. About half of the blocks covering just under half of the project area had higher levels of land use intensity in the late 1970s than they had in the late 1960s but these were almost as often found in the southern as in the northern half of the project area.

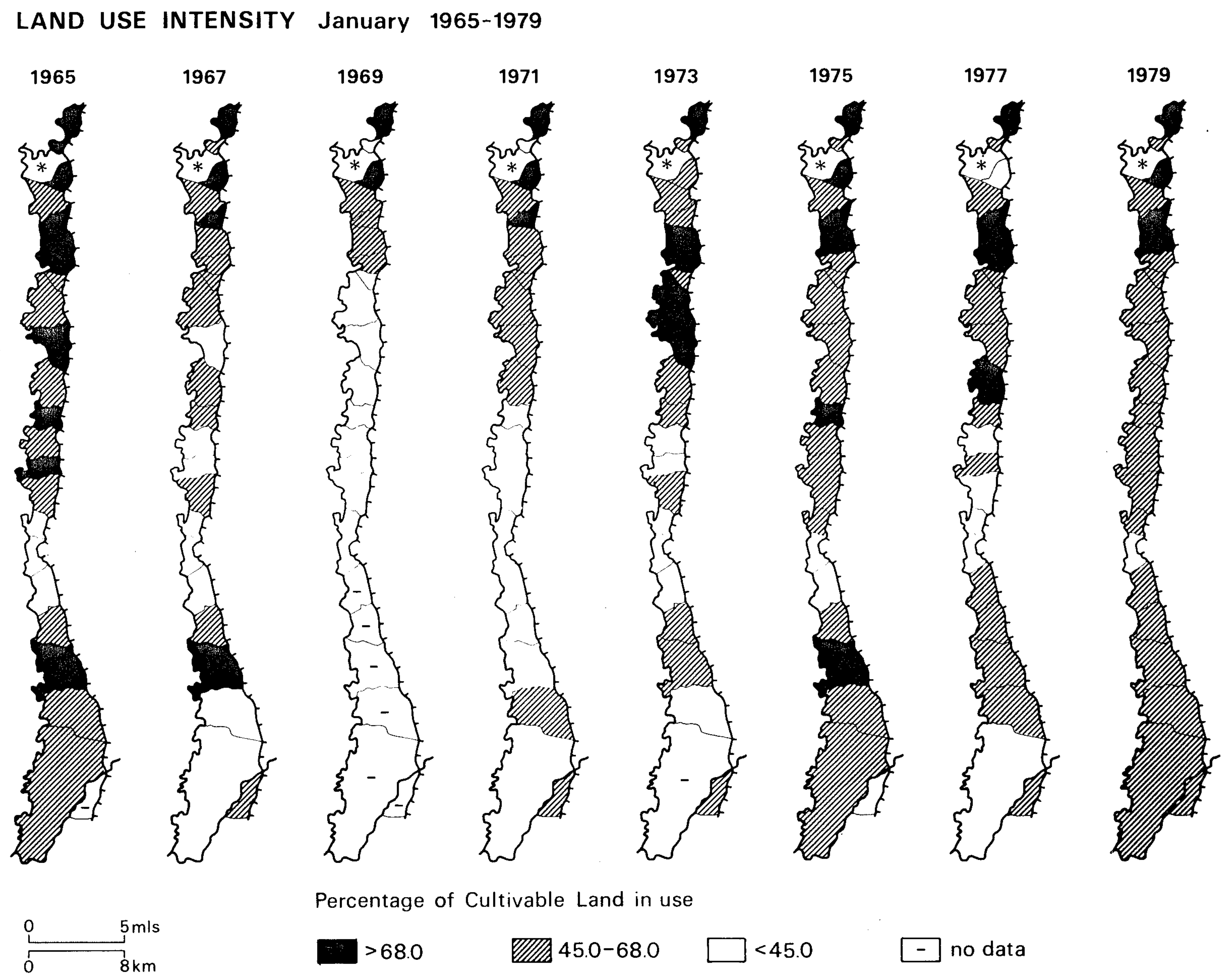

Fig. 6.5 EAST GHOR CANAL PROJECT: PATTERN OF LAND USE INTENSITY, JANUARY, 1965-1979

TABLE (6.11) EAST GHOR CANAL PROJECT:

SUMMARY TRENDS OF LAND USE INTENSITY, JANUARY AND JULY, 1965-1979

Blocks	JANUARY Late 1960s 1965-69	Early 1970s 1970-74	Late 1970s 1975-79	Average 1965-79	JULY Late 1960s 1965-69	Early 1970s 1970-74	Late 1970s 1975-79	Average 1965-79
1	77-0	77.9	84.4	79.8	69.4	64.3	70.1	67.9
2	51.9	37.7	56.7	48.7	35.4	26.3	46.0	35.9
4	82.7	72.5	61.0	72.1	36.2	46.1	49.8	44.0
5	58.8	55.9	55.0	56.6	40.3	41.2	43.8	41.8
6	79.6	71.7	78.4	76.6	54.8	56.5	62.9	58.1
7	61.1	68.2	72.7	67.3	49.7	54.3	61.4	55.1
8	69.4	61.4	65.3	65.4	41.4	37.6	44.1	41.0
9	56.9	58.9	55.2	57.0	29.1	22.9	41.5	31.0
10	61.2	60.1	68.5	63.3	34.1	36.3	46.7	39.0
11	56.3	55.8	58.0	56.7	26.4	27.7	39.9	31.0
12	60.8	53.3	61.0	58.4	34.1	38.2	45.3	42.2
13	64.4	55.4	63.3	61.0	31.5	29.4	39.1	33.3
14	45.1	41.9	49.5	45.5	20.6	24.9	28.6	24.7
15	69.8	62.8	55.9	62.8	21.0	19.8	18.6	19.8
16	51.7	39.4	48.9	46.6	13.7	14.5	14.0	14.0
17	39.1	35.4	45.8	40.1	6.8	11.7	5.5	8.0
18	16.0	9.4	17.9	14.4	8.6	4.4	4.0	5.7
19	43.8	36.4	45.6	57.3	12.1	14.6	14.6	13.8
20	53.3	45.7	50.5	49.6	11.3	12.7	17.1	13.7
21	72.5	49.0	66.7	62.0	6.5	5.6	14.2	8.8
22	57.4	45.0	58.1	53.2	5.1	9.3	11.9	8.8
23	47.1	42.7	43.5	44.3	2.8	5.5	9.1	5.8
24	72.6	56.8	53.4	58.0	3.9	7.1	14.0	8.6

6.4.2 The July Pattern

The July pattern of intensity (Fig. 6.6) is much simpler because far less land everywhere was in use. In contrast to a median January intensity percentage of 55 for all blocks for the data period, in July this was only 25 per cent. There was again a divide between northern and southern areas with blocks to the north generally much more intensively used. The years 1966-70 were again years of less intensive use although, with all land less heavily used in July, the trough seemed less marked. Whereas Table 6.11 shows that in January 20 blocks had lower land use intensities in the early 1970s than in the late 1960s, the equivalent figure for July was only 8 blocks with a total area of 21 per cent of the project so that the trough in land use in those years affected summer cropping far less than winter cropping. 18 blocks also showed an increased intensity of land use in the late 1970s over the late 1960s although it still remained much less intensive than the winter pattern. Much of this increased use of land in the summer occurred in the northern blocks particularly with the increasing importance of citrus, but spread south in the late 1970s.

6.4.3 The April and October Patterns

Less need be said of the April and October land use intensity patterns which are made more complex than the winter and summer ones by the effect of some winter and summer crops occurring side by side in the ground at these intermediate seasons. Table 6.12 summarizes the block by block situation based on 5 year averages while Figs. 6.7 and 6.8 shows the highly variable spatial patterns seen on an annual basis.

The April pattern showed particularly high levels of land use intensity since some winter crops were still in the ground and many summer ones were planted so that the trough in amount of land use in the middle years of the study is again well seen with 13 blocks showing less land in use then than in the late 1960s. All blocks showed an increased mean intensity in the late 1970s compared with the early 1970s with higher intensities predominating in the northern blocks as is to be expected.

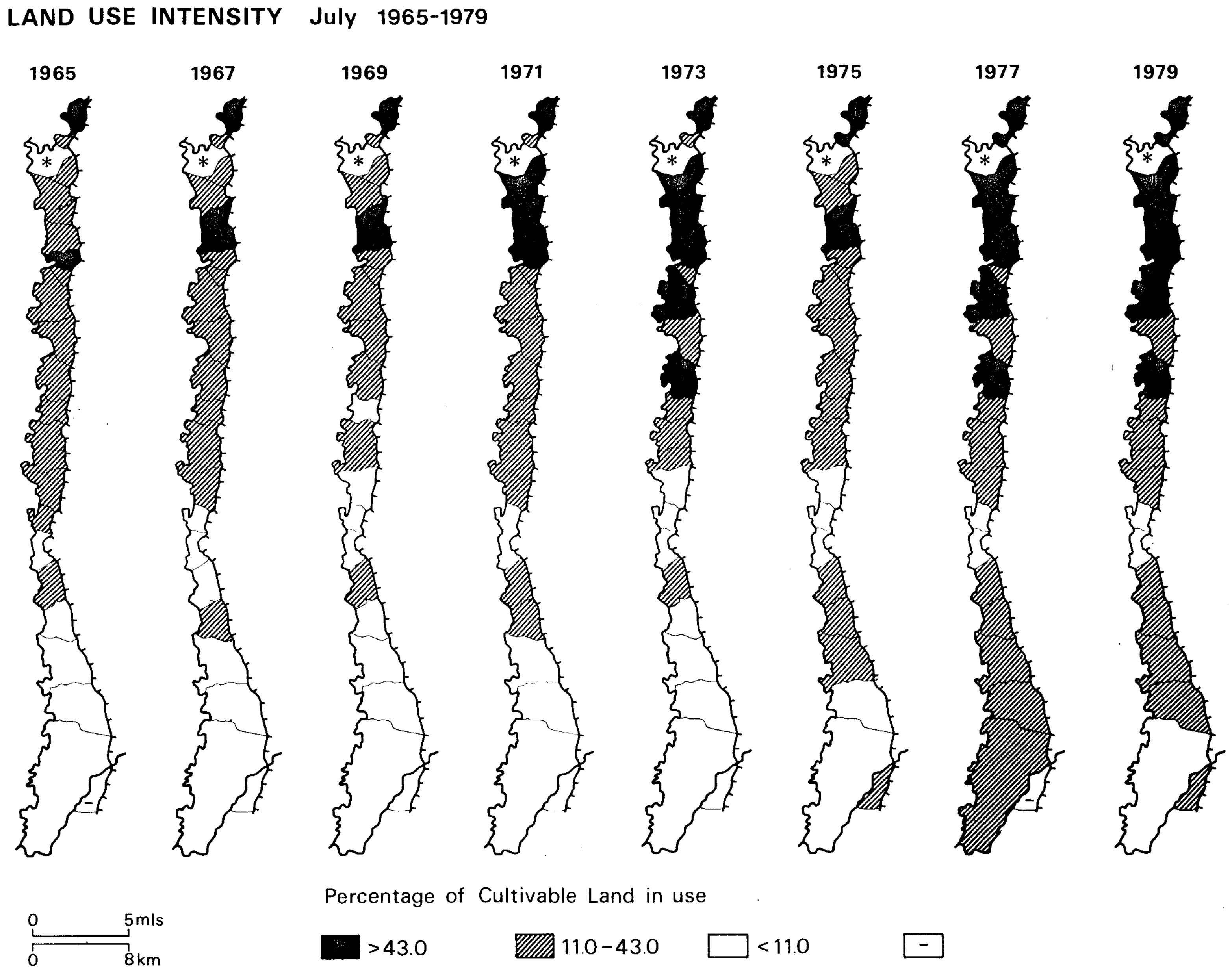

Fig. 6.6 EAST GHOR CANAL PROJECT: PATTERN OF LAND USE INTENSITY, JULY, 1965-1979

TABLE (6.12) EAST GHOR CANAL PROJECT:

SUMMARY TRENDS OF LAND USE INTENSITY, APRIL AND OCTOBER, 1965-1979

Blocks	APRIL Late 1960s 1965-69	APRIL Early 1970s 1970-74	APRIL Late 1970s 1975-79	APRIL Average 1965-79	OCTOBER Late 1960s 1965-69	OCTOBER Early 1970s 1970-74	OCTOBER Late 1970s 1975-79	OCTOBER Average 1965-79
1	74.4	75.8	85.0	78.4	74.4	78.2	82.3	78.3
2	48.2	38.7	74.0	53.6	43.2	34.7	56.3	44.2
4	67.0	68.6	69.7	68.5	60.4	61.7	65.1	62.4
5	58.0	55.4	68.4	60.6	52.4	50.6	52.5	51.8
6	80.4	79.5	88.8	82.9	53.5	61.1	67.6	60.7
7	68.9	76.8	74.9	73.5	45.3	50.3	61.9	52.5
8	61.0	63.9	70.3	65.1	36.3	34.2	44.5	38.4
9	61.2	60.5	61.4	61.1	19.6	22.0	40.6	27.4
10	61.0	62.0	68.0	63.7	31.6	31.6	48.6	37.3
11	60.9	60.4	78.7	65.8	31.5	29.7	45.7	35.6
12	52.5	56.7	70.5	59.2	40.6	41.3	54.9	45.6
13	57.5	49.9	68.3	57.9	38.8	35.7	48.6	41.0
14	45.4	40.8	50.0	45.1	27.3	30.6	39.7	32.5
15	45.4	45.4	55.2	48.2	27.0	20.9	34.5	27.4
16	46.2	42.3	43.6	44.1	16.5	22.5	25.8	21.6
17	34.8	35.8	35.8	35.4	10.3	18.4	22.7	17.1
18	21.0	18.0	18.3	19.2	9.4	8.7	14.8	11.1
19	45.0	37.2	45.6	42.6	26.6	28.3	36.1	30.4
20	49.6	47.8	59.8	52.6	35.5	37.2	40.9	37.9
21	52.2	57.1	60.3	56.6	43.7	42.3	40.6	42.2
22	56.2	49.5	50.7	52.3	42.8	34.4	31.3	37.1
23	36.2	37.8	42.3	38.9	27.4	17.1	20.4	23.0
24	54.8	50.9	54.1	52.9	25.6	34.1	22.8	27.5

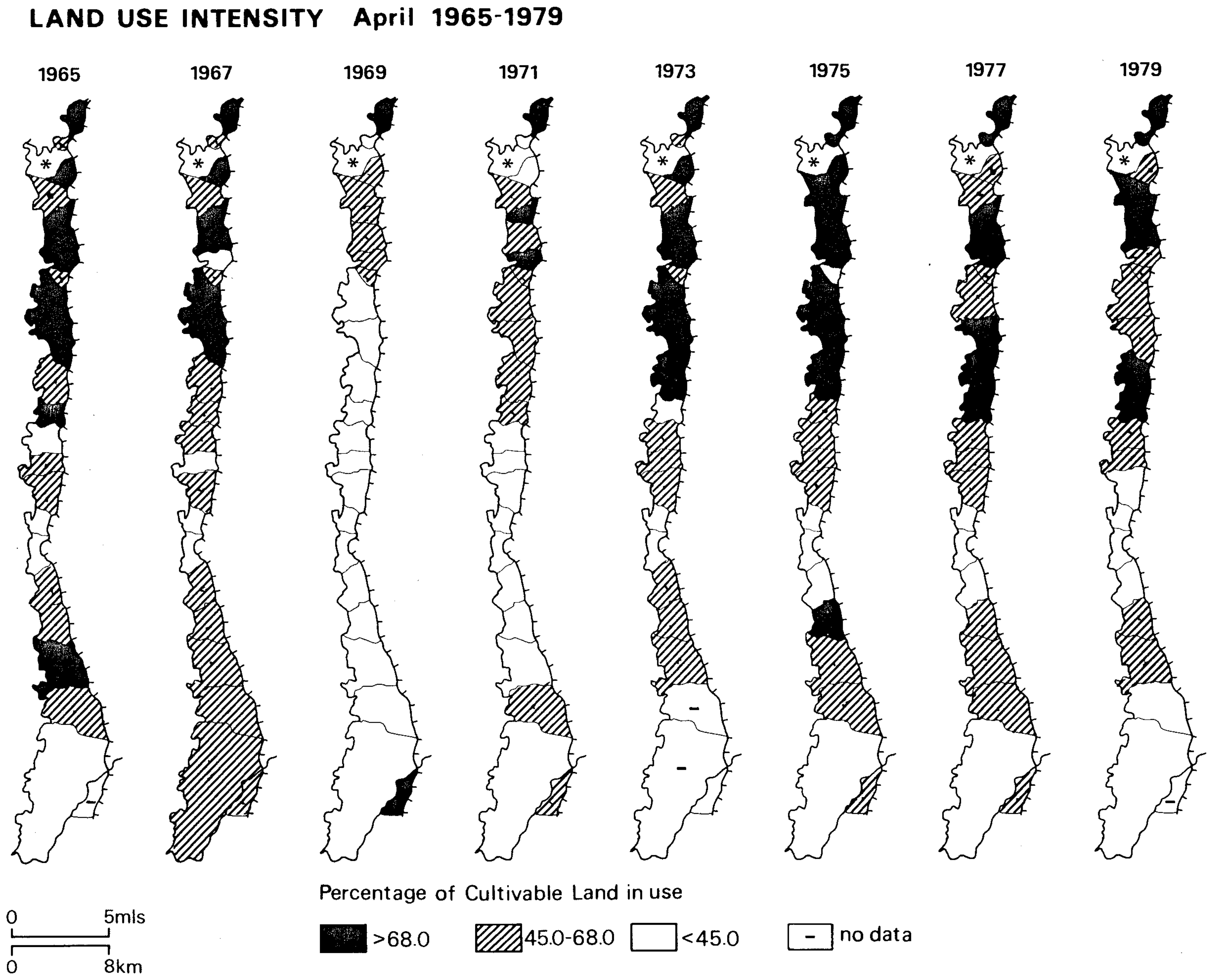

Fig. 6.7 EAST GHOR CANAL PROJECT: PATTERN OF LAND USE INTENSITY, APRIL, 1965-1979

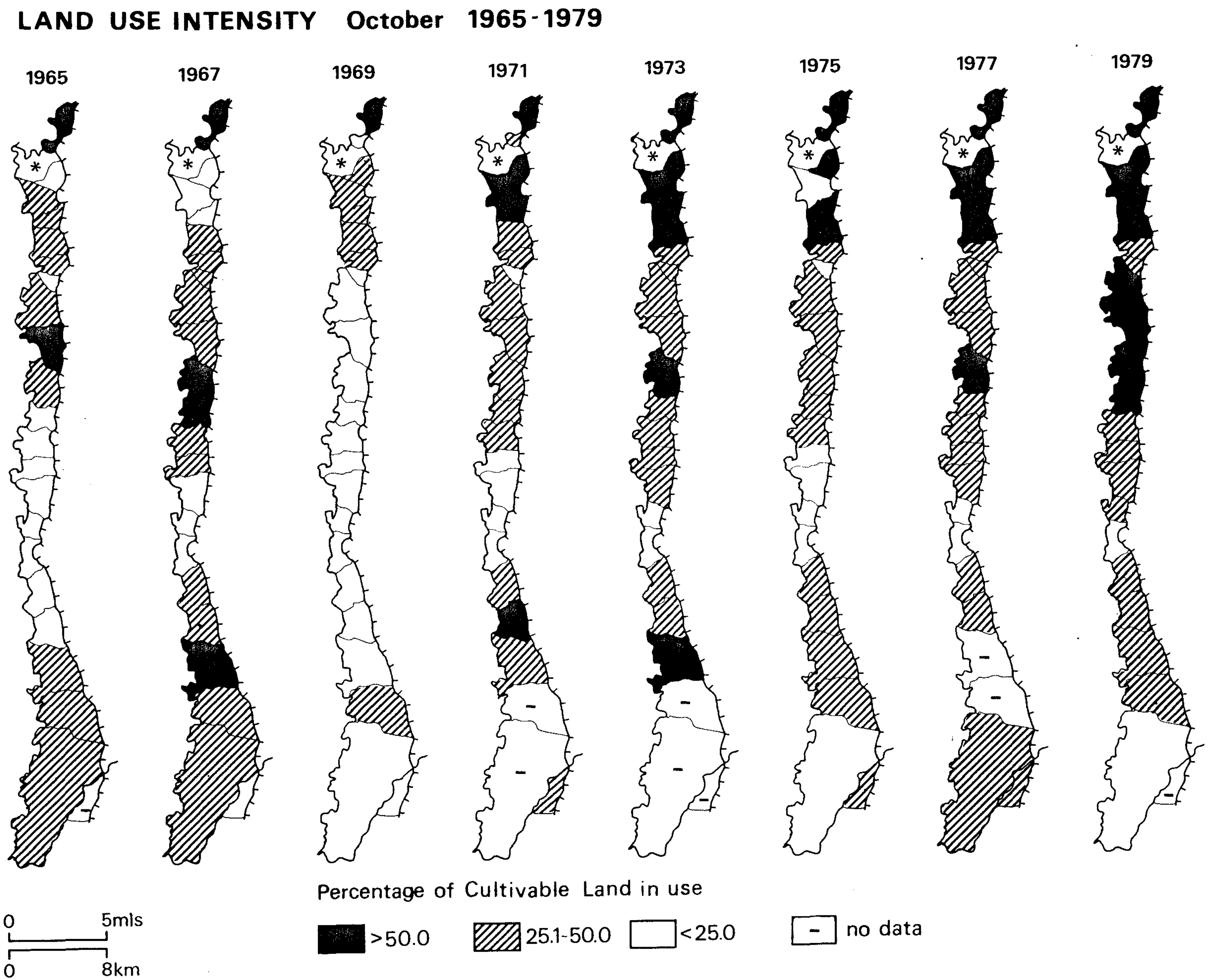

Fig. 6.8 EAST GHOR CANAL PROJECT: PATTERN OF LAND USE INTENSITY, OCTOBER, 1965-1979

The October pattern showed much lower levels of intensity compared with April because many summer crops are being harvested by then and other winter crops are not yet planted. In fact October intensities are closer to the summer pattern than any other. As a result the reduction in land use intensity in the early 1970s was less marked in this set of data, as was also noted for the July data but virtually all blocks, except for a few in the south for which some data was missing, raised their land use intensities in the later 1970s both above the mean levels of the early 1970s and the late 1960s.

In summary the period under review appears to have been marked by a transition about a set of years of lower land use intensity as certain crop specialisations were replaced by others in different types and lengths of crop combinations, both in the dominant winter season and the subordinate summer cropping period. What is particularly clear is that considerable variety could be seen in the way in which different areas and blocks behaved which in turn suggests that some consideration should be given to cropping changes at the farm level. The next chapter is devoted to some examination of this.

Notes and References

1. Several cropping patterns have been suggested from time to time for the project but little has ever been done to enforce them. Early on the Authority envisaged a pattern made up of: vegetables 60 per cent of the area, of which two thirds would be winter crops; forage crops 35 per cent; fruit trees 25 per cent; cereals 15 per cent and industrial crops 8 per cent of the area. Allowing for two crops per year on some land this would represent the use of 143 per cent of the project area. In 1966 the actual cropping areas, totalling 108 per cent of the project area, were made up of: vegetables 51 per cent; cereals 34 per cent; fruit 14½ per cent, forage crops 8½ per cent and insignificant amounts of industrial crops.
2. As the project area has been extended the number of blocks and sections has increased but this part of the study considers the main blocks 1 to 24 excluding Block 3 which has never been used. Also excluded is the southern extension area for which no similar crop data is available.
3. Chapter 7.

4. Weaver J.C. (1954) Crop combination regions in the Middle West, Geographical Review, 44, 175-200.
5. Scott, P. (1957) The agricultural regions of Tasmania: a statistical definition, Economic Geography, 33, 109-121.
6. Coppock, J.T. (1964) Crop, Livestock and enterprise combinations in England and Wales, Economic Geography, 40, 65-81.
7. Thomas, D. (1963) Agriculture in Wales during the Napoleonic Wars, University of Wales Press, Cardiff.

CHAPTER 7 ANALYSIS OF LAND USE AT THE FARM LEVEL

7.1 Introduction

The previous chapter has shown that there appears to be a number of dominant crops within the various crop combinations across the different blocks of the project but these have changed markedly since the 1960s. Each block contains many individual farms so that it would be useful to know if there is much variety of farm enterprises within the blocks. It is not possible to examine all blocks for this purpose but four blocks shown in Fig. 7.1 have been selected from the 23 in the project area in order to examine local patterns of farm enterprise and land use in more detail. Findings from this analysis of farm records will also be linked to the analysis of farming activities of the writer's sample of 353 farm units scattered across the project area.

7.2 Analysis of Land Use in Four Selected Blocks

The present survey covers 537 farms in the four blocks. Blocks 4 and 5 represent the farm patterns in Section I at the northern end of the project, these two blocks adjoining each other. Since much of their farm data is amalgamated in the records it is sensible to consider them both here. The 249 farm units included in these two blocks make up about a quarter of the area of Section I and 25.3 per cent of all the farms in that Section. Most of the land is rated as Class I and II.

Block 12 lies in Section II and contains 188 farm units, or 19.4 per cent of the farms in that section and 17.6 per cent of its area. Again most of the land is good quality (Class I and II) with smaller areas of Class III and IV. Section III of the project is here represented by Block 19 which contains 100 farm units.[1] These make up 12.3 per cent of the farms and 16.3 per cent of the area of the section. Only half of the land in this block is of good quality.

The data used in this analysis has been collected from the project's headquarters at Deir Alla. For several years since the beginning of the irrigation scheme, the water distributors in each area

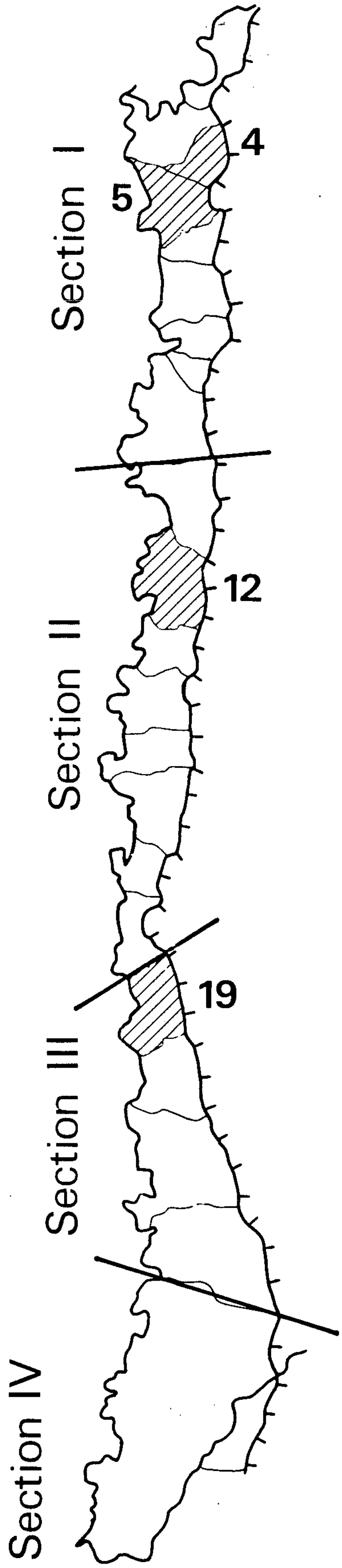

Fig. 7.1 EAST GHOR CANAL PROJECT: THE FOUR BLOCKS SELECTED FOR THE FARMLAND USE STUDY

have collected monthly records of the crops growing on each farm in their area. This information has to be provided regularly by each farmer to the water distributor and occasionally when water is requested for irrigation. Water distributors are not required to make their own measurement of farm cropped areas so that inaccuracies are likely within the data because of mis-reporting by farmers. However, the water distributors are generally familiar with their areas and are able to record crop patterns with some accuracy and to correct individual farm reports.

A major problem in the use of the data is that while these local reports have been regularly sent to the project headquarters for many years, no previous attempt has been made to use them or indeed to care for them. As a result the writer was unable to find any data for several blocks for certain months and years. This greatly restricted the choice of blocks and periods for which a useful run of data was available. Therefore data for January and July 1977 forms the main basis for this section. It is convenient to deal with each of the selected blocks in turn using the Thomas method of crop combination analysis already outlined in the last chapter.

7.2.1 Crop Combination Analysis in Block 4 Farms

There were 97 farms in Block 4 in 1977 and their levels of activity, range of crop combinations and crops grown appeared fairly typical of much of the northern section of the project with its emphasis upon citrus supported by a range of vegetables and some cereals. These features can be seen in a simple analysis of the farm data for this block. In January 1977, 80 (82.5 per cent) of the 97 farms were reported as being under crops. Crop combination analysis shows that these crops included two major ones, citrus and eggplant, supported by cereals and pepper. Banana, tomato and olive occurred only as minor crops. Table 7.1 lists seven crops according to their relative importance within different combinations on the farms in the block. 70 per cent of the farms were under single crops, the rest under two crops. In July the number of active farms declined slightly to 76 (78.4 per cent of farms) because of the cost and scarcity of water.

TABLE (7.1) BLOCK 4: CROP RANKS WITHIN THE VARIOUS FARM CROP COMBINATIONS

	Single Crop Combination Farms		Multi Crop Combinations Crops in order of rank in the combinations				Total Farms per crop	
	No.	%	1st	2nd	3rd	4th	No.	%
January								
Citrus	31	55.4	11	6	–	–	48	60.0
Eggplant	19	33.9	9	9	–	–	37	46.3
Cereals	6	10.7	3	1	–	–	10	12.5
Pepper	–	–	3	4	–	–	7	8.8
Banana	–	–	1	–	–	–	1	1.2
Tomato	–	–	–	1	–	–	1	1.2
Olives	–	–	1	–	–	–	1	1.2
Total cropped farms	56						80	
July								
Citrus	25	67.6	14	3	5	–	47	61.8
Cabbage	7	18.9	21	5	–	–	33	43.4
Jew's Mallow	4	10.8	9	17	1	1	32	42.1
Eggplant	–	–	–	5	3	1	9	11.8
Pepper	–	–	1	5	2	–	8	10.5
Olives	–	–	1	1	–	–	2	2.6
Corn	1	2.7	–	–	–	–	1	1.3
Total cropped farms	37						76	

As the table shows a range of seven crops was still grown, with citrus still dominant but with a different range of vegetables, notably cabbage and jew's mallow. Eggplant and pepper were also of some significance. As in January one crop combinations were common in July although rather more multi-crop enterprises were seen, reflecting the range of vegetables entering into the farm pattern at that season.

It is worth considering further these crop combinations in relation to crops grown and the spatial pattern of these different enterprises in the block for each season. On the basis of the January data given the farms can be divided into 3 families of combinations.

a) 56 or 70 per cent, of the active farms reported having a single crop combination. Over half of these (31) were simply citrus units. Eggplant and cereal farms respectively made up the other 19 and 6 single-crop units.

b) Table 7.2 shows that 23 farms, or 28.8 per cent, represented a two crop combination. All of these combined either citrus or eggplant with another crop, doing much to create the crop variety seen in this block. Most common was the citrus/eggplant combination, seen on 11 farms. Eggplant and pepper occurred on 5 farms while citrus or eggplant occurred with various other crops on 6 more farms.

c) There was only one farm with a 3 crop combination. This had a citrus, eggplant and cereals combination.

July crop combinations were rather more complex than those for January with single-crop systems becoming less important because higher vegetable prices wherever water was available made it worthwhile for some, but not all, farmers to grow additional crops. Three families of combinations were found as can be seen in Table 7.2.

a) About 49 per cent of the farms were single-crop enterprises (compared with 70 per cent in January). These units were again predominantly citrus growers: 25 appeared as single crop units in July compared with 31 in January. On the other hand, other single-crop enterprises dropped drastically in number. Whereas there were 25 non-citrus single crop farms in January, these declined to 12 in July, 7 of them being cabbage farms, 4 jew's mallow and one corn.

b) As the single crop farms had become less numerous in July, the two

TABLE (7.2) BLOCKS 4, 5, 12 and 19: LENGTH OF CROP COMBINATION FARM ENTERPRISE

Length of Crop Combination Farm Enterprise	BLOCK 4 Classified Farms		BLOCK 5 Classified Farms		BLOCK 12 Classified Farms		BLOCK 19 Classified Farms	
	No.	%	No.	%	No.	%	No.	%
JANUARY								
1. Single Crop Combination	56	70.0	94	67.1	97	55.1	18	19.8
2. Double Crop Combination	23	28.8	32	22.9	39	22.2	17	18.7
3. Three-Crop Combination	1	1.2	11	7.8	24	13.6	23	25.3
4. Four-Crop Combination			3	2.1	12	6.8	15	16.5
5. Five-Crop Combination					4	2.3	9	9.9
6. Six-Crop Combination							8	8.8
7. Seven-Crop Combination							1	1.0
Total Farms	80		140		176		91	
JULY								
1. Single Crop Combination	37	48.7	96	78.7	105	70.9	33	94.3
2. Double Crop Combination	26	34.2	22	18.0	33	22.3	2	5.7
3. Three-Crop Combination	9	11.8	4	3.3	9	6.1		
4. Four-Crop Combination	3	4.0			1	0.7		
5. Five-Crop Combination	1	1.3						
Total Farms	76		122		148		35	

crop units increased from 23 to 26 farms representing 34 per cent of all the active farms but only half of these combined citrus or eggplant with another crop, as had been the case universally in January. Now jew's mallow had become the dominant crop with cabbage.

c) Nine farms had a 3 crop combination; three farms had a 4 crop combination and one a 5 crop enterprise. Cabbage, jew's mallow and citrus were most important in these.

In brief, Block 4 shows a fairly simple range of farm types, mainly of short combinations with simple enterprises. Often farms with only one crop provided much of the basic pattern of the block by growing citrus or eggplant. The important vegetable crops mostly occurred within 2 or 3 crop combinations. Although slightly fewer farms operated in July compared with January, the July vegetable crop was an important income source.

Mapping the distribution of these various types of farms and combination lengths within the block revealed no explicable pattern. As land quality is equally good over the block one might expect little grouping of different farm types. An indication of this is seen in Fig. 7.2 which shows the pattern of monocultural crop farms in Blocks 4 and 5 in July 1977.

7.2.2 Crop Combination Analysis in Block 5 Farms

Block 5 which adjoins Block 4 to the south, contains more farm units (152) compared with the 97 in Block 4. The general crop patterns and combinations were much the same however, with the main exception of a greater area directed to banana production, partly because Block 5, unlike 4, contains some zor land beside the Jordan river where banana is more suited.

As in Block 4 farming activity over the block as a whole was lower in July than January with 140 of the units (92.1 per cent) used in January and 122 (80.3 per cent) used in July. Even so, as Table 7.3 shows a good range of vegetable and other crops were reported in both the summer and the winter season. For the most part, however, the similarities between this block and Block 4 are striking. As

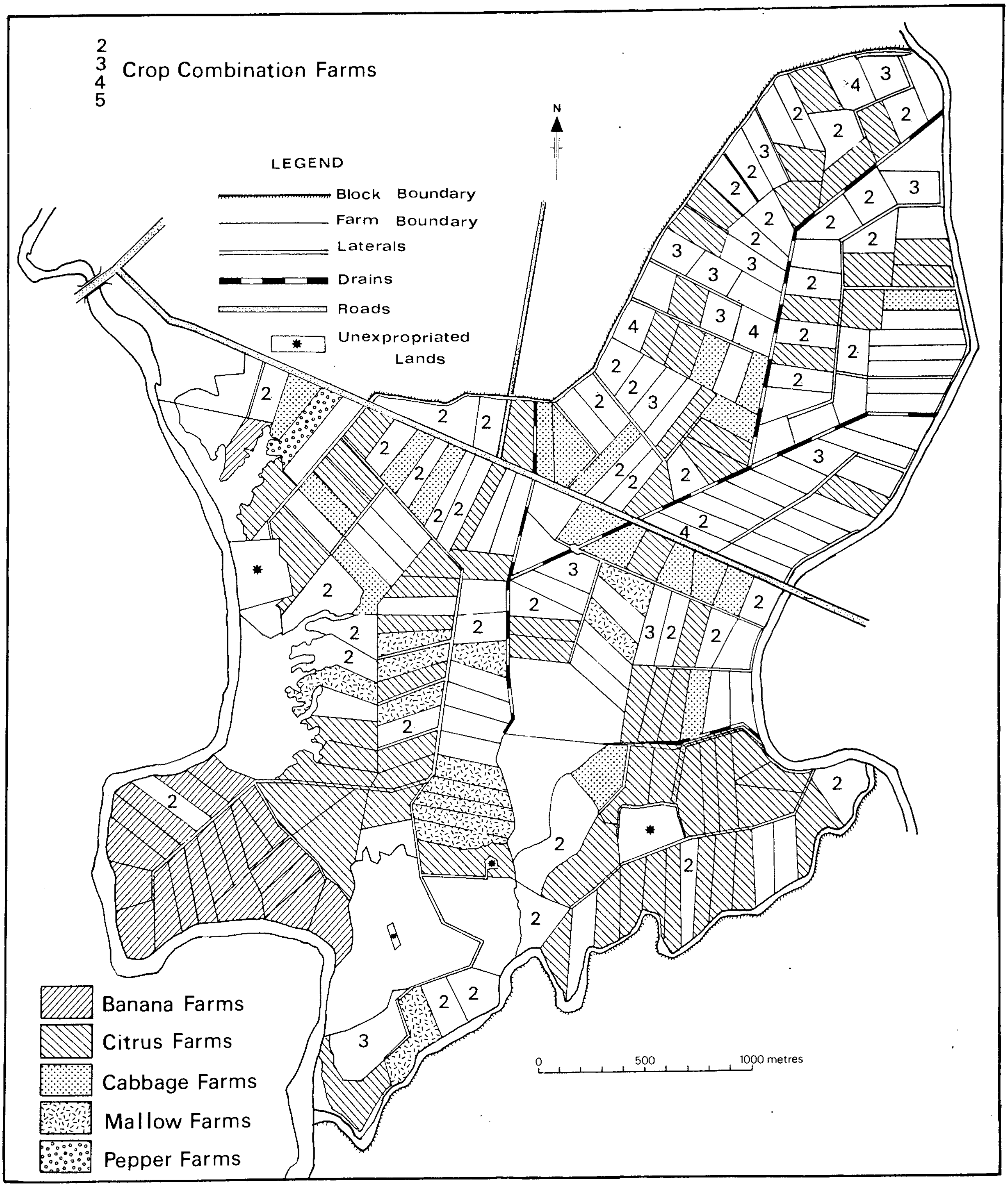

Fig. 7.2 BLOCKS 4 AND 5: PATTERN OF MONOCULTURAL CROP FARMS AND DISTRIBUTION OF MULTI CROP FARMS, JULY, 1977

TABLE (7.3) BLOCK 5: CROP RANKS WITHIN THE VARIOUS FARM CROP COMBINATIONS

	Single Crop Combination Farms		Multi Crop Combinations Crops in order of rank in the combinations				Total Farms per crop	
	No.	%	1st	2nd	3rd	4th	No.	%
January								
Citrus	42	44.7	22	6	2	–	72	51.4
Eggplant	27	28.7	15	15	2	1	60	42.9
Banana	19	20.2	7	4	2	–	32	22.9
Cereals	3	3.2	8	6	–	–	17	12.1
Broad beans	–	–	1	7	7	–	15	10.7
Olives	3	3.2	1	1	–	–	5	3.6
Pepper	–	–	–	2	1	–	3	2.1
Lettuce	–	–	–	3	–	–	3	2.1
Avocado	–	–	–	1	–	–	1	0.7
Total cropped farms	94						140	
July								
Citrus	49	51.0	19	4	–	–	72	59.0
Banana	21	21.9	5	5	–	–	31	25.4
Cabbage	13	13.5	2	7	2	–	24	19.7
Jew's Mallow	12	12.5	3	6	1	–	22	18.0
Pepper	1	1.0	–	5	–	–	6	4.9
Avocado	–	–	–	1	–	–	1	0.8
Total cropped farms	96						122	

Table 7.3 shows, on the basis of January data, half of the active farms were involved in citrus production, 42 of them being single crop units. These figures are not too dissimilar to those for Block 4. There were also considerable numbers of eggplant and banana farms where the modal unit was a single crop operation. Eggplant was commonly seen in the one crop units in Block 4. As in Block 4 also there were only a few multi-crop units and much of the vegetatble and other crop production occurred on these, including a number of farms growing some broad beans.

The July pattern largely repeats that for January with citrus and banana being dominant especially with the one crop units. But summer enterprises here were rather simpler than in Block 4 as Table 7.2 shows. There were several single crop units growing jew's mallow or cabbage, unlike in Block 4 where summer single-crop farms growing non-citrus crops were fewer in number. In July in Block 5 no farms showed a crop combination greater than 3 whereas Block 4 had a few of these.

These various farm types are well dispersed across the block although two zones of more uniform cropping were also found to stand out. Fig. 7.2 shows the banana units on the zor in the bend of the Jordan river and a concentration of farms emphasising jew's mallow in the centre of the block.

7.2.3 Crop Combination Analysis in Block 12 Farms

Block 12 lies near the northern end of Section II of the Project area and contains 188 farms. Most of the land in this block is of class I and II quality. As the earlier analysis of the crop data of the blocks in Section II showed, farming in this area in 1977 was predominantly based on citrus and cereal production within simple crop combination or monocultural enterprises. Vegetable growing featured in some of these enterprises.

This pattern is also well seen in the individual farm data for this block, but analysis at this level reveals that there are some spatial and other variations within the pattern. These variations reflect influences like land quality differences upon individual farm land use practices.

Firstly, one should note the relatively high level of active cropping of land found in this block as was also seen in Blocks 4 and 5. This seems again to be related to the simple nature of the enterprises practiced by farmers. In January 1977, 93.6 per cent (176) of the farms were reported as being at least partly in crops. Although this percentage fell, as one would expect with the July figures in the summer drought to 78.7 per cent, it is not possible to say how significant this fall was as summer data for 8 farms was missing.

As Table 7.2 shows for these cropped farms, 77.3 per cent of them in January had either a single or a double-crop combination. Only 16 of the farms (9.1 per cent) had a range of four or more crops. In the dry summer season, the emphasis upon simple enterprises was even more marked when 93.2 per cent of the cropped farms, on which data was available, had either only one or two crops in their combinations.

From the crop ranks shown in Table 7.4 it is immediately clear that in winter citrus and cereals were dominant with six other crops, mainly vegetables like broad beans and cabbage playing some relatively small part in the enterprises on some of the 176 farms. In July citrus was even more dominant. Apart from eggplant only four other crops filled out the very limited range of other crops on the 148 farms then in active use. A distinction should be drawn here between the monocultural units and those with multiple crops. In both seasons the monocultural farms outnumbered the multiple-cropped farms, as in the other two blocks already considered, but it is also clear that these single crop units were more closely related to the citrus culture. The enterprises which commonly featured winter cereals, or in summer eggplant, were either single or double crop farms, whilst much vegetable production was associated with enterprises involving three or more crops. Table 7.4 shows of the 97 single-crop farms reporting in January, 62 per cent were growing only citrus and another 35 per cent were simply cereal growing units, a much higher proportion than in Blocks 4 and 5. Only 3 (3.1 per cent) single crop farms concentrated on one of the other six crops grown in that January.

TABLE (7.4) BLOCK 12: CROP RANKS WITHIN THE VARIOUS CROP COMBINATIONS

	Single Crop Combination Farms		Multi Crop Combinations Crops in order of rank in the combinations				Total Farms per crop	
	No.	%	1st	2nd	3rd	4th	No.	%
January								
Citrus	60	61.9	26	9	7	1	103	58.5
Cereals	34	35.0	52	10	2	1	99	56.2
Broad beans	-	-	4	26	8	3	41	23.3
Cabbage	3	3.1	6	14	10	4	37	21.0
Cauliflower	-	-	7	8	4	-	19	10.8
Marrow	-	-	2	8	3	3	16	9.1
Potato	-	-	-	2	-	-	2	1.1
Total cropped farms	97						176	
July								
Citrus	73	69.5	22	3	-	-	98	66.2
Eggplant	29	27.6	23	18	1	-	71	48.0
Pepper	2	1.9	1	15	3	1	22	14.9
Tomato	-	-	-	4	4	-	8	5.4
Olives	-	-	-	1	-	-	1	0.7
Cucumber	1	1.0	-	-	-	-	1	0.7
Total cropped farms	105						148	

The same type of emphasis is seen with the July data. On 69.5 per cent of the monocultural farms citrus was the crop grown. On the other hand only 27.6 per cent of these enterprises reported eggplant as their single crop. Eggplant is a very common summer crop but much of it is grown in combination with other crops as can be seen in Table 7.4.

Some geographical patterns can be discerned in these farm types. Plotting the farms showed the common monocultural enterprises, where citrus is the single crop, were mainly to be found along the Jordan River flood plain, where they form a solid zone, with a lesser concentration in the centre of the block. Fig. 7.3 shows this for January 1977 together with the pattern of more scattered cereal farms which occur more commonly in the north than in the south. Individual crops on the multicropped farms are not shown on Fig. 7.3 but these farms were more scattered with a tendency to be rather more common in the south. Most of the two crop farms occurred in the north, where the simple cereals-related farm enterprises were also common. The units with more complex combinations including vegetables were mainly found in the centre and south of the block on the best quality land.

7.2.4 Crop Combination Analysis in Block 19 Farms

Block 19 lies at the northern end of Section III of the Project area. It contains 100 farm units and 44.3 per cent of the land in this block is either Class I or II with a further 9.5 per cent in Class III and IV. 45.6 per cent of the land is Class VI of very poor quality for farming, most of this being unused land beside the Jordan River. Records were available for only 92 farms.

Levels of active farm cultivation in this block in 1977 differed considerably from the previously examined blocks. Whereas levels of use were high in winter, they were very low in the summer reflecting the problems of using this more difficult land with costly canal water. With irrigation water only more recently available many farmers are not yet familiar with summer cropping. In 1977, 91 of the 92 farm units, or 98.9 per cent, were reported as cropped in January but this proportion fell to only 38 per cent in July. Partly as a result of

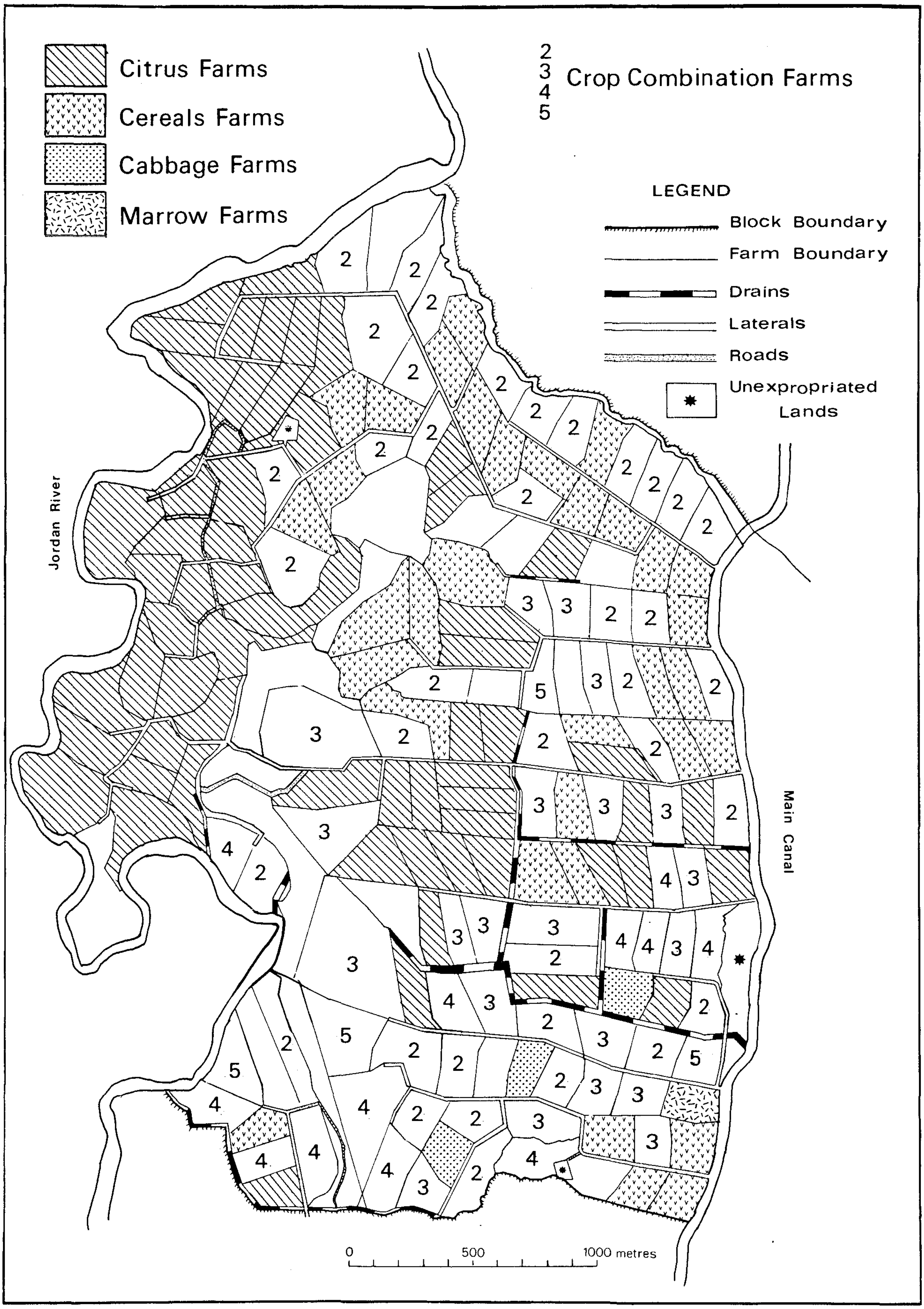

Fig. 7.3 BLOCK 12: PATTERN OF MONOCULTURAL CROP FARMS AND DISTRIBUTION OF MULTI CROP FARMS, JANUARY, 1977

this, the pattern of crop combinations on the active farms varied markedly from winter to summer, as Table 7.5 shows. All combinations from 1 to 4 were common in January with the 3 crop combination being the mode in winter. On the other hand in summer one crop enterprise was almost universal amongst the small number of active farms. Table 7.2 shows how in this respect this block contrasts with the others already considered.

There are two ways in which this block distinguishes itself from the blocks already examined in the older established parts of the project. Firstly, cropping is predominantly a winter activity here for most farmers, and secondly, in that winter period there was a much wider range of enterprise patterns than in the other blocks considered, both very simple and more complex combinations being commonly seen. Whereas in Block 12, 77 per cent of the farms had either a single or double crop combination, in Block 19 they made up less than 40 per cent of the units. Combinations of up to 6 crops were not uncommon. This variety of farm types is also seen in the range of crops grown in winter, 11 being listed in the records, 10 of which occurred in significant amounts.

In January tomato was clearly the most commonly reported crop followed by a group of other common vegetables. Citrus was far less widely seen here than in other blocks examined to the north, being reported on only 24.2 per cent of the active farms. Cereals also were unimportant. Only in summer did the citrus and banana farms come into their own as virtually all other cropping ceased.

A plot of the various farm types in the block showed little discernible pattern except that the banana and citrus farms, which are often the simpler one and two crop farms, concentrated along the main canal where they were accessible to secure supplies of essential irrigation water. This is seen in Fig. 7.4 for July 1977 where the large numbers of unused farms at that season are also clear. Fig. 7.5 shows the contrasted pattern in winter when virtually all farms, except the large undeveloped areas, were in use often with quite elaborate multi-crop combinations.

Overall it seems that there is not only considerable variety between the four blocks but variety within them as well, although

TABLE (7.5) BLOCK 19: CROP RANKS WITHIN THE VARIOUS CROP COMBINATIONS

	Single Crop Combination Farms		Multi Crop Combinations Crops in order of rank in the combinations						Total Farms per crop	
	No.	%	1st	2nd	3rd	4th	5th	6th	No.	%
January										
Tomato	–	–	58	9	1	–	–	–	68	74.7
Pepper	–	–	4	18	5	5	2	1	35	38.5
Beans	–	–	–	13	10	3	4	–	30	33.0
Marrow	–	–	–	12	7	6	4	–	29	31.9
Broad beans	–	–	1	12	6	2	2	–	23	25.3
Citrus	11	61.1	9	2	–	–	–	–	22	24.2
Cauliflower	–	–	–	11	1	6	–	1	19	20.9
Potato	–	–	2	7	2	5	–	–	16	17.6
Cereals	–	–	4	8	1	–	–	–	13	14.3
Banana	7	38.9	4	–	1	–	–	–	12	13.2
Cucumber	–	–	–	–	1	–	–	–	1	1.0
Total cropped farms	18								91	
July										
Citrus	23	69.7	2	–	–	–	–	–	25	71.4
Banana	10	30.3	–	2	–	–	–	–	12	34.3
Total cropped farms	33								35	

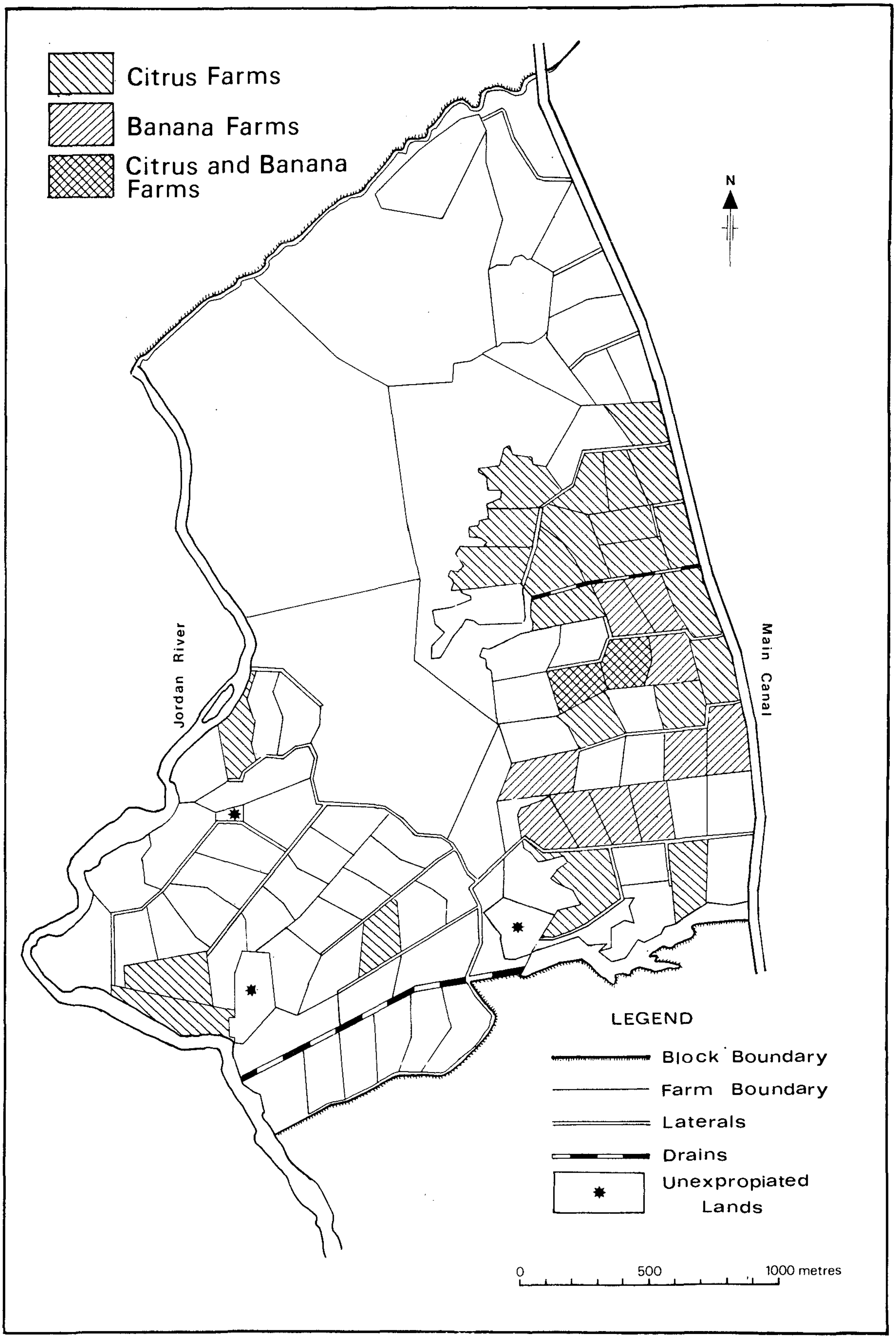

Fig. 7.4 BLOCK 19: PATTERN OF CITRUS AND BANANA FARMS, JULY, 1977

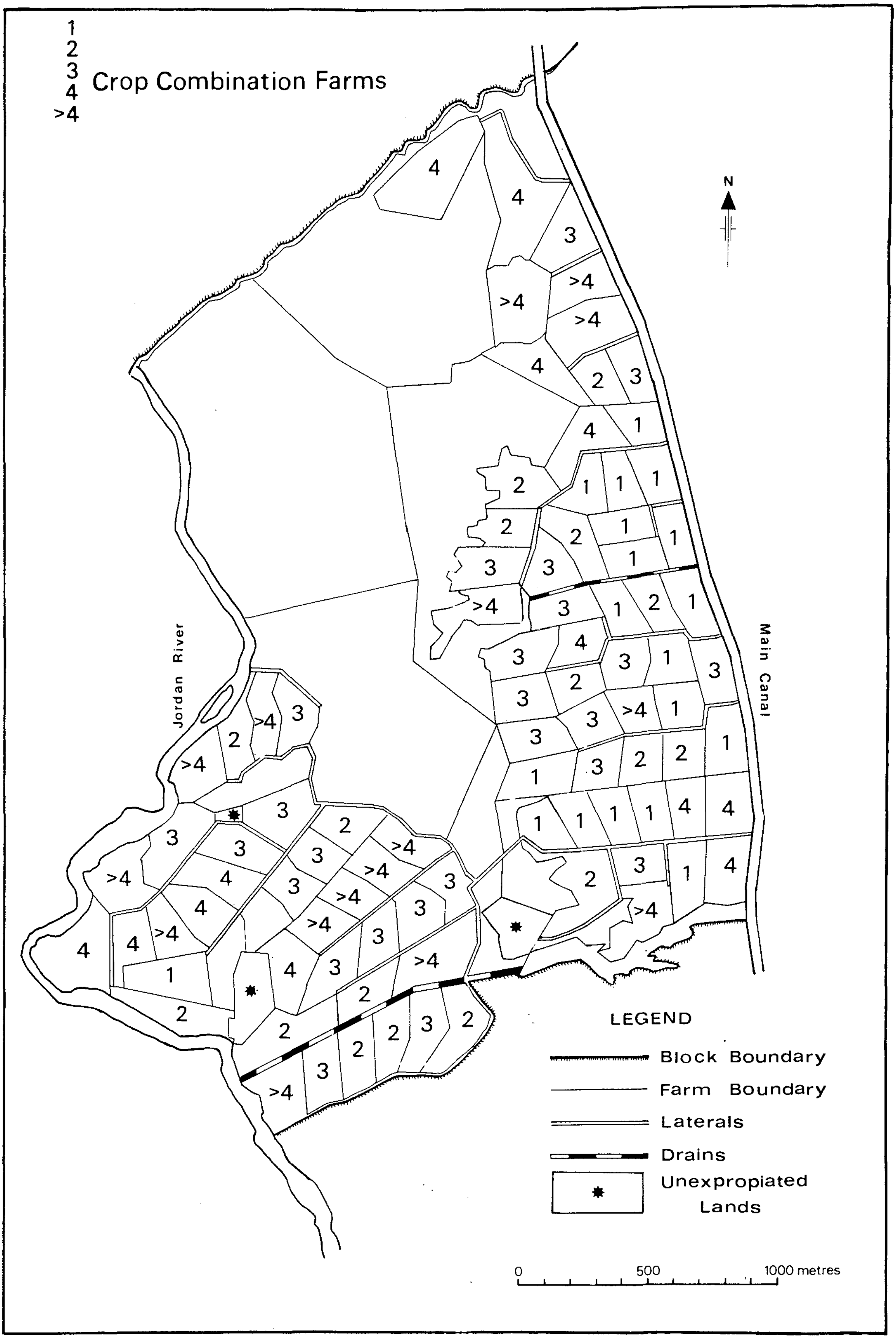

Fig. 7.5 BLOCK 19: DISTRIBUTION OF MULTI CROP FARMS, JANUARY, 1977

particular common sets of crops and crop combinations and seasonal patterns do appear.

7.2.5 Land Use Intensity in the Selected Blocks

One important aspect of land use, already referred to, is its intensity which can be measured by examining the proportion of land used on farms at any one time to the total area of land available. This was carried out for the farms in the four blocks using the January and July data to represent the maximum period of activity and the secondary season.

Table 7.6 and 7.7 show the results of this analysis. Because the analysis is here based on individual farm records, some of which were missing, the figures for the numbers of farms in use differ somewhat from those used previously in connection with their crop combination analysis.

As was stated before, the data on Block 4 showed that slightly more farms were cultivated in January 1977 than in July indicating the rather lower summer intensity of land use. However, if one takes the data on the percentage of land recorded as under cultivation on each farm (Tables 7.6 and 7.7) one can see that the intensity data indicate a greater amount of land in use in July than January. For example, only 29 farms (30 per cent) used more than 60 per cent of their land in January compared with 33 (34 per cent) in July. At the same time 1338 dunums were recorded as cropped in Block 4 in January 1977 against 1375 dunums in July. This increase in land use intensity in July can probably be attributed to the rising importance of summer vegetables on many of the active farms at the same time as other farms remained idle.

From the cropping patterns it has already been seen that Block 5 was similar to Block 4 which it adjoins, but Tables7.6 and 7.7 show that here winter land use is more intensive than in the summer. In January 1977, 78 farms (51.7 per cent) had more than 60 per cent of their land cropped compared with 54 farms (35.5 per cent) in July. 23 farms were entirely fallow in July compared with 7 in January. Whereas 3029 dunums were cropped in January this dropped to 2473 dunums, an 18 per

TABLE (7.6) BLOCKS 4, 5, 12 and 19: LAND USE INTENSITY OF FARMS, JANUARY, 1977

Land Use Intensity (in percentage)	BLOCK 4 Farms		BLOCK 5 Farms		BLOCK 12 Farms		BLOCK 19 Farms	
	No.	%	No.	%	No.	%	No.	%
Over 100 *	3	3.1	10	6.6	11	5.9	21	21.0
81–100	18	18.6	46	30.3	67	35.6	41	41.0
61–80	8	8.2	22	14.5	44	23.4	24	24.0
41–60	11	11.1	32	21.0	34	18.1	4	4.0
21–40	23	23.7	18	11.8	20	11.2	1	1.0
1–20	12	12.4	12	7.9	–	–	–	–
Fallow Land	14	14.4	7	4.6	5	2.7	1	1.0
No Records **	3	3.1	5	3.3	7	3.7	8	8.0
Farm Area Unknown ***	5	5.2	–	–	–	–	–	–
Total Farms	97		152		188		100	

* Because some farmers grow two crops together on some plots, their total area was sometimes listed under both crops in the records, so giving figures in excess of 100 per cent in Tables

** Farms with no records either because they were uncropped or simply unrecorded.

*** These farms are cropped but it is not possible to calculate their land use intensity since the total area of each of them is unknown.

TABLE (7.7) BLOCKS 4, 5, 12 and 19: LAND USE INTENSITY OF FARMS, JULY, 1977

Land Use Intensity (in percentage)	BLOCK 4 Farms		BLOCK 5 Farms		BLOCK 12 Farms		BLOCK 19 Farms	
	No.	%	No.	%	No.	%	No.	%
Over 100 *	2	2.1	8	5.3	3	1.6	1	1.0
81-100	20	20.6	34	22.4	50	26.6	19	19.0
61-80	11	11.3	12	7.9	10	5.3	5	5.0
41-60	26	26.8	19	12.5	23	12.2	4	4.0
21-40	6	6.2	28	18.4	33	17.6	1	1.0
1-20	6	6.2	21	13.8	29	15.4	5	5.0
Fallow Land	12	12.4	23	15.1	27	14.4	57	57.0
No Records **	9	9.3	7	4.6	12	6.9	8	8.0
Farm Area Unknown ***	5	5.2	-	-	-	-	-	-
Total Farms	97		152		188		100	

* Because some farmers grow two crops together on some plots, their total area was sometimes listed under both crops in the records, so giving figures in excess of 100 per cent in Tables

** Farms with no records either because they were uncropped or simply unrecorded.

*** These farms are cropped but it is not possible to calculate their land use intensity since the total area of each of them is unknown.

cent decrease in July. Much of this reduction in dunums resulted from a general lowering of land use intensity rather than many more idle farms.

In Block 12 the emphasis upon winter land use became even more clear. 65 per cent of the farms in the block used over 60 per cent of their land in January compared with only 33 per cent in July. The number of farms fallow in July was over five times the number idle in January.

This seasonal variation in land use intensity became most marked in Block 19 where previously it was noted that 97% of the farms were cropped in winter compared with about one-third in summer. Data presented here in Tables 7.6 and 7.7 on land use intensity again demonstrates this seasonal use of land. 86 per cent of the farms had over 60 per cent of their area cultivated in January 1977 but this fell to only 25 per cent in July. Whereas only 1 farm was reported as fallow in the January, no less than 57 farms were in this category in the July.

All of this suggests that whereas generally land use intensity is higher in January than in July the difference becomes much more marked in the south than to the north. In Block 4 in the north the number of dunums in use and the number of farms in use could point to either July or January as being the more important cropping season but in Block 5 the winter dominance is rather clearer and this becomes more pronounced still in Blocks 12 and 19. This means that in the northern blocks, as Fig. 7.6 indicates, a farmer will often rest his land either in winter or in summer depending on his annual cropping programme. In the southern blocks, however, far less land is out of use in January because it is more likely to be uncropped in the arid summer. Cropping here is much more seasonal. Hence if one looks at farms using over 60 per cent of their land in January one finds this ranges from only 30 per cent in Block 4 in the north to 86 per cent in Block 19. 14 per cent of farms were entirely fallow in January in the northern block compared with only 1 per cent in Block 19.

In contrast in July the pattern of idle land shows that there is far less farming activity in the south than in the centre and north. 57 per cent of farms in Block 19 were unused in July 1977 compared with

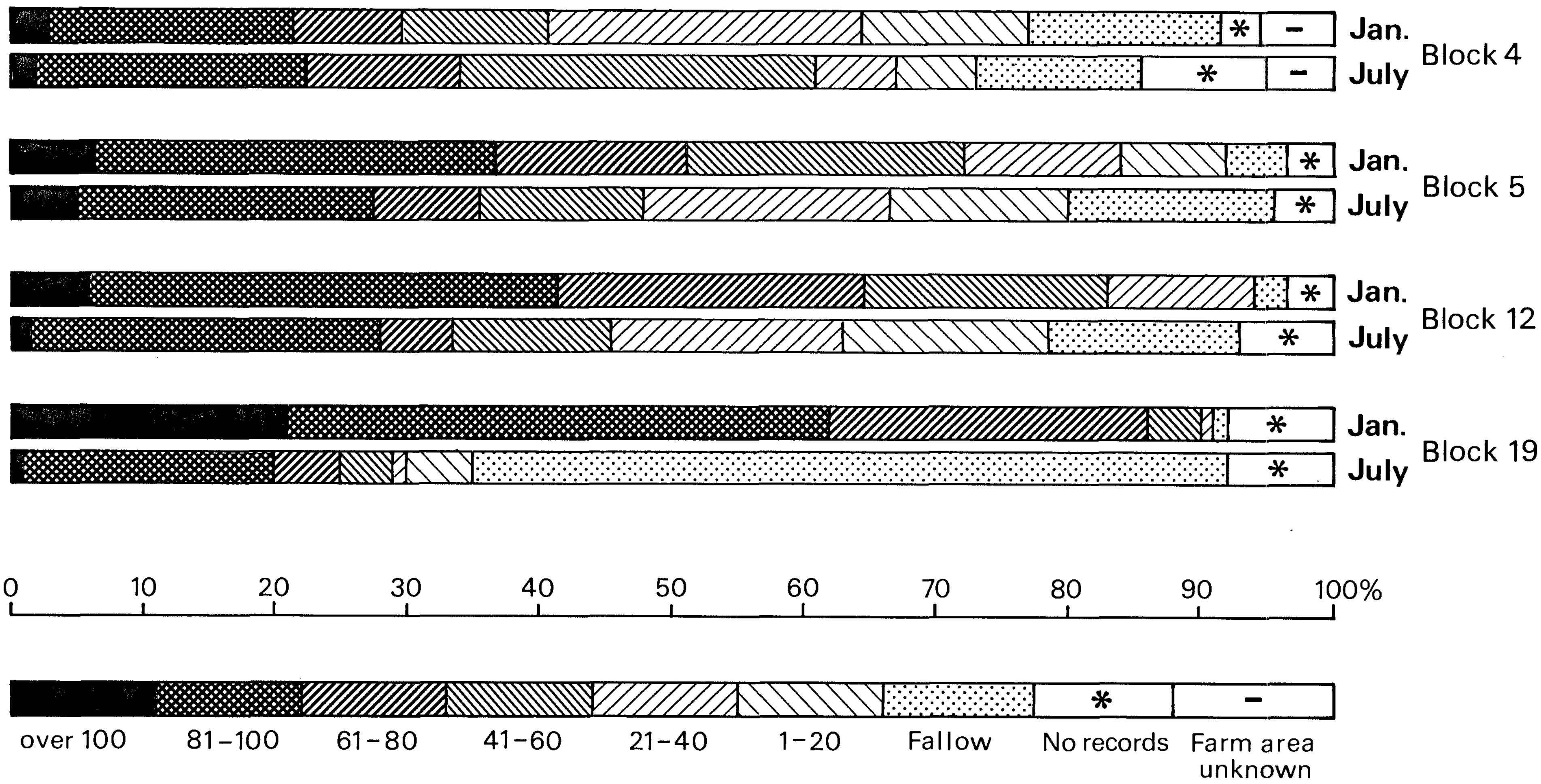

Fig. 7.6 THE FOUR SELECTED BLOCKS: LEVELS OF LAND USE INTENSITY, 1977

under 15 per cent in all of the three blocks to the north. On the other hand some farms, particularly those concentrating on citrus remained active in July in Block 19 so that the number of farms using more than 60 per cent of their land in July was not much less in Block 19 than in the other blocks. A quarter of farms in Block 19 used over 60 per cent of their land in July compared with between 30 and 40 per cent in the other 3 blocks. It was, then, in the multi-crop vegetable farms in the southern block that activity ceased in the arid season. All of this would suggest that there are, in reality, several different classes of farm enterprise within the project area, ranging from all-year round farms more commonly found in the north, where summer vegetable production is often as important as winter citrus and cereal production, to winter-producing vegetable units in the south, where summer cropping is more unusual except for citrus. Not all farms in all blocks follow these patterns, however. As we have seen, one can find idle land in the north in summer, whilst some southern farmers produce summer crops.

7.3 Farm Enterprises in the Project Area

The previous section has shown that at the farm level there was a considerable degree of variety of crop combinations and crop types between and within the selected blocks. Areas of homogeneity could, however, be picked out. The examination of farms in only four blocks does not necessarily demonstrate that the same mixture of homogeneity and heterogeneity would apply across the whole project area. As a result it was decided to attempt a rather simpler analysis and classification of enterprises across the whole project area. As it was not possible to get farm records for the whole project area from the project authority and as it would not have been possible, in any case, to process such a mass of data, it was decided to base this simpler analysis on the cropping records for the month of April 1979 for the same 353 farms used in the writer's 1980 sample survey. It seemed sensible to use these farms because they are not only well distributed across the project but because the results of the analysis could also be fed into the general classification of these farms made in Chapter 11. The 353 farms were selected across the four sections of the project area so that results given in Tables 7.8 and 7.10 are based on these sections. Section I includes Blocks 1 to 10. Section II includes Blocks 11 to 18; Section III Blocks 19 to 22; and Section IV Blocks 23 to 24. Details of the sampling of the 353 farms are given in Chapter 1.

7.3.1 Method of Analysis

Two different approaches were used to classify and analyse the sample farms into types of enterprises. Firstly, the Thomas method of crop combination analysis already applied to the data at the block level in Chapter 6 and at the farm level in the first part of this chapter was again employed. The second approach was based on two multivariate classificatory techniques - cluster and discriminant analysis - which are also used more extensively in Chapter 11 for the general farm classification. The Thomas and the multivariate methods produced results that were very similar to each other, so confirming the correctness of the enterprise classification. For the sake of clarity most of the description of the enterprise groups revealed by the analysis is based on the results obtained by the Thomas method of analysis.

In all cases a step taken prior to the classification and analysis of the farm data was to group all crops under three headings: fruit trees (mainly citrus and banana), vegetables, and cereals (mainly wheat with some barley). As farm records recorded all individual crops in dunums this was first converted into the percentage area of each farm taken up by fruit, vegetables and cereals.

7.3.2 Farm Enterprise Classification (Thomas Model)

The computer programme previously used in the crop combination analysis at the block and farm level was now applied to the 353 sample farms. This produced a grouping into 7 main enterprise types, ranging from the common single crop type enterprise through three forms of dual enterprise, to an uncommon enterprise involving fruit, vegetable and cereal crops together on the farm unit. These 7 enterprise types are listed in Table 7.8 together with their frequency of occurrence in each of the four sections of the project area. The distribution of the sample farms grouped by these enterprise types is shown in Fig. 7.7.

7.3.2.1 Single Crop Type Enterprises[2]

The single crop type enterprises can be considered first since they were the most common and widespread. 68.9 per cent of all sampled farms were of single crop types, that is predominantly growing only fruit, or vegetables or cereals, but they showed considerable spatial variation being much more common in Section III - where they included over 91 per cent of all the sampled farms - than in other sections. Sections II and IV had 73 and 60 per cent respectively in this group but in Section I only a little over half of the sample (54 per cent) were single crop type enterprises.

Most common of the single crop-type enterprises were the vegetable farms. 67.5 per cent of all single crop-type enterprises were vegetable growers. These made up nearly a half of all sampled farms (46.4 per cent). The main concentration of vegetable farms occurred in the middle two sections of the project area where two-thirds of all these farms were found. In contrast Section I had only 10 per cent of these farms. Within the middle part of the project area Section III was the main area of vegetable farms where 82.5 per cent of the sampled farms were single crop-type vegetable enterprises. In Section II to the north and Section IV to the south, only about half of the sampled farms were of this type.

Single crop-type enterprises based on fruit trees were much less common than vegetable enterprises with only 19.3 per cent of all sampled farms of this type and only 28 per cent of the single crop-type enterprise farms. Part of the reason for this lesser importance of fruit as against vegetable farms is that there is, of course, a wider range of vegetable crops grown in the project area so that vegetable farmers could grow a number of different vegetable crops yet still be classed as a single enterprise farm. On the other hand citrus and banana form the only two fruit crops grown in the area so that farmers are much less likely to grow nothing but fruit.

TABLE (7.8) EAST GHOR CANAL PROJECT:

FARM ENTERPRISE CLASSIFICATION (THOMAS MODEL), SAMPLE SURVEY, 1979

Farm Enterprise Combinations	Section I		Section II		Section III		Section IV		Total EGCP	
	No	%	No	%	No	%	No	%	No	%
Single Enterprise Combination:-	55	53.9	68	73.1	73	91.3	47	60.3	243	68.9
1) Fruit trees enterprise (F)	36	35.3	23	24.7	7	8.8	2	2.6	68	19.3
2) Vegetables enterprise (V)	17	16.7	43	46.2	66	82.5	38	48.7	164	46.4
3) Cereals enterprise (C)	2	2.0	2	2.2	0	0	7	9.0	11	3.1
Two Enterprise Combination:-	45	44.1	23	24.7	7	8.7	31	39.7	106	30.0
4) Vegetables - Fruit trees enterprise (VF)	33	32.3	13	14.0	6	7.5	1	1.2	53	15.0
5) Vegetables - Cereals enterprise (VC)	11	10.8	9	9.7	1	1.2	30	38.5	51	14.4
6) Fruit trees - Cereals enterprise (FC)	1	1.0	1	1.0	0	0	0	0	2	0.6
Three Enterprise Combination:-										
7) Fruit trees - Vegetables - Cereals (FVC)	2	2.0	2	2.1	0	0	0	0	4	1.1
Total	102		93		80		78		353	

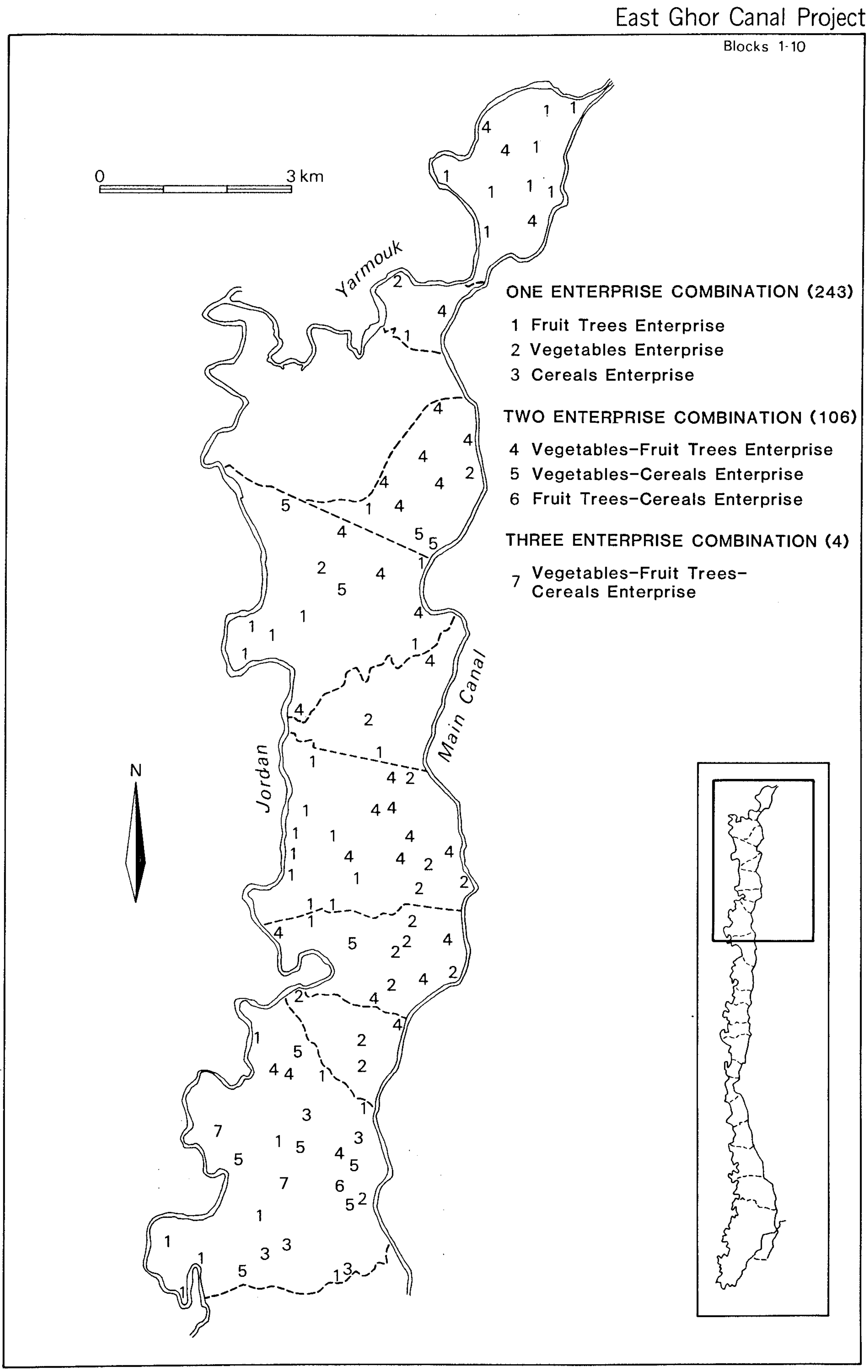

Fig. 7.7 EAST GHOR CANAL PROJECT: DISTRIBUTION OF FARMS ACCORDING TO THE FARM ENTERPRISES CLASSIFICATION (THOMAS MODEL) APRIL, 1979

East Ghor Canal Project

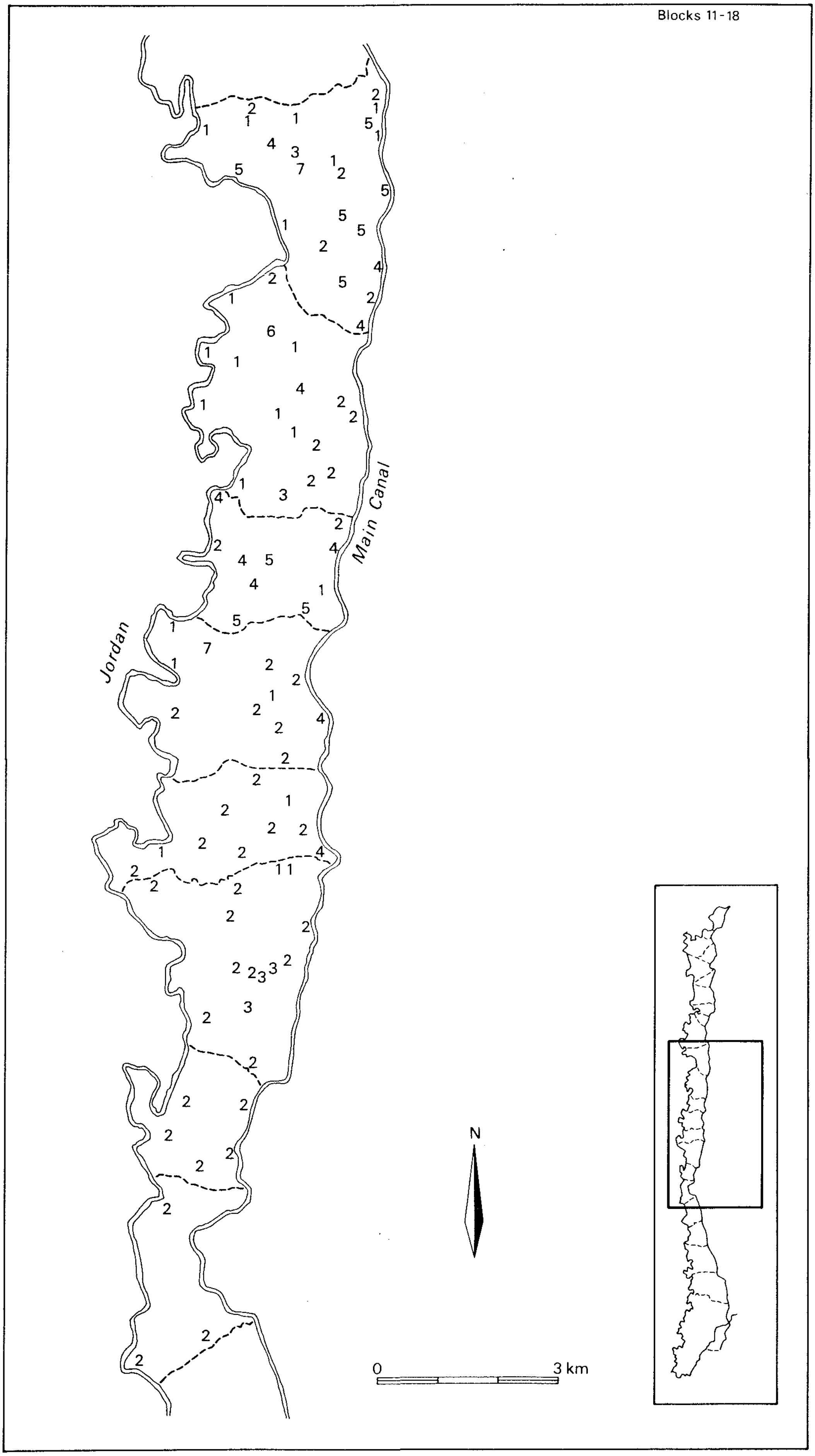

Fig. 7.7 continued

East Ghor Canal Project

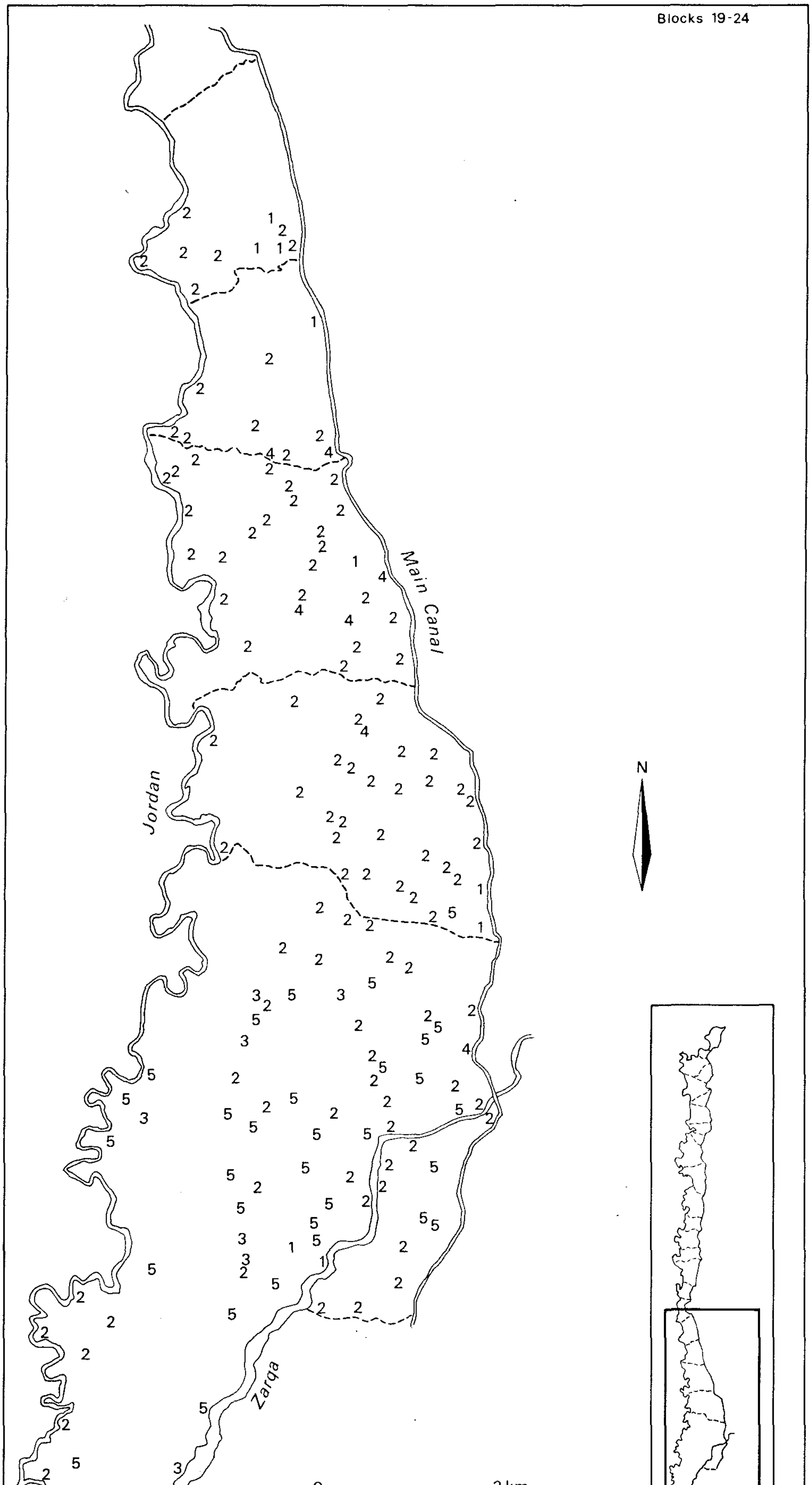

Fig. 7.7 continued

Fruit enterprises concentrated in the northern part of the project area. 86.8 per cent of all of this type of enterprise were found in Sections I and II, and particularly Section I which had 53 per cent of all the single crop fruit enterprises. This type of farm was much less common in the southern two sections where only 10 and 3 per cent of the sampled single enterprise farms were of this type.

Single enterprise cereal farms were uncommon amongst the sample, probably because farm units in the project area are seldom large enough to allow a farmer to rely entirely on the produce of such a low value crop. Only 11 of the sample farms, or 3 per cent, were of this type, two-thirds of them occurring in Section IV, but even here they only formed 9 per cent of the sampled farms in that section. Their pattern of distribution probably reflected the occurrence of areas of poorer land and the occasional farm being rested temporarily from more profitable crops.

7.3.2.2 Dual and Triple Crop Type Enterprises

Dual crop enterprises made up 30 per cent of all the sampled farms with vegetable-fruit and vegetable-cereal combinations being equally common. The fruit-cereal combination, however, was rarely found. The two common dual enterprises were, however, differently distributed amongst the sampled farms. Vegetable-fruit enterprises were common in the north and vegetable-cereal combinations in the south. Section III had fewer of each with less than 9 per cent of its farms having a dual enterprise. This was the section where single enterprise vegetable farms were so common. 62 per cent of vegetable-fruit farms were found in Section I in the north with 24 per cent in Section II. Section III had only 11 per cent of these farms and Section IV only 2 per cent.

Almost as common as the vegetable-fruit farms were the vegetable-cereal farms which made up 14.4 per cent of all the farms that were sampled. 59 per cent of these farms were found in Section IV in the south while Sections I and II in the north each had less than 20 per cent of these units. Only one farm of this type was found in Section III.

The fruit-cereal type of enterprise was rarely found within the sample with only one farm of this type in each of Sections I and II. Similarly there were only 4 farms classified by the Thomas method as fruit-vegetable-cereal combination enterprises, or only 1.1 per cent of the sampled farms. All 4 of these farms were in Sections I and II.

7.3.3 Enterprise Classification by Cluster and Discriminant Analysis

An analysis of the same farm crop data for the 353 sampled units, using cluster and discriminant analysis, allowed a variable number of classes of enterprises to be recognised depending on the degree of generalisation to be accepted. Much more use is made of this method of computer based classification in Chapter 11 so that details of the technique are further discussed there. It is sufficient to note here that the Ward method of cluster analysis was employed. This depicted five main groups of farm enterprises at a low level in the classification and the reliability of this grouping was tested and confirmed by discriminant analysis. Fig. 7.8 shows the computer print-out of this classification.

A test of this classification, given in Table 7.9 indicates that the actual groups correspond very closely with statistically predicted groups, suggesting the validity of the grouping created by the method. Further confirmation of the method is also provided by the fact that the five groups depicted are the same as the five common enterprises picked out by the Thomas approach to the farm data. These were the three single enterprise combinations - vegetable (group 3), fruit (group 1) cereals (group 5) - and two dual crop enterprises - vegetable-fruit (group 2) and vegetable-cereals (group 4). This method created no fruit-cereal or fruit-vegetable-cereal classes but it will be recalled that those types of farm were rarely found by the Thomas approach. Because the results obtained by cluster and discriminant analysis of the sampled farms were very similar to those obtained by the Thomas method it has not been felt necessary to deal with them in much detail. This method of analysis, however, also took into account information on the percentage of land on each farm devoted to each enterprise, and some reference is made to this.

Table 7.10 shows the distribution of these five enterprise types

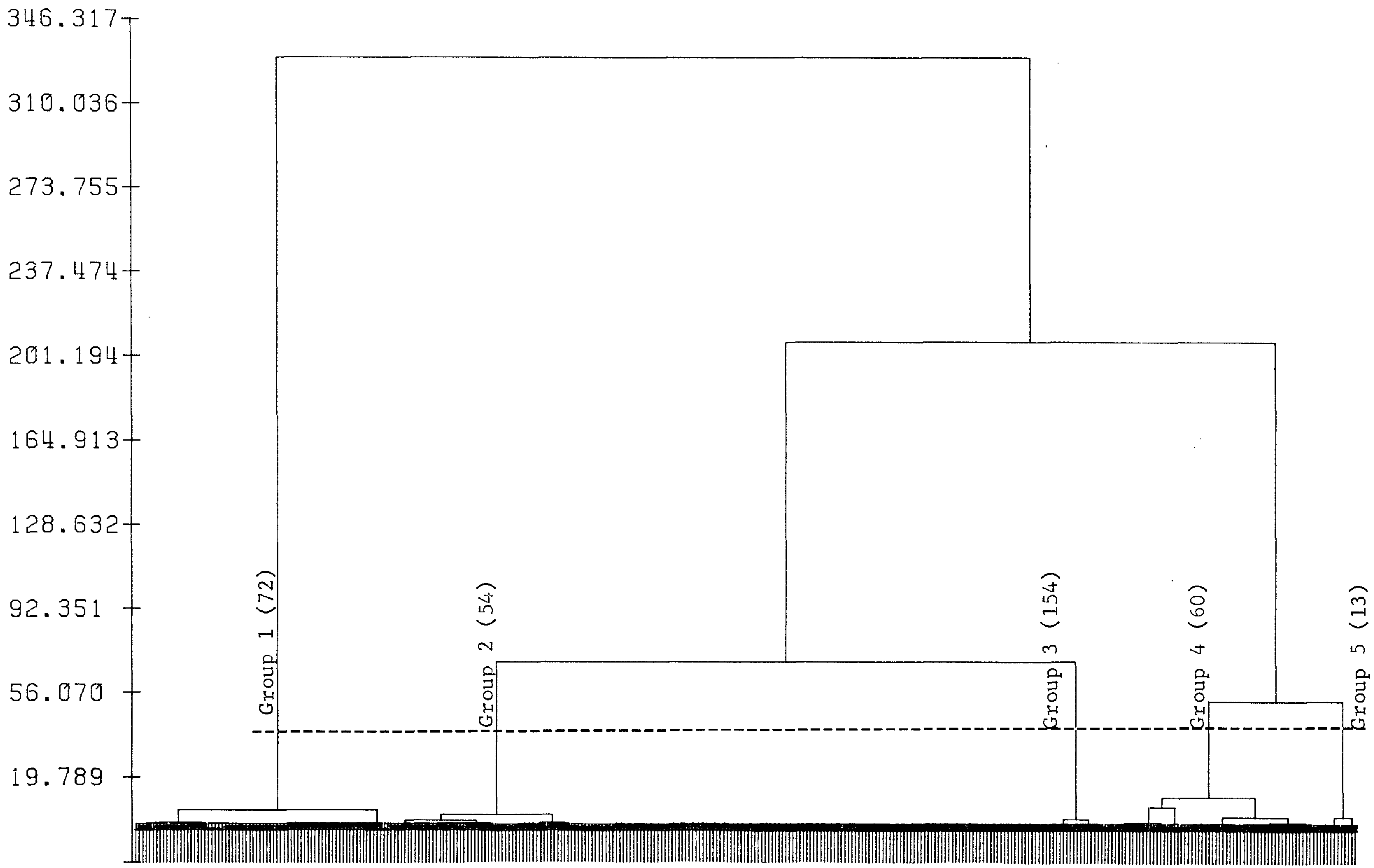

Fig. 7.8 EAST GHOR CANAL PROJECT: DENDROGRAM OF FARM ENTERPRISES

TABLE (7.9) EAST GHOR CANAL PROJECT:

TESTING FARM ENTERPRISE CLASSIFICATION BY DISCRIMINANT ANALYSIS

Actual Group	No of Cases	Predicted Group Membership: Group 1	Group 2	Group 3	Group 4	Group 5
Group 1	72	72 100.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
Group 2	54	0 0.0%	54 100.0%	0 0.0%	0 0.0%	0 0.0%
Group 3	154	0 0.0%	0 0.0%	154 100.0%	0 0.0%	0 0.0%
Group 4	60	1 1.7%	1 1.7%	1 1.7%	57 95.0%	0 0.0%
Group 5	13	0 0.0%	0 0.0%	0 0.0%	0 0.0%	13 100.0%

Percent of "Grouped" Cases correctly classified: 99.15%

TABLE (7.10) EAST GHOR CANAL PROJECT: DISTRIBUTION OF FARM ENTERPRISE GROUPS (CLUSTER AND DISCRIMINANT METHODS) SAMPLE SURVEY, 1979

	Section I			Section II			Section III			Section IV			Total Project		
	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %
Group 1	41	40.2	56.9	22	23.6	30.6	7	8.8	9.7	2	2.6	2.8	72	20.4	100.0
Group 2	28	27.5	51.8	17	18.3	31.5	7	8.8	13.0	2	2.6	3.7	54	15.3	100.0
Group 3	15	14.7	9.7	40	43.0	26.0	64	80.0	41.6	35	44.9	22.7	154	43.6	100.0
Group 4	15	14.7	25.0	12	12.9	20.0	2	2.5	3.3	31	39.7	51.7	60	17.0	100.0
Group 5	3	2.9	23.1	2	2.2	15.4	–	–	–	8	10.2	61.5	13	3.7	100.0
Total	102	100.0		93	100.0		80	100.1		78	100.0		353	100.0	

across the four sections of the project area and Table 7.11 indicates the proportions of land actually under particular uses on farms in each of the five types. As with the Thomas approach, the cluster analysis showed that single crop type vegetable enterprises (group 3) were most common making up 44 per cent of the farms sampled (compared with 46 per cent by the Thomas approach). Again most of these were found in Section III which had 80 per cent of its farms in this group, with the fewest found in Section I. All of this only confirms the importance of this group, already referred to, although as Table 7.11 shows, it is also possible to see that farms of this type rarely used even relatively small amounts of their land for other crops. Only 5 per cent of farms in this group used any land for crops other than vegetables.

The single enterprise fruit tree farms (group 1) were, by this method of analysis, as by the Thomas approach, shown to be the second most numerous farm type in the sample, accounting for 20 per cent of the sample (19 per cent by the Thomas method). 88 per cent of these were in Section I and II. In the case of this group over 70 per cent of the farms devoted no land to any other crop, the remainder having less than 30 per cent of their cropped land under vegetables, again indicating the extent to which enterprise specialisation has occurred.

The vegetable-cereal enterprise (group 4) was the third most common group with 17 per cent of the total sample (compared with 14 per cent classed as such by the Thomas method). Just over half of these farms were in Section IV with only 2 farms of this type in Section III, and the remainder in the northern sections. It is noticeable in Table 7.11 that this group is more varied and more difficult to classify - hence the greater divergence between the results obtained for these under the two methods of classification - partly because many of these farms have more land under other uses than their prime crop type. 18 per cent of these farms grow some fruit although this generally took up less than 31 per cent of the cropped land on these farms. Vegetables were the dominant crop on most units - 55 per cent devoted over 60 per cent of their cropped land to these crops - with cereals a secondary crop.

TABLE (7.11) EAST GHOR CANAL PROJECT: CROPPING CHARACTERISTICS OF FARM ENTERPRISE GROUPS (CLUSTER AND DISCRIMINANT ANALYSIS)

		Percentage of Cropped Land				
		1–30	31–60	61–99	100	Total
Group 1						
Fruit Trees	Freq	–	–	21	51	72
	%	–	–	29.2	70.8	100.0
Vegetables	Freq	21	–	–	–	21
	%	29.2	–	–	–	29.2
Group 2						
Fruit Trees	Freq	7	39	8	–	54
	%	13.0	72.2	14.8	–	100.0
Vegetables	Freq	1	31	22	–	54
	%	1.9	57.4	40.7	–	100.0
Cereals	Freq	2	–	–	–	2
	%	3.7	–	–	–	3.7
Group 3						
Fruit Trees	Freq	8	–	–	–	8
	%	5.2	–	–	–	5.2
Vegetables	Freq	–	–	8	146	154
	%	–	–	5.2	94.8	100.0
Group 4						
Fruit Trees	Freq	7	3	1	–	11
	%	11.7	5.0	1.7	–	18.4
Vegetables	Freq	3	22	33	–	58
	%	5.0	36.7	55.0	–	96.7
Cereals	Freq	19	37	4	–	60
	%	31.7	16.7	6.7	–	100.1
Group 5						
Vegetables	Freq	5	–	–	–	5
	%	38.5	–	–	–	38.5
Cereals	Freq	–	–	5	8	13
	%	–	–	38.5	61.5	100.0

The last two groups of enterprises - vegetable and fruit (group 2) and cereals (group 5) need little further consideration especially as their pattern has already been discussed when the Thomas method of grouping was considered. 15 per cent of the total sample was classified as vegetable-fruit enterprises under both this and the Thomas method of classification, with 83 per cent of these units being found in the northern two sections of the project. Vegetables appeared to be the dominant crop on most of these farms. 40 per cent of them devoted more than 60 per cent of their cropped land to vegetables compared with only 15 per cent having a similar emphasis upon fruit. Two farms also grew small amounts of cereals.

The 13 farms classed as cereal enterprises (group 5) compare with the 11 put into this class by the Thomas method. The majority occurred in Section IV. It was earlier noted that one would expect few farms of this type in view of the low value of cereal crops and it is to be noted here that Table 7.11 shows that 38.5 per cent of these farms also grew some vegetables in order to diversify their income sources.

7.4 Conclusion

Some pattern seems to emerge from this complex detail of land uses at the farm level. This suggests that some distinction can be made between the northern and southern parts of the project area as well as other differences superimposed on this between farmers who place greater or lesser reliance upon perennial fruit crops, annual vegetable production and cereals. Both the data for the farms in the four selected blocks and for the 353 farms sampled across the project area suggest that in the north the farm enterprises are predominantly of a simple type based in most cases on citrus or, occasionally, banana production supported to a greater or lesser extent by vegetable growing. This type of enterprise depends upon a whole-year farming programme so that land use intensity varies less with the greater amounts of rainfall and irrigation water available throughout the year on the northern ghor. Moving southwards vegetable production soon becomes the dominant type of enterprise on farms although the range of vegetables grown is considerable. In some cases these farms mix vegetable production with citrus, cereals or some other land use but generally the cropping programme emphasises the winter period when the southern climate is more suitable for crop production and irrigation water supplies are more secure.

It should also be re-iterated, however, that the analysis of farm cropping made in this chapter was based entirely on data for a few months in 1977 and 1979. The analysis of crop combinations across the project area in Chapter 6 showed that the pattern of cropping in the late 1970s was still undergoing change and was markedly different from what it had been in earlier years of the project's operation. Yet it can be noted that as these changes occurred the broad spatial variations, especially between north and south were still to be seen and have, in this chapter, been demonstrated to still exist at the level of the individual farm.

There are clearly other elements to the development of a pattern of more intensive irrigated agriculture than simply crop outputs. Such aspects of farming as the supply of basic needs, as well as credit, and the development of marketing are also likely to show spatial variations across the project area and it is to these that attention is turned in the next chapters.

Notes

1. Section III originally covered the project area south of Block 18 and here refers to Blocks 19 to 22, but as the scheme was lengthened and developed in the south, part of Section III became a separate Section IV and, later, Block 24 became part of a Section V. It was not possible to sample a block in the far south of the project area because of lack of suitable data.
2. The term "crop-type enterprises" is used here to distinguish them from "crop enterprises" already referred to. Whereas particular crops can be specified in a crop enterprise, a crop type enterprise is made up of groups of crops such as vegetables and fruits although the particular crops are not specified.

CHAPTER 8 FARM SERVICES I: SUPPLY AND MARKETING

8.1 Introduction

Although the pattern of cropland use and its development must be considered central to a geographic study of an irrigation scheme, it can be argued that, since the East Ghor Project is also a cash-cropping farm system, it is necessary to also examine how the farmers obtain their supplies and other essential services, like loans and advice, and how they market their produce. It soon became apparent to the writer, in his surveys of cropland use, that major variations occurred across the project area, not only in terms of the crop combinations employed, but also in the farmers' use of these other farm services, and he felt that these should be enquired into as a vital part of the total farm system. As a result alongside his crop studies during his 1978 and 1980 fieldwork seasons, the writer undertook sample questionnaire surveys enquiring into farmers' use of a variety of supply, marketing and other needs and services. The results of the analysis of several parts of those surveys are presented in the next three chapters along with supplementary data from official and other sources.

Because of the limited size of the questionnaire sampled used - 156 respondents in 1978 and 353 in 1980 - and the small numbers of farmers found in some categories, it has not been possible to statistically test the validity of all the apparent relationships between farmers' use of services and their other characteristics. In such cases the writer has based his often tentative conclusions only on the more striking differences revealed within the samples, and only where the results of the 1980 survey confirm those obtained in 1978. It is convenient to firstly consider the farm supply situation where there are a number of alternative sources of supplies available to east ghor farmers, before looking at the produce marketing position where the farmers have a more restricted range of options. The chapter ends by considering the important role played by commission agents for many east ghor farmers, both for farm supplies, credit and produce marketing.

Although the provision of agricultural credit is mainly considered in the next chapter, the role of commission agents extends into credit provision just as co-operatives have also expanded their activities across the loaning field into farm supplies, so that it is not entirely possible to separate loaning activities from supply and marketing.

8.2 Supply and Marketing Agencies

A number of agencies, both private and public, exist in the Jordan Valley to provide the farmer with the range of farm supplies that he needs such as seeds, fertilizers, pesticides and equipment. Several of these agencies also provide credit or cash loans on a short term or longer term basis either to tide the farmer over a seasonal cash shortage or to provide for major farm improvements. The range of agencies providing marketing outlets for crops, however, appears to be much narrower. What is also apparent is that there is a north-south distinction across the project area in the availability and use of these agencies. In general the farmer in the longer developed northern parts of the project area has available a wider range of supply, marketing and credit agencies than the farmer in the more recently-developed southern areas.

In outline six main agencies can be identified for these various services of which two are government-sponsored.

a) Village merchants appeared, from the writer's 1978 survey, to be the most important supply source for farmers' regular needs, much more so in the longer-established northern parts of the project area than in southern areas where village merchants were totally absent in some parts. There is some evidence to suggest, however, that they may be of declining importance to many northern farmers as a result of the recent development of supply services by farm co-operatives and the Jordan Valley Farmers Association. Village merchants have the advantage of being close to the farmers they supply and therefore knowing their needs but unlike some of the other agencies increasingly available to farmers, they get little involved either in providing goods on credit or actual cash loans, or in the marketing of farm produce which reduces their usefulness to some farmers.

b) Like the village merchants agricultural supply companies, based in towns outside of the ghor like Amman and Irbid are also significant sources of farm supplies in the ghor. They also rely on cash payment and do not often provide loans or marketing facilities.

c) In some cases landlords act as suppliers to their tenants or sharecroppers and may also provide credits and loans as well as assist in the marketing of tenants' produce, but since most farmers are owner-occupiers, landlords are a relatively unimportant agency compared with others.

d) Commission agents are also important sources of farm supplies for many ghor farmers. Their primary role was to act as marketing agents for the farmers' produce by auctioning or selling it, for a commission, at various markets in the valley and towns to the east. It will later be shown that they are the main marketing outlet for most ghor farmers. In order to maintain their market share and increase their own profits, however, many commission agents also now provide supplies, often on credit, and even short-term cash loans. While commission agents are everywhere important for marketing in the ghor area they seem only to have developed this more inclusive role in the southern areas. This has led in many cases to a strong relationship between a farmer and his commission agent which in some instances may involve the farmer in permanent indebtedness.

e & f) Two additional service agencies of a co-operative nature which are both government sponsored - the local branches of the Jordan Co-operative Organisation and the Jordan Valley Farmers Association - have developed in the valley in more recent years to offer alternative but similar supply and loaning services to those already available, but with the additional aim of helping to improve farming standards. In neither case, however, do they yet provide much of a marketing service.

Branches of the Jordan Co-operative Organisation have increased in number and strength in the valley since the early 1960s to the point where in 1980 the writer found nearly half of his respondents were members, and over a half of all sampled farmers stated that they obtained supplies from the co-operatives, much of them on short term credit. They have also had an increasingly important role to play in providing loans, mainly over the medium-term for farm improvements, but have, so far played little or no role in either the marketing field or in the provision of advice. Although everywhere important in the valley they tend to be stronger in some areas than others. Because of their recent development and increasing influence on several aspects of farming in the ghor they are considered more fully in Chapter 10.

The Jordan Valley Farmers Association (JVFA) is similar in its functions to the co-operatives but even more recent in its development, being established in 1974. Its membership has grown rapidly particularly in those parts of the valley where the co-operatives have been weaker, notably in the south. Although the JVFA has plans to develop marketing facilities for its members, so far it has concentrated on expanding its supply and loaning services. Because of its increasing importance to ghor farmers its role is further considered, along with that of the co-operatives, in Chapter 10.

8.3 Farm Supply Conditions

8.3.1 Farm Suppliers

With a range of agencies involved in providing supplies to farmers it is convenient to examine the use made of these before considering the marketing situation for ghor farmers.

In his 1978 pilot questionnaire survey the writer obtained data from farmers in each of the four sections of main project area (Stage I) as well as some in the southern extension area and around Karameh - South Shuneh - Kafrain which together form the uncompleted second stage of the project. In asking the farmers where they obtained their supplies he divided these sources into three main groups - village merchants, co-operatives and commission agents - and grouped all others into a single fourth miscellaneous category. As several respondents stated more than one major source from which they took their supplies, the number of individual observations given in Table 8.1 exceeds the number of farmers questioned. The percentages based on those also total to more than 100. In the second part of the table, however, only the main source stated by each farmer is recorded.

With the 1980 questionnaire, the writer modified his survey by increasing the range of sources separately identified to include

TABLE (8.1) EAST JORDAN VALLEY: SOURCES OF FARM SUPPLIES, SAMPLE SURVEY, 1978

	East Ghor Canal Project						(STAGE I)				Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Stage I		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Stage II	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Reported sources																
Village merchant	17	50.0	22	62.9	19	65.5	5	27.8	63	54.3	0	0	0	0	0	0
Co-operative	14	41.2	23	65.7	6	20.7	2	11.1	45	38.8	2	18.2	6	20.7	8	20.0
Commission agent	3	8.8	1	2.8	4	13.8	15	83.3	23	19.8	1	9.1	11	37.9	12	30.0
Others	5	14.7	4	11.4	12	41.4	2	11.1	23	19.8	9	81.8	17	58.6	26	65.0
Total observations	39	114.7	50	142.8	41	141.4	24	133.3	154	132.7	12	109.1	34	117.2	46	115.0
First Choice (Main) Sources																
Village merchant	15	44.1	16	45.7	12	41.4	2	11.1	45	38.8	0	0	0	0	0	0
Co-operative	13	38.2	17	48.6	4	13.8	1	5.6	35	30.2	2	18.2	3	10.4	5	12.5
Commission agent	3	8.8	1	2.9	4	13.8	14	77.8	22	19.0	1	9.1	11	37.9	12	30.0
Others	3	8.8	1	2.9	9	31.0	1	5.6	14	12.0	8	72.3	15	51.7	23	57.5
Total Sample (No. of farmers)	34	99.9	35	100.1	29	100.0	18	100.1	116	100.0	11	100.0	29	100.0	40	100.0

agricultural supply companies, the Jordan Valley Farmers Association and landlords. He also noted where farmers simply reported that they used a combination of sources. This 1980 survey was also restricted to the four sections of the main project area although a much bigger sample was used. The results of this survey are summarized in Tables 8.2 and 8.3.

Table 8.1 shows that village merchants and co-operatives were the main supply sources for the sampled farmers in the main project area in 1978 with commission agents and other sources being least, but still fairly commonly, used. In contrast in the southern areas (StageII) the miscellaneous, or other sources, were dominant with no reported supplies from village merchants. Commission agents and co-operatives were also used to some extent for supplies. The second part of the table which only records the farmers' prime supply sources, shows much the same pattern.

Not surprisingly when these patterns are broken down into the various sections within Stages I and II of the valley , considerable variations in supply sources are seen. Although village merchants were important in Sections I, II and III their dominance was replaced by that of commission agents in Section IV. They were also important in the South Shuneh area in the far south. Co-operatives, on the other hand, were most important suppliers to farmers in the northern two sections while the other miscellaneous sources were important in both of the Stage II sections and in Section III of Stage I. When one examines the pattern of prime suppliers to farmers it is little different but it is clear that least change has occurred to the frequency of use of commission agents who, because they both marketed the farmers' produce and offered supplies on credit, tended to hold a monopoly on those farmers they dealt with. On the other hand many farmers who got most of their supplies from village merchants, co-operatives or other sources often reported that they obtained some of their needs from alternative suppliers.

It is, then, worth noting that, overall, village merchants in 1978 were generally strongest in the longer-established northern farming areas although they were there rivalled by the expanding co-operatives

TABLE (8.2) EAST GHOR CANAL PROJECT:

PRIME SOURCE OF FARM SUPPLIES, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Source:										
Village Merchant	24	23.5	8	8.6	8	10.0	2	2.6	42	11.9
Co-operative	11	10.8	22	23.6	2	2.5	26	33.3	61	17.3
Commission Agent	1	1.0	2	2.2	6	7.5	18	23.1	27	7.6
Agricultural Co.	17	16.7	9	9.7	7	8.7	2	2.6	35	9.9
JVFA	2	2.0	8	8.6	11	13.7	3	3.8	24	6.8
Landlords	0	0	0	0	2	2.5	0	0	2	0.6
Mixed	47	46.0	44	47.3	44	55.0	27	34.6	162	45.9
Total Sample (No. of farmers)	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

TABLE (8.3) EAST GHOR CANAL PROJECT:

REPORTED SOURCES OF FARM SUPPLIES, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Village Merchant	69	67.6	34	36.6	32	40.0	4	5.1	139	39.4
Co-operative	39	38.2	66	71.0	35	43.8	52	66.6	192	54.4
Commission Agent	3	2.9	17	18.3	34	42.5	49	62.8	103	29.2
Agricultural Supply Companies	66	64.7	30	32.2	34	42.5	20	25.6	150	42.5
JVFA	23	22.5	47	50.5	43	53.8	14	17.9	127	36.0
Landlords	2	2.0	2	2.1	8	10.0	4	5.1	16	4.5
Total observations	202	198.0	196	210.7	186	232.5	143	183.1	727	206.0
Total sample (No. of farmers)	102		93		80		78		353	

which, at that time, remained weaker in the south. Commission agents were most active in Section IV and the far south where co-operatives and village merchants were weakest. Other sources, such as the fast-developing Jordan Valley Farmers Association and agricultural supply companies, generally based in Amman, appeared to have gained an important foothold in the developing farm areas in Stage II.

The situation revealed in Table 8.2 derived from the 1980 questionnaire, based on a larger sample of farms entirely confined to the four sections of the main project, suggests a number of differences from the situation in 1978 although the two survey samples are not strictly comparable. While overall village merchants remained important suppliers, particularly in the three northern sections, where the 1978 results had showed them to be dominant, their position had been much eroded. Clearly many more farmers were now reporting that they were getting their supplies from more than one source. Table 8.2 shows that those who reported mixed sources as their prime suppliers formed the biggest single category in all four sections of the project area while Table 8.3 shows that on average each farmer now used two supply sources. The enhanced role of the co-operatives, the agricultural supply companies, the Jordan Valley Farmers Association, and in the south the commission agents, is also clear in 1980 if compared with the relatively small proportion of farmers who took supplies from these and the miscellaneous sources listed in the 1978 results.

8.3.2 Farm Supply Availability

The questioned farmers in both years of sampling showed a reasonably high degree of satisfaction with their sources of farm supply availability (Tables 8.4 and 8.5), although it can be noted that a higher level of supply difficulty in 1978 was noted in Section II where only two main sources, co-operatives, and village merchants, were reportedly used. Section IV farmers also reported some supply difficulties and here commission agents were the dominant suppliers. These samples were, however, very small and not statistically testable. In 1980 farmers in Section III recorded the most complaints yet this was a section which had a wider range of supply sources in use in both

TABLE (8.4) EAST JORDAN VALLEY:

AVAILABILITY OF FARM SUPPLIES, SAMPLE SURVEY, 1978

	East Ghor Canal Project (STAGE I)										Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Project		Ext. Area (Damya)		Karameh S.Shuneh & Kafrain		Total Stage II	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Facing difficulty in getting farm supplies																
No	33	97.0	28	80.0	26	90.0	13	72.2	100	86.2	10	90.9	21	72.4	31	77.5
Yes	1	3.0	7	20.0	3	10.0	2	11.1	13	11.2	0	0	2	6.9	2	5.0
Sometimes	0	0	0	0	0	0	3	16.7	3	2.6	1	9.1	6	20.7	7	17.5
Total Sampled Farmers	34	100.0	35	100.0	29	100.0	18	100.0	116	100.0	11	100.0	29	100.0	40	100.0

TABLE (8.5) EAST GHOR CANAL PROJECT:

AVAILABILITY OF FARM SUPPLIES, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Facing difficulty in getting farm supplies										
No	86	84.3	78	83.9	49	61.2	62	79.5	275	77.9
Yes	15	14.7	10	10.7	27	33.8	12	16.7	65	18.4
Sometimes	1	1.0	5	5.4	4	5.0	3	3.8	13	3.7
Total Sampled Farmers	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

1978 and 1980. In 1980, for example, each questioned farmer in Section III used on average 2.3 supply sources, a higher level than in any other section which may, of course, reflect a degree of dissatisfaction with all sources. Section III also seemed to experience greatest changes in supply sources between the two sample years.

But what is perhaps of more interest is the high level of satisfaction reported with supply availability. In 1978,86 per cent of sampled farmers in the main project (Stage I) area and 77 per cent in the Stage II area reported that they could get supplies as they needed them. Similarly high levels of satisfaction were expressed by the sample interviewed in 1980. The most frequently reported difficulties mentioned problems with obtaining seeds and certain pesticides at critical times.* While levels of satisfaction with supply availability in 1980 remained strong, but less so than with the smaller 1978 sample, a noticeable increase in supply complaints was recorded in Section I where the co-operatives appeared to have lost some influence, as well as in Section III.

8.3.3 Method of Payment for Farm Supplies

In both his 1978 and 1980 sample surveys the writer asked farmers by which of three methods they paid for their supplies - by cash, by end of season settlement, or by some other form of instalment payment. Since many respondents reported that they used more than one method of payment, their prime method was separately recorded in Tables 8.6 and 8.7 as well as all reported methods. It can be seen in Table 8.6 that over 60 per cent of sampled farmers used end of season payment in 1978 although, with wider use of varied sources of supplies seen in the 1980 survey, it is clear that other methods of payment had become important by then. Payment in cash at the time of purchase was the second most common method of payment, in 1980, but about 29 per cent of respondents did not specify their main method of payment, mainly because of varied method of payments associated with the growth of the mixed supply sources already noted.

It might be noted that cash payments were less common in 1978 in Section IV and in part of the Stage II area, a pattern repeated in

* Footnote: In one case a farmer reported that he had to send a man to Syria to get a certain pesticide he needed urgently.

TABLE (8.6) EAST JORDAN VALLEY:

METHODS OF PAYMENT FOR FARM SUPPLIES, SAMPLE SURVEY, 1978

	East Ghor Canal Project (STAGE I)										Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Stage I		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Stage II	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Reported Methods																
Cash	15	44.1	11	31.4	18	62.1	4	22.2	48	41.4	0	0	13	44.8	13	32.5
End of Season	20	58.8	27	77.1	15	51.7	18	100.0	80	69.0	11	100.0	22	75.9	33	82.5
Instalment	6	17.6	3	8.6	4	13.8	1	5.5	14	12.1	0	0	0	0	0	0
Total Observations	41	120.5	21	117.1	37	127.6	23	127.7	142	122.5	11	100.0	35	120.7	46	115.0
First Choice (Main) Method																
Cash	12	35.3	7	20.0	13	44.8	0	0	32	27.6	0	00	11	37.9	11	27.5
End of Season	17	50.0	26	74.3	13	44.8	18	100.0	74	63.8	11	100.0	18	62.1	29	72.5
Instalment	5	14.7	2	5.7	3	10.3	0	0	10	8.6	0	0	0	0	0	0
Total Sample (No. of farmers)	34	100.0	35	101.0	29	99.9	18	100.0	116	100.0	11	100.0	29	100.0	40	100.0

TABLE (8.7) EAST GHOR CANAL PROJECT:

METHODS OF PAYMENT FOR FARM SUPPLIES, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Reported Methods:										
Cash	81	79.4	52	55.9	25	31.2	9	11.5	167	47.3
End of Season	26	25.5	56	60.2	56	70.0	76	97.4	214	60.6
Instalment	37	36.3	26	27.9	33	41.2	14	17.9	110	31.2
Total Observation	144	141.2	134	144.0	114	142.4	99	126.8	491	139.1
First Choice (Main) Methods:										
Cash	44	43.1	27	29.0	13	16.2	1	1.3	85	24.1
End of Season	10	9.8	27	29.0	39	48.7	58	74.3	134	38.0
Instalment	12	11.8	9	9.7	10	12.5	1	1.3	32	9.1
Non specified	36	35.3	30	32.2	18	22.5	18	23.1	102	28.9
Total Sample (No. of Farmers)	102	100.0	93	99.9	80	99.9	78	100.0	353	100.0

Section IV in the 1980 survey. These were all areas where village merchants who usually require cash payments were weaker, and where commission agents, co-operatives and the Jordan Valley Farmers' Association, who all often rely on end of season payments, were commonly used. On the other hand, end of season payments were less common in Section I in 1980 where village merchants remained popular sources of farm supplies. Overall end of season payments and commission agents are most popular in the south and this relationship is examined a little further at the end of this chapter.

8.4 Farm Marketing Conditions

As farm products have increased from the ghor in amount and diversity over the last two decades a pattern of produce marketing has also grown up with it but in several ways it has appeared to be one of the least developed parts of the whole project. Not only have there been fewer alternatives available to the farmers for marketing than in the case of the provision of supplies, but the widespread development of the commission agent system may well have reduced the operating freedom of some farmers as a result of their becoming dependent on these agents for loans, so restricting their marketing opportunities as well. Furthermore while there had been a rapid development of the co-operatives, they have so far operated entirely in the farm supply and loaning fields whereas it is in the marketing area that most effort seems needed to raise the quality and value of the marketed produce and to offer farmers an alternative to the commission agent system.

8.4.1 The Marketing System

8.4.1.1 Market Location and Use

Project farmers have available two main types of market, assembly and urban markets, but both are under the control of the commission agents who auction or sell the farmers' produce in return for a fee, normally 5 per cent of the value of the produce sold. The only other alternative available to some farmers for some crops is to sell direct from the farm to merchants or exporters but such 'on the farm' sales are not yet common.

There are four assembly markets located in the valley where produce is brought in by farmers, sometimes for grading and packing, and then for sale through commission agents to merchants from the urban wholesale markets and to exporters. Markets of this type offer the farmers the advantage of shorter journey to a sale point where he is more or less assured of making a sale. This may not always be at the best price, however, since some of the markets attract few buyers and, at times, local gluts of produce may force prices down. For the buyer these valley markets offer produce at prices generally below those at the urban markets and without the trouble of going to individual farms to get these lower prices.

The oldest two assembly markets were set up in the valley in the 1950's at North Shuneh in the far north and at Karameh in the south. After the Israeli invasion in 1968 which destroyed Karameh town, the market there was re-established further north at Sawalha (near Deir Alla) where it has since continued to operate. Another has been established at Wadi Yabis while the one at Karameh has been re-opened but on a much reduced scale.*

Apart from these outlets for farm produce there are various central urban markets to the east of the valley in towns like Amman and Irbid. Although municipally-run, these markets, like those in the valley, still involve the farmer getting a commission agent to find a buyer for his produce in return for the commission. Most sales from these wholesale markets are to retailers in the towns and other parts of Jordan although some exporters will also buy from these markets. The advantage for the farmer using these markets is that produce often sells for higher prices than in the valley markets but for this he has to travel further and spend more time away from his farm.

No official data is available on the volume of farm produce which passes through each of these valley or urban markets but in his 1978 survey the writer was able to establish that 96 per cent of his sample of farmers in the project area and 95 per cent in the non-project area to the south used these valley and urban markets rather than sold their produce directly from the farm (Table 8.8). In his 1980 survey he then asked farmers to which of the three main valley markets then

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* Footnote: Karameh market was not included in the 1980 survey because it is outside the project area.

TABLE (8.8) EAST JORDAN VALLEY:

METHODS OF CROP MARKETING, SAMPLE SURVEY, 1978

	East Ghor Canal Project (STAGE I)										Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Stage I		Ext. Area (Damya)		Karameh S.Shuneh & Kafrain		Total Stage II	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
A Reported Methods:-																
Through Commission Agent	32	94.1	35	100.0	27	93.1	18	100.0	112	96.6	11	100.0	27	93.1	38	95.0
On the Farm	16	47.0	9	25.7	3	10.3	0	0	28	24.1	0	0	13	44.8	13	32.5
Total observations	48		44		30		18		140		11		40		51	
Total sampled Farms	34		35		29		18		116		11		29		40	
B First Choice (Main) Methods:-																
Through Commission Agent	32	94.1	35	100.0	27	93.1	18	100.0	112	96.6	11	100.0	25	86.2	36	90.0
On the Farm	2	5.9	0	0	2	6.9	0	0	4	3.4	0	0	4	13.8	4	10.0
Total Sampled Farms	34	100.0	35	100.0	29	100.0	18	100.0	116	100.0	11	100.0	29	100.0	40	100.0

operating, and the urban markets of Amman and Irbid, they sent some or all of their produce. The results of this part of the survey are summarized in Tables 8.9 and 8.10. Because many farmers stated that they used more than one market outlet, the number of observations and percentages given in Table 8.10 are over double the number of farmers questioned. It can be seen that the valley market of Sawalha and the urban markets were easily the most important. Because of Sawalha's southern location (as seen in Fig. 8.1) its attraction was greatest for farmers in the southern two sections of the project area but also attracted considerable numbers from Section II. The more northerly assembly markets of Wadi Yabis and North Shuneh assumed more importance for farmers in Sections I and II but neither of them seemed as important in the north as was Sawalha in the south. Even in Section I North Shuneh market only attracted 32 per cent of the farmers and had no attraction to farmers in more southerly sections. Part of the limited appeal of those northern assembly markets to farmers even within the sections where they are located is because of the strong competition offered by the urban market of Irbid which is closer to Sections I and II than to Sections III and IV.

Fig. 8.1 and Table 8.10 show widespread use was made of Amman market by farmers throughout the project area and especially those in Sections II and III. 62 per cent of sampled farms stated they sold produce at Amman market.[1]

8.4.1.2 On the Farm Sales

There is no evidence to suggest that ghor farmers sell produce direct to any of the many small retail outlets throughout Jordan but some sales were reported direct from farms and these should be briefly considered. These are mainly on the farm sales to merchants and sales through the government agricultural marketing corporation. Where farmers did not use either the valley or urban markets to dispose of their produce, the only alternative left to them were 'on the farm' sales. These were, however, far less important than market sales - accounting for only 3 per cent of farmers' main marketing method in the project area sample for 1978 although considerably more in the 1980

TABLE (8.9) EAST GHOR CANAL PROJECT:

REPORTED METHODS OF CROP MARKETING, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
<u>Reported Methods of Marketing</u>										
Through Commission Agent	94	92.2	89	95.7	79	98.8	77	98.7	339	96.0
On the Farm	39	38.2	32	34.4	15	18.8	4	5.1	90	25.5
Through Marketing Corporation	10	9.8	3	3.2	7	8.8	0	0	20	5.7
Total Observation	143		124		101		81		449	
Total Sampled Farms	102		93		80		78		353	

TABLE (8.10) EAST GHOR CANAL PROJECT:

REPORTED MARKETS USED, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total E.G.C.P.	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Assembly Markets										
North Shuneh	33	32.4	0	0	1	1.2	0	0	34	9.6
Wadi Yabis	31	30.4	64	68.8	5	6.2	0	0	100	28.3
Sawalha	9	8.8	52	55.9	79	98.7	77	98.7	217	61.5
Urban Markets										
Amman	58	56.9	65	69.9	62	77.5	37	47.4	222	62.9
Irbid	87	85.3	70	75.3	31	38.7	6	7.7	194	55.0
Total observation	218	213.8	251	269.9	178	222.3	120	153.8	767	217.3
Total sample (No. of farmers)	102		93		80		78		353	

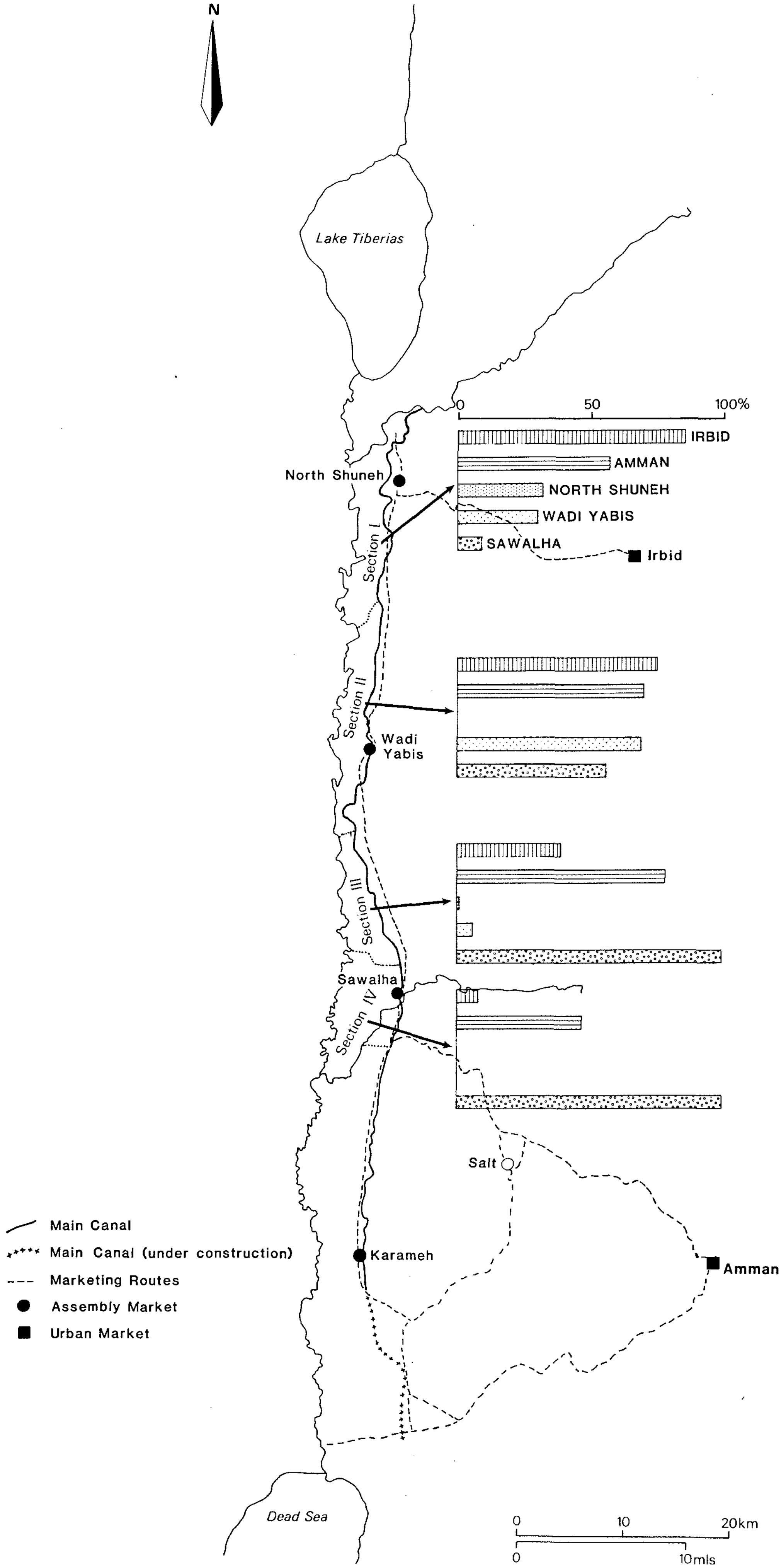


Fig. 8.1 EAST GHOR CANAL PROJECT: MARKET LOCATIONS AND THEIR SIGNIFICANCE TO THE PROJECT FARMERS

sample. This method of marketing seemed to be much more popular in some areas than others. For example Table 8.8 shows for the 1978 sample that nearly half of the farmers interviewed in Section I reported some 'on the farm' sales, as did 24 per cent of farmers throughout the project area. Table 8.9 shows that for the 1980 sample the farmers in the northern two sections used this method of selling produce much more than those to the south.

To help explain the reasons for these variations across the area it is necessary to recognise that it is a form of marketing more suited to some crops than others. There are two types of 'on the farm' sale. 'On the tree' sales, a method locally known as 'daman' and largely restricted to the marketing of citrus, involves the farmer signing a contract with a merchant or exporter early in the season to sell the crop at an agreed price when ready for harvest. Part payment is made at the time the contract is signed and the farmer continues to irrigate and look after the crop until harvest time when the merchant arranges for the picking, packing and transport and final payment is made.

An alternative and less common method of 'on the farm' sale, largely confined to the export trade in bananas and some vegetables, involves merchants who purchase crops direct from the farm after they have been picked. A price is agreed per box, ton or other unit and all grading, packing and transport is carried out by the merchant.

That the use of 'on the tree' and 'on the farm' sales varies widely throughout the project area largely reflects the crop pattern found in each section. Both were found to be common in Section I where there is much citrus and banana production with which both are commonly associated. They were less common further south in the main project area where these crops are also less common. In 1978 the writer found them more widely again in the far south where citrus and vegetables recur and are sometimes marketed here in this way.

8.4.2 The Jordanian Corporation for Agricultural Marketing

Because of the weaknesses of the marketing system already indicated some efforts have been made by the Jordanian Government to help the farmers get better prices for their produce and to get crops to their point of consumption in better condition. For this reason the Jordanian Corporation for Agricultural Marketing was set up in 1968 to improve marketing methods and to allow farm products to contribute a greater amount to the national economy. For the most part in the ghor the Corporation has been involved in making contracts with farmers to grow various crops, notably green peppers and beans on selected acreages for export markets in Europe.[2]

The Corporation gives the co-operating farmer a guaranteed price for his crop as well as technical advice, seeds, fertilizer and other needs. Collection, grading and marketing is all done by the Corporation. In his 1980 survey the writer noted (Table 8.9) that about 5 per cent of sampled farmers were marketing some of their produce this way.

8.4.3 Marketing Problems

It is not only that the marketing system often leaves the farmer with a rather limited choice of outlets for his produce. It is also clear that at the very local level of the individual farmer, produce marketing remains one of the least well managed aspect of the East Ghor development. There are several reasons for this. As the data presented in the last section has indicated most crop harvesting, grading, packing and transport to market is carried out by the farmers where the produce is passed to the commission agents. 'On the farm sales' which pass these tasks onto merchants, who are often better able to perform them, are as yet poorly developed. Most farmers pay little attention to proper methods of picking, grading or packing so that much of the crop arrives at the market damaged or, at least, in a less than peak condition. Frequently harvesting is carried out by unskilled labour or children and little consideration is paid to ensuring the the crop is not too ripe when it reaches the market. The grading of produce on the farms, by size, ripeness or other qualities, is often almost entirely neglected.

Packing generally consists of no more than filling boxes in such a way that the best produce at the top covers the poorer at the bottom, but since the buyers are familiar with this practice, prices are lowered accordingly. Few farmers use standard containers capable of reducing damage to the produce placed at the bottom or sides of the box. The most commonly used boxes, locally known as markah and toffahi, are made of rough wood rather than plastic. Not only do these scratch the produce but this type of box can take as many as five layers of some fruit. This bruises those at the bottom.

Only limited attempts have yet been made to improve grading and packing standards. The first station for this was set up at Wadi Yabis market but it was only large enough to handle the produce of a small number of farms. After it was bombed in the 1967 war it has never been re-opened. Another station at North Shuneh is in operation and one is expected to open shortly at Ma'adi in the middle ghor. The Wadi Yabis plant is expected to be repaired and another is planned for South Shuneh so that the need for better grading and packing is recognised, and the situation could be improved somewhat in the future.

The transportation part of the marketing process is also at present poorly organized. Since farmers have to take much of their produce themselves to either the 'assembly' or central urban markets, there are many causes for delay and damage. Various types of transport are used by the farmers ranging from tractor trailers to pickup trucks and lorries, while many farmers with no transport of their own have to rely on other farmers. Even after produce has reached the assembly markets in the valley it has to be moved on, often to urban markets and this can involve more damage and delay in transit.

Many farmers do seem to be aware of how factors like poor marketing can affect the value of their produce, but they often feel powerless to improve the situation. In his 1978 survey the writer asked his sample of farmers to what extent they were interested in getting the best prices for their crops. As Table 8.11 indicates interest was everywhere high in the prices offered although sizeable minorities did express little or no concern. These more disinterested respondents seemed to be rather more numerous in those areas, like Section IV and the extension area in the south where farmers feel, perhaps as a result of more limited options in their marketing, least able to help themselves. Some simply pointed out that if their crop was ripe it had to be sold regardless of the price they could obtain for it.

TABLE (8.11) EAST JORDAN VALLEY:

FARMERS INTEREST IN MARKET PRICES, SAMPLE SURVEY, 1978

	East Ghor Canal Project						(STAGE I)				Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Stage I		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Stage II	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Much interest	30	88.2	28	80.0	24	82.8	11	61.1	93	80.2	7	63.6	26	89.7	33	82.5
Little interest	1	2.9	2	5.7	0	-	1	5.6	4	3.4	1	9.1	-	-	1	2.5
No interest	3	8.8	5	14.2	5	17.2	6	33.3	19	16.4	3	27.3	3	10.3	6	15.0
TOTAL SAMPLE (No. of farmers)	34	99.9	35	100.0	29	100.0	18	100.0	116	100.0	11	100.0	29	100.0	29	100.0

8.4.4 The Farmer - Commission Agent Relationship

It is already clear from what has been covered in this chapter that for a large proportion of ghor farmers the commission agent has played a major service role. It is not only that over 90 per cent of sampled farmers reported that they used commission agents to market their produce. It was earlier made clear that commission agents also provided many farmers with supplies and, as will be shown in this section, they have also become important cash-lenders partly to reinforce their marketing function.

The extent of this relationship between the agents and some farmers may, in many cases, have led to long-term farmer indebtedness where a farmer has had little option but to sell his produce through an agent who then has provided supplies and even cash loans for the next season. When the farmer finds he cannot repay those debts at the end of that season they are carried over and the farmer is then less able to market his crops or get supplies through other outlets. One reason for the recent rapid expansion of co-operatives and the Jordan Valley Farmers Association in the supply and loaning field, which is considered later, has been to reduce the scale of this enforced link between the indebted farmer and the commission agent. But until a wider range of marketing alternatives are also provided, the commission agent is likely to remain in this exclusive and dominant position with some farmers.

In order to more clearly specify the nature of this farmer-agent link, and how it may encourage farmer indebtedness, the writer, in his 1978 and 1980 surveys, asked the sampled farmers a number of questions on their use of commission agents. It was clearly not reasonable to ask farmers if, or to what extent, they were actually in debt to an agent, so the questions attempted to establish the strength of the farmer-agent link in other ways. The writer therefore asked about the extent to which farmers relied on only one specific agent for crop marketing, when they received payment from him for their produce,and the reasons for maintaining the relationship. In this way it was hoped to identify where, and to what extent, farmers were tied to their commission agents for reasons other than purely marketing and supply convenience. The results of these questions are summarized in Tables

8.12, 8.13 and 8.14. From Table 8.12 it can be seen that when farmers were asked in 1978 if they only used one specific agent to market their produce, it was found that nearly half of the respondents (43 per cent) in the main project area (Stage I), and well over half (72 per cent) of those in Stage II, reported that they marketed through only one particular agent. This relationship was much more common in the southern areas - Section IV and all of Stage II with 89 per cent of farmers in Section IV and all 11 farmers sampled in the extension area linked to one agent. In contrast only about a third of farmers in Sections I and II were so linked.

When farmers were asked when they were paid for their produce sold for them (Table 8.13), the great majority in the main project area reported that they were either paid at the time of the sale or within a week of the sale. But many farmers in the southern areas (Section IV and Stage II) stated that they were paid at some other time, often not till the end of the season. That is, payments made at or near the time of the sale were unusual in all these southern areas whereas they were the universal practice in Sections I and II. So, in the north where farmers were least likely to be tied to a specific agent and also had several alternative sources of supplies and credit, they were also most likely to get immediate payment for their produce. In the south, however, where many more farmers were likely to be tied to specific agents and where alternative sources of supplies and credit were fewer, farmers seemed to be more likely to receive delayed payment from the agent. This may well point to a situation where a proportion of the southern farmers could be permanently in the debt of the agent.

In having identified this possible difference spatially in the use of commission agents by farmers in his 1978 survey, the writer decided in his 1980 survey not simply to repeat the questions and update the results, but to seek possible reasons for the link where a farmer used a specific commission agent. The results of this part of the questionnaire are summarized in Table 8.14. At the bottom of the table it will be seen that within the limits of the sampling method the general patterns revealed in the 1978 results are confirmed. Rather more farmers in the northern sections now stated that they used a particular agent for produce marketing than was suggested in the 1978 sample, but

TABLE (8.12) EAST JORDAN VALLEY:

CHOICE OF MARKETING THROUGH COMMISSION AGENT, SAMPLE SURVEY, 1978

	East Ghor Canal Project						(STAGE I)				Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Stage I		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Stage II	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Marketing Through:																
A specified Agent	10	29.4	12	34.3	12	41.4	16	88.9	50	43.1	11	100.0	18	62.1	29	72.5
Any Commission Agent	22	64.7	23	65.7	15	51.7	2	11.1	62	53.4	0	0	9	31.0	9	22.5
No answer (not relevant)	2	5.9	0	0	2	6.9	0	0	4	3.5	0	0	2	6.9	2	5.0
Total sample (No. of farmers)	34	100.0	35	100.0	29	100.0	18	100.0	116	100.0	11	100.0	29	100.0	40	100.0

TABLE (8.13) EAST JORDAN VALLEY:

METHODS OF PAYMENT OF FARMERS FOR PRODUCE, SAMPLE SURVEY, 1978

	East Ghor Canal Project						(STAGE I)				Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Stage I		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Stage II	
Methods of Payment	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
At time of sale	25	73.5	16	45.7	12	41.4	1	5.6	54	46.6	1	9.1	3	10.7	4	10.7
Within one week	9	26.5	19	54.3	7	24.1	3	16.7	38	32.8	1	9.1	7	25.0	8	20.5
At the end of season	-	-	-	-	4	13.8	8	44.4	11	10.3	6	54.5	8	28.6	14	35.9
Others	-	-	-	-	6	20.7	6	33.3	12	10.3	3	27.3	10	35.7	13	33.3
Total Sample (No. of farmers)	34	100.0	35	100.0	29	100.0	18	100.0	116	100.0	11	100.0	28	100.0	39	100.0

TABLE (8.14) EAST GHOR CANAL PROJECT:

REPORTED REASON FOR MARKETING THROUGH A SPECIFIED COMMISSION AGENT, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Reasons										
Trusting relationships	43	87.3	43	86.0	15	53.6	45	73.8	146	77.7
Agent provides loans	13	26.5	17	34.0	19	67.9	46	75.4	95	50.5
Agent pays at time of sale	41	83.7	24	48.0	15	53.6	22	36.1	102	54.3
Agent owned by landlord or a relative	5	10.2	8	16.0	1	3.6	2	3.3	16	8.5
Total observations	102	208.2	92	184.0	50	178.7	115	188.6	359	191.0
Sub total farmers	49	48.0	50	53.8	28	35.0	61	78.2	188	53.3
Farmers who sell to any Agent	53	52.0	43	46.2	52	65.0	17	21.8	165	46.7
Total Sample (No. of Farmers)	102	100.0	93	100.0	80	100.0	78	100.0	353	100.0

Section IV farmers again revealed a much higher level (78 per cent) of linkage between farmer and a specific agent.

Overall in the main project area 53 per cent of farmers sampled stated that they used a specific commission agent to sell their produce and reasons were elicited from these farmers for this relationship. Since many farmers gave more than one reason for their use of an agent the number of observations listed in Table 8.14 are about double the number of farmers involved. The most commonly stated reason for this farmer-agent relationship - given by 77 per cent of the farmers - was the level of trust that had been built up between farmer and agent which, apart from Section III, was the dominant response in all four sections of the main project area. 54 per cent of respondents stated that they continued to do business with their agent because he paid them immediately he had sold their produce, although this reason was less commonly stated in Section IV where it has already been noted that delayed payment was more normal. That loans and supply credits were available from the agent was also a commonly stated reason for keeping a link with a particular agent and it can be noted that this was a very commonly given reason in Sections III and IV. It has already been noted that in these areas over 60 per cent of farmers stated that they also obtained their supplies from commission agents, compared with only 3 per cent in Section I. In these areas, then, agents would generally be acting as providers of supplies on credit if not actual cash loans. The southern agent therefore more often provides supplies, marketing facilities and credit and a strong relationship is built up with farmers on this all-inclusive basis. In the north a link between a farmer and an agent is largely restricted to marketing where the farmer then relies on a rapid settlement. Clearly if farmers are at all indebted over the medium or long-term to their agents this is much more likely to be the case in the southern sections than in the north.

Part of the reason for these stronger farmer-agent relationships in the south could be the result of the larger number of tenant farmers and share croppers whose landlords sometimes also act as commission agents. Nevertheless Table 8.14 shows that few farmers gave this as a reason for the link to a specific agent and these were also more common in the north than the south. Rather the reasons should be sought in a combination between the farming, supply, marketing and loaning systems. It has already been concluded that the typical southern farmer has a narrower range of options available to him in his season of crop production, and now in his sources of supply and marketing outlets. It is, then, appropriate to consider the loaning system a little further as it affects farmers in different parts of the project, before examining the role of government initiatives - by means of the establishment of co-operatives and the Jordan Valley Farmers Association - for providing farmers with alternative sources for their needs, and, therefore, greater flexibility in their farming decisions.

Notes and References

1. Produce sales through Amman market, much of it from the Jordan Valley rose from JD 2.5 m to 5.5 m between 1966 and 1972. In 1980, 35 commission agents worked in Amman market, 9 of them commanding the bulk of the trade.
2. The potential value of the European market for high grade and high value vegetables in the winter production season from the Jordan Valley can be seen in the fact that the Corporation has been able to harvest and air freight green peppers to Europe at a total cost of about JD 210 per ton, of which JD 60 was paid to the farmer. The prices at which green pepper is sold at the European airports ranged from JD 232 to 3.17. It is reckoned that the port price would have been JD 280 to 400 per ton if marketed through a normal merchant.
   Source: (1974) Technical and Economic Feasibility of Expanding Vegetable Production in the Jordan Valley, Part 2, 269, Arab Organization for Agricultural Development, Khartoum, 1974 (in Arabic).

CHAPTER 9 FARM SERVICES II: AGRICULTURAL CREDIT

9.1 Introduction

The limited financial strength of most of the valley farmers means that many of them rely, at least intermittently, on supplies obtained on credit or short term cash loans to tide them over to the next harvest or other source of cash flow. The last chapter has suggested the extent to which this probably occurs, particularly in the southern area, again helping to differentiate between the north and south parts of the project. It is logical to move on to consider credit both for short-term purposes and for farm development and improvement purposes where much more limited use of loans has been found. For example, the writer's sample surveys suggest that as many as 80 per cent of farmers used supply credits, about a half have used short-term loans but only about one farmer in six had a longer-term loan. This chapter examines these longer term and shorter term loan sources before considering loan behaviour amongst valley farmers.

9.2 Loan Sources

It has already been pointed out that one can really recognize two main types of loan. Supply credits and short-term seasonal borrowings last only a few weeks or months and are used mainly to pay for seeds, fertilizer and other immediate farm cash flow needs. Longer term loans are taken out by farmers mainly in order to carry out farm improvements. Whereas short term borrowing may be for a wide variety of purposes, and may be either in the form of cash from varied sources including co-operatives, commission agents and landlords, or in the form of credit on supplies to be paid for at harvest time, the longer-term loans are generally available from far fewer sources and for a narrow range of purely farm improvement purposes. These can include land levelling, farm canal construction, the planting of fruit trees and similar projects to increase the longer-term profitability of the holding. As longer term loans are generally for larger cash sums they require a greater degree of security for the lender. It is convenient to first outline each main loan source for those various loan types available to ghor farmers, dividing them into institutional and non-institutional lenders.

9.2.1 Institutional Lenders

These include, in order to importance, the co-operative societies, the Jordan Valley Farmers Association and the Agricultural Credit Corporation.

The Co-operative societies represent a very important source of longer term credit as well as the main source of short term credit for many ghor farmers. These loans are only available to co-operative society members but, as will be shown in Chapter 10, where the growth and role of the co-operatives is more fully considered, nearly half of the farmers sampled by the writer in 1980 claimed membership of their local co-operative and were in theory eligible for their loans. Overall in the writer's 1980 farm sample survey 58 per cent of those who stated they had used credit reported that they got credit from the co-operatives.

Table 9.1 lists the sources of cash loans as reported being used in the writer's 1980 sample of ghor farmers, while Fig. 9.1 provides a diagrammatic summary of this. It is clear from these that the co-operatives exceeded all other loan sources in most parts of the project area except in the southern two sections where more farmers expected that they used commission agents for these loans. No distinction was made in the type and length of loan in this part of the survey.

No detailed data is available from the Jordan Co-operative Organisation for the whole project area on the three types of borrowing possible from co-operatives - seasonal credits related to the supply of farm needs, seasonal cash loans and other cash loans, normally repayable over 12 months or more. The 11 co-operatives in the northern valley in 1979, however, lent out JD 1.013 m of which 50 per cent was in the form of supply credits, 13 per cent was seasonal cash loans and 37 per cent was for longer term farm improvement loans. This was probably a greater mount and range of loan types than available in the whole project area from any other institutional sources. Table 9.1 suggests that the uptake of loans from the co-operatives varied across the

TABLE (9.1) EAST GHOR CANAL PROJECT:

REPORTED SOURCES OF CASH LOANS, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Co-operatives	23	74.2	36	67.9	18	38.3	32	58.2	109	58.6
JVFA *	11	35.5	21	39.6	22	46.8	11	20.0	65	34.9
ACC ++	21	67.7	16	30.2	13	27.7	12	21.8	62	33.3
Commission agents	6	19.3	16	30.2	24	51.1	39	70.9	85	45.7
Relatives and friends	5	16.1	5	9.4	13	27.9	1	1.8	24	12.9
Village merchants	6	19.3	5	9.4	7	14.9	0	0	18	9.7
Landlords	0	0	0	0	6	12.8	3	5.5	9	4.8
Total reporting observations	31	232.1	53	186.7	47	219.3	55	178.2	186	199.9
% Total farmers	102	30.4	93	57.0	80	58.8	78	70.5	353	52.7

* JVFA = Jordan Valley Farmers Association.

++ ACC = Agricultural Credit Corporation.

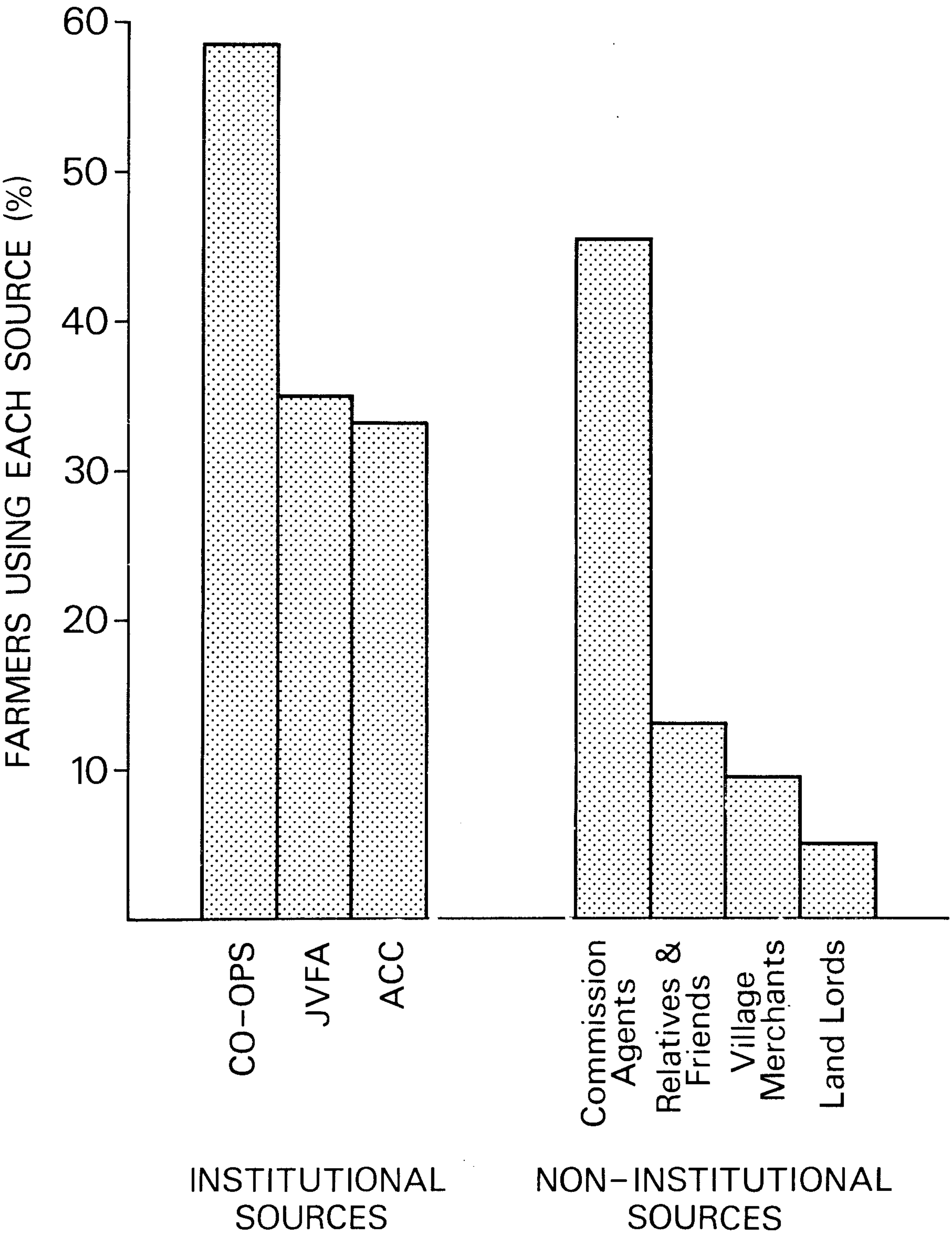


Fig. 9.1 EAST GHOR CANAL PROJECT: SOURCES OF FARM LOANS

project area and this could be the result of several factors including differing levels of co-operative membership, the availability of alternative sources of credit and different levels of farm development calling for varying amounts of outlay on farm improvements. As a result considerably more farmers in the northern two sections of the project area stated that they had used loans from the co-operatives than in the southern two sections. Because of the importance of the co-operatives as loan sources and because of the relationship between this activity and other roles of local co-operatives, this topic is considered further in Chapter 10.

The Jordan Valley Farmers Association (JVFA) is the second most important institutional loan source for ghor farmers, as well as providing farmers with farm supplies, as do the co-operatives, on credit. Although the JVFA was only set up in 1974 the writer's 1980 survey (Table 9.1) showed that about 35 per cent of sampled farmers who took loans stated that they had used a loan from the JVFA. Rather surprisingly this proportion fell to only 20 per cent in Section IV even though the Association's headquarters is at Deir Alla. This probably reflects the strength in that area, especially, of the commission agents whose dominant relationships with many farmers for supply, marketing and loaning has been referred to in the last chapter. Apart from providing supply credits in 1979, the JVFA made over 430 seasonal loans to its members with a total value of JD 238,000 which made it a significant, if recent, influence in the field of farm development. As a result a more detailed examination of its role is presented in Chapter 10.

The Agricultural Credit Corporation (ACC) is the third main institutional source of credit in the valley and as Table 9.1 shows 33 per cent of sampled farmers in 1980 who took loans claimed to have used a loan from this source. A national body, the ACC has been lending money to farmers since before 1960 both for longer-term improvements and seasonal or short-term purposes. Longer-term loans have been more important in its work. There has been a decline, however, nationally and in the valley, in the number of ACC loans made although the average loan value has increased in line with inflation. Figures on ACC loaning activity are not available for the whole valley but in 1978, 64 northern valley farmers obtained JD 121,000 of medium-term loans and 188 farmers obtained JD 55,000 of seasonal loans. Because of the importance of ACC's role in the field of medium-term loans for farm development, it is considered in a little more detail later in this chapter. It is clear from Table 9.1 that in 1980 a much higher proportion (67 per cent) of the sampled farmers who took loans in Section I used ACC loans than in other parts of the project area.

9.2.2 Non Institutional Lenders

These include, in order of importance, the commission agents, relatives and friends of the borrowers, village merchants and landlords.

Commission agents are, as was indicated in the previous chapter, mainly concerned with the marketing of the farmers' produce but many agents have extended their functions to the provision of farm supplies on credit and cash loans, almost entirely of a short-term or seasonal nature and often used to tide farmers over till the harvest season, to cover farm wages and other immediate cash needs.

There is no official data on the extent of the loaning activities of these agents but Table 9.1 shows that over 45 per cent of the writer's sample of farmers in 1980 who reported taking a loan had used this source. As a result commission agents may well be a much more widely used source of loans, either in the form of credits or cash, than any other non-institutional source. As a loan source they could be second in importance overall to the co-operatives although the average size of individual loans from agents could well be much smaller than those provided by co-operatives, since short term loans and credits are generally for lesser amounts than farm improvement loans.

The commission agents should be such a popular loan source results from two main reasons. Firstly, the farmer normally has only to give an unwritten promise to the agent when he seeks a loan that he will let the agent market his produce. Unlike arranging a loan with a co-operative or other institutional body, the farmer does not have to provide a mortgage or other major security for the loan, the agent being able to recover his debt with the commission on the sale of the farmer's produce later in the season. Since many poorer farmers, sharecroppers and tenants would not qualify for a loan from an institutional source because of the risk involved, the commission agent is often the only alternative.

Second, if the farmer is unable to clear his debt to the agent at the end of the season it is often in the interest of both the farmer and the agent to carry it over, a flexibility generally not available with an institutional loan where a farmer might be in danger of forfeiting his mortgage for non-payment. But continuing a loan can be to an agent's advantage both as a means of ensuring the farmer continues to trade with him and as a means of continuing to loan money. It is this established position of the agent which can lead farmers into permanent indebtedness and which probably partly accounts for the high rate of borrowing by farmers from this source especially in Section IV of the project area and already referred to in Chapter 8. As Table 9.1 shows over 70 per cent of farmers in that section who said they had taken a loan reported that they had used loans from an agent, a higher level than from any other source.

Relatives and friends are a source of some cash borrowed by farmers. 12 per cent of the farmers sampled in 1980 who took loans stated that they had used money from this source, making this the second largest non-institutional loan source, but in terms of numbers of borrowers involved smaller than any of the institutional sources. No information is available on this type of borrowing but it can be expected that most loans would be of a small, short-term nature at low or nil interest. This source is probably mainly used by smaller farmers unable to get low interest credit from elsewhere because, for example, they are not members of, or do not qualify for a loan from, a co-operative or the Jordan Valley Farmers Association. As Table 9.1 indicates loans from friends and relatives accounted for over 27 per cent of responses amongst farmers who had taken a loan in Section III where other loan sources, notably the co-operatives, have been less well developed.

Village merchants appear to be a relatively minor loan source. They mainly provide farm supplies for cash payment, as has been indicated in the last chapter, but some will occasionally provide supplies on credit and short term loans. 18 of the farmers questionned (or about

10 per cent of the total borrowers) reported that they had had a loan from a village merchant. Their numbers are too small to suggest any significant spatial variation across the project area. Landlords are only a minor source of loans in the project area largely because it is only their sharecroppers who would turn to this source. Some might obtain both supplies and cash loans of a short term nature from their landlord who would then deduct the sum owed from the value of the crops he markets for his sharecropper at the end of the season. This method of loaning was not found at all amongst the farmers interviewed in 1980 in the northern sections of the project area and was not common further south where more sharecropping farmers are found. This situation is even more likely to lead the sharecropper into indebtedness to his landlord than in the case of the farmer who regularly borrows from a commission agent. The sharecropper will often be less able to repay his debt and the landlord can take advantage of the farmer's plight by making him continue to work the land until the debt is cleared. But since landlords and sharecroppers are not as numerous as owner-occupiers they may represent a lesser problem of indebtedness. In any case no further data is available on this.

9.3 Farmers' Experience with Loans

In his two sample surveys, in 1978 and in 1980, the writer decided to examine different aspects of the borrowing behaviour of farmers. In 1980, as has already been indicated, he obtained information on farmers' sources of loans, but in 1978, because it was not then clear what the loaning pattern was, he concentrated on farmers' use of short term and longer term loans. The results of this survey are summarized in Tables 9.2 and 9.3 for each section of the main project area and its southward (Stage II) extensions. In view of the small number of respondents in several categories these results cannot be considered statistically significant. Statistical correlations have been restricted to the much larger 1980 survey results. But it is felt that the 1978 results do provide some general indications of the loaning situation throughout the valley. No attempt was made in either survey to obtain information from farmers on the sizes of their loans because

TABLE (9.2) EAST JORDAN VALLEY:

FARMERS' EXPERIENCE WITH SHORT TERM LOANS AND CREDITS, SAMPLE SURVEY, 1978

	East Ghor Canal Project (STAGE I)										Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Stage I		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Stage II	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Get supplies on credit	23	67.4	29	82.9	22	75.9	18	100.0	92	79.3	11	100.0	21	72.4	32	80.0
Had short term cash loan	12	35.3	14	40.0	17	58.6	11	61.1	54	46.6	11	100.0	17	54.5	28	70.0
Indebted with short term loan	5	14.7	10	28.6	8	27.6	8	44.4	31	26.7	8	72.3	12	41.4	20	50.0
Had difficulty in getting short term loan	4	11.8	14	40.0	6	28.6	10	55.5	34	29.3	11	100.0	2	6.9	13	32.5

TABLE (9.3) EAST JORDAN VALLEY:

FARMERS' EXPERIENCE WITH INTERMEDIATE-LONG TERM LOANS, SAMPLE SURVEY, 1978

	East Ghor Canal Project (STAGE I)										Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total Stage I		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Stage I	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Had at least 1 intermediate/long term loan	8	23.5	5	14.3	3	10.3	0	0	16	13.8	0	0	8	27.6	8	20.0
Difficult to get such a loan	4	11.8	23	65.7	19	65.5	13	72.2	59	50.9	10	90.9	11	34.4	21	52.5
Failed to get such a loan 1976-78	3	8.8	2	5.7	0	0	0	0	5	4.3	0	0	0	0	0	0
In need of such a loan	8	23.5	13	37.1	16	55.2	2	11.1	39	33.6	1	9.1	9	31.0	10	25.0
Were aware of credit sources	19	55.9	19	54.3	14	48.3	9	50.0	61	52.6	2	18.2	18	62.0	20	50.0

of the difficulty of checking on the reliability of responses. For the only data on this we have to turn to figures provided by institutional sources and referred to later in this chapter and in the next chapter.

Because almost no information is available on the level of seasonal loan use by valley farmers, several questions in the writer's 1978 sample survey were directed at this. It was not in all cases possible to separate a farmer's understanding of what constituted a short and a longer term borrowing. However it is clear that seasonal loans and credits were much more commonly used by the sample of farmers than longer-term loans.

Most commonly reported was the use of credit for the provision of farm supplies. As Table 9.2 shows, and, as was discussed in Chapter 8, 79 per cent of the farmers interviewed within the main project area and 80 per cent of the farmers interviewed in the southern area (Stage II) obtained some supplies on credit. Levels of use of credit appeared to rise southwards within the project area into the more recently established farm districts. Although the size of the sample does not allow any significance to be read into these differences, the pattern does tend to confirm the existence of the strong commission agent-farmer relationship in the southern areas.

Short term cash loans were rather less common than supply credits. 46 per cent of the farmers interviewed in the project area (Table 9.2) reported that they had made use of a cash loan. Again the proportion of farmers using loans seemed to increase southward into the newer sections of the project area and areas south of the main project. In the extension area all 11 farmers interviewed had recently used a cash loan. This increased use of cash loans southwards is confirmed in the writer's 1980 survey which shows that 30 per cent of farmers interviewed in Section I in the north reported their use of a cash loan with 57, 66 and 71 per cent so reporting in Sections II, III and IV respectively (Table 9.4).

The regional differences in levels of loan use between the older established northern part of the project and the newer southern areas is also seen in Table 9.2 in which indebtedness of farmers in 1978 is indicated. Here the results suggest that the farmers in the newly

TABLE (9.4) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST LOCATION

Count Row % Col %	Location Section I	Section II	Section III	Section IV	Row Total
Loan takers	31	53	53	55	192
	16.1	27.6	27.6	28.6	
	30.4	57.0	66.2	70.5	54.4
Non Loan takers	71	40	27	23	161
	44.1	24.8	16.8	14.3	
	69.6	43.0	33.7	29.5	45.6
Column	102	93	80	78	355
Total	28.9	26.3	22.7	22.1	100.0

Chi Square = 36.64186 with 3 degrees of freedom Significance = 0.0000

established southern districts were more likely to be indebted than farmers to the north. Whereas 46 per cent of the farmers sampled in the main project area reported that they had used a short-term loan at some time, 26 per cent reported that they were currently in debt from such a loan but this percentage rose markedly in the southern districts. The figure reached 50 per cent of the farmers sampled in the southern (Stage II) area where agriculture remains a more precarious financial exercise. Not surprisingly many farmers given their low incomes reported difficulties in getting short term cash loans.

Levels of use of longer term loans were much lower than for seasonal loans amongst valley farmers, because they are generally for larger sums which, in turn, require rates of repayment and guarantees which many farmers could not meet. As Table 9.3 shows that only 13 per cent of the farmers in Stage I and 20 per cent of farmers in Stage II had used a loan of this type, in contrast to the situation with short term credits and loans where most farmers made use of these borrowings.

The pattern of use of these longer term loans was different, however, from that for short term borrowing. More farmers in the northern parts of the main project area reported taking out long term loans than in the southern districts. This is not an unexpected pattern since these loans are mainly for farm improvement purposes and one might expect farmers to embark on such improvements a few seasons after they had established themselves within the project area. Since farms have generally been long-established in the northern districts it is here that one would expect farm improvements to be more commonly made, with resultant borrowing activity. Nevertheless Table 9.3 indicates that some farmers in the northern districts have been unable to get loans, for lack of guarantee or other reasons, suggesting that farm improvements had been slowed by shortage of loan security in the north. Many southern farmers, on the other hand, had not yet even attempted to get such loans at the time of the questionnaire survey. The slowness with which farmers in the south had attempted to get these loans must partly reflect the short time that many of them had been farming there, so that farm improvements might have been premature in

1978. There was also a widespread view, especially in the south, that these loans were difficult to obtain which may have contributed to the very low rate of application for them. The greater success rate of getting loans in the north reduced this concern amongst farmers there. Levels of information about loan sources were also fairly low, with only about half of the farmers in each sample area of the project being aware, as far as the interviewer could judge, of credit sources.

9.4 The Relationship between Loan-taking and other Farmer Variables

Apart from enquiring into the rather diverse sources of credit in his 1980 survey, the writer differentiated all farmers who had ever taken a cash loan for farm purposes from those who had not, in order to seek any statistically significant correlations between loan-taking by farmers and some of their other characteristics. This was done using the chi-square test with frequency data conveniently derived from the questionnaire, and stating a null hypothesis which needed to be rejected. The collected questionnaire material was categorised so as not to infringe any of the restrictions of the test. Each category was made mutually exclusive to give expected values greater than 5 in at least 80 per cent of the cells. The aim of the tests was to seek any significant differences between the various samples, with a significance level of 0.05 (95.0 per cent) being adopted. In each case the sample of farmers who took loans was compared with the sample who did not to find significant differences. In Tables 9.4 to 9.14 the data is arranged to show the actual number of respondents in each group. These figures are also shown as percentages which total up across the rows in the table to give the proportion in each sub-type column. The lower figure in each group totals down the column to show the percentage division between loan-takers and non loan-takers. The level of statistical significance of the chi-square test on each data set is also given.

The uneven distribution across the project area of loan-taking farmers, which was referred to earlier, was found to be highly significant statistically. As Table 9.4 shows whereas 71 per cent of the sampled farmers in Section IV stated that they had taken a loan, this proportion fell northwards through each section to only 30 per cent in Section I.

In order to further examine this pattern the loan/non-loan farm population data was tested against various farmer characteristics. Significant correlations were found with three other farmer characteristics: the number of years the farmers had spent in the valley, their level of education and their use of family labour on the farm. No correlations were found, however, with several other variables, namely the size of the farm, the length of farm experience and levels of farm income, investment and farm expenditure. Not only did one find a frequent lack of correlation between farmers who borrowed and their other characteristics, but in the few cases where correlations were established they appeared to be complex ones, possibly involving a third variable that was not being tested. Significant correlations were, however, established between loan-taking and more progressive farming attitudes.

As Table 9.5 indicates a statistically significant relationship was established between the number of years the farmer had been in the valley and his loan behaviour. It seems that the older farmers with over 30 years experience in the valley were more likely to take a loan whereas those with 21-30 years were less likely to, and the youngest farmers were about equally divided. This could well be related to a prevalence of long term indebtedness amongst the older farmers which forced them into borrowing, at the same time as many younger farmers took loans for other reasons. A similar complexity is suggested by Table 9.6 showing the proportion of loan and non-loan farmers according to their educational background. The less educated farmers were generally more often borrowers, whereas amongst those with more education the pattern was varied, admittedly on a small sample base. Those reporting a secondary level of schooling tended to be borrowers whereas those with pre- or post-secondary education tended not be borrowers. Those farmers who reported that they used some family labour on their holdings, were more often borrowers than those farmers who used no family labour (Table 9.7). This last group divided almost equally into loan-takers and those who did not take loans.

TABLE (9.5) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST LENGTH OF FARMER RESIDENCE IN THE VALLEY

Count Row % Col %		Number of years the farmer had been in the Valley 20 years & less	21-30	31-40	Over 40 years	Row Total
Loan takers		27 14.1 48.2	33 17.2 42.3	58 30.2 57.4	74 38.5 62.7	192 54.4
Non loan takers		29 18.0 51.8	45 28.0 57.7	43 26.7 42.6	44 27.3 37.3	161 45.6
	Column Total	56 15.9	78 22.1	101 28.6	118 33.4	353 100.0

Chi Square = 9.12039 with 3 degrees of freedom Significance = 0.0277

TABLE (9.6) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST FARMERS' EDUCATIONAL LEVEL

Count / Row % / Col %	Educational Attainment of the Farmer: Illiterate	Elementary	Preparatory	Secondary	Graduate	Row Total
Loan takers	87	74	13	13	5	192
	45.3	38.5	6.8	6.8	2.6	
	56.1	59.7	34.2	65.0	31.2	54.4
Non Loan takers	68	50	25	7	11	161
	42.2	31.1	15.5	4.3	6.8	
	43.9	40.3	65.8	35.0	68.7	45.6
Column Total	155	124	38	20	16	353
	43.9	35.1	10.8	5.7	4.5	100.0

Chi Square = 12.18526 with 4 degrees of freedom Significance = 0.0160

TABLE (9.7) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST FAMILY HELP ON THE FARM

Count Row % Col %	Family Work No Family Work	 Some Family Work	 Row Total
Loan takers	107 55.7 49.3	85 44.3 62.5	192 54.4
Non Loan takers	110 68.3 50.7	51 31.7 37.5	161 45.6
Column Total	217 61.5	136 38.5	353 100.0

Chi Square = 5.34462 with 1 degree of freedom Significance = 0.0208

Statistically significant correlations were established, not too surprisingly, between borrowing behaviour and farmers' sources of supplies and methods of payment for supplies. As Table 9.8 shows a high proportion - generally over 70 per cent - of farmers who reported that they obtained their supplies from commission agents, co-operatives or the Jordan Valley Farmers Association also took loans, whereas those supplied by village merchants were less often borrowers. This, of course, reflects, amongst other factors, the greater availability of supply and other credits from commission agents and the institutional services which were referred to in the previous chapter. Those that were supplied from agricultural supply companies, or a mixture of sources, were more evenly divided in their loan behaviour. It follows from this that those farmers who paid for their supplies at the end of the season, or by a mixture of methods, were also often borrowers although it is interesting to note here (Table 9.9) that a third of those who were using supply credits did not seem to consider that was a form of loan. Those that reported paying cash for their supplies were much less often borrowers for any other farm purpose.

Members of the co-operatives or of the Jordan Valley Farmers Association, or of both, were much more often borrowers than non-members, since a major reason for membership of these associations, as will become clear later, is to be able to obtain farm supplies on credit and longer-term farm improvement loans. As Table 9.10 shows nearly 70 per cent of the farmers who stated that they were members of both their local co-operative and of the Association also reported that they had taken a loan. In contrast only 35 per cent of non-members reported that they had taken a loan.

That loan-takers included a proportion of farmers who used advanced agricultural techniques is also suggested by the significant relationship established with those farmers who reported using plastic culture, or drip irrigation techniques, or both. As Table 9.11 shows, although the numbers using these farm methods were relatively small, the great majority of them were also borrowers. Over 84 per cent of those who reported using both advanced techniques were borrowers, compared with 78 per cent of those who used only one of the techniques. Only half of the farmers who used neither advanced technique were loan takers.

TABLE (9.8) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST SOURCE OF FARM SUPPLIES

Count Row % Col %	Commission Agent	Village Merchant	Co-operative	JVFA	Agricultural Supply Company	Landlord	Mixed	Row Total
	Source of Farm Supplies							
Loan takers	19	15	43	21	16	2	76	192
	9.9	7.8	22.4	10.9	8.3	1.0	39.6	
	70.4	35.7	70.5	87.5	45.7	100.0	46.9	54.4
Non Loan takers	8	27	18	3	19	0	86	161
	5.0	16.8	11.2	1.9	11.8	0.0	53.4	
	29.6	64.3	29.5	12.5	54.3	0.0	53.1	45.6
Column Total	27	42	61	24	35	2	162	353
	7.6	11.9	17.3	6.8	9.9	0.6	45.9	100.0

Chi Square = 32.05518 with 6 degrees of freedom   Significance = 0.0000

TABLE (9.9) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST METHOD OF PAYMENT FOR FARM SUPPLY

Count Row % Col %	Method of Supply Payment Cash	 End of Season	 Mixed	 Row Total
Loan takers	15	32	145	192
	7.8	16.7	75.5	
	17.6	66.7	65.9	54.4
No Loan takers	70	16	75	161
	43.5	9.9	46.6	
	82.4	33.3	34.1	45.6
Column	85	48	220	353
Total	24.1	13.6	62.3	100.0

Chi Square = 60.94186 with 2 degrees of freedom Significance = 0.0000

TABLE (9.10) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST CO-OPERATIVE AND J.V.F.A. MEMBERSHIP

Count Row % Col %		Co-operatives and JVFA Membership Not member	Co-operative or JVFA member	Member of both	Row Total
Loan takers		46	66	80	192
		24.0	34.4	41.7	
		34.6	62.9	69.6	54.4
Non loan takers		87	39	35	161
		54.0	24.2	21.7	
		65.4	37.1	30.4	45.6
	Column	133	105	115	353
	Total	37.7	29.7	32.6	100.0

Chi Square = 34.73615 with 2 degrres of freedom Significance = 0.0000

TABLE (9.11) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST APPLICATION OF ADVANCED FARM TECHNIQUES

Count Row % Col %	Advanced Techniques Non	Drip or Plastic	Drip and Plastic	Row Total
Loan takers	156	25	11	192
	81.2	13.0	5.7	
	50.6	78.1	84.6	54.4
Non loan takers	152	7	2	161
	94.4	4.3	1.2	
	49.4	21.5	15.4	45.6
Column Total	308	32	13	353
	87.3	9.1	3.7	100.0

Chi Square = 13.79171 with 2 degrees of freedom Significance = 0.0010

Of course some of the farmers using these techniques may have been borrowing to pay for the cost of the equipment. On the other hand, no significant correlation was established between loan behaviour of farmers and the numbers of machines on their holdings, the use of farm advice, the quality of the land farmers occupied or the size of their holdings. All of this again suggests that those who took out loans were a very mixed group partly because loans can vary so much in their size, purpose and speed of repayment.

That the project farmer who takes out a loan does not clearly fall into any one category and that his borrowing behaviour is influenced by other factors not tested here, is suggested by two final sets of statistically significant correlations - between loan taking and certain types of farm land use and between loan taking and the use of certain produce markets. As Tables 9.12 and 9.13 indicate, farmers who cultivated fruit to the exclusion of all other crops in 1980 - and these were most commonly found in the far northern part of the project - were divided more or less equally in their use of loans. The farmers who concentrated on fruit growing but had a limited amount of other cropland were less frequently borrowers. On the other hand, these farmers who grew little or no fruit - mainly in the middle and southern areas of the project - were frequently borrowers. While this suggests a locational factor is intruding into the relationship, the same does not appear to be the case for the borrowing activities of vegetable producers. In Table 9.13 it can be seen that those who concentrated on this type of land use were more often borrowers than those who grew few vegetables. Here borrowing by these farmers reflects the high costs and seasonal income of this more intensive type of farm enterprise. No valid correlation was found between loans and cereal-producing farmers.

One can also note significant correlations were obtained between farmers' loans and some of the produce markets they used, which again largely reflects the intrusion of a third variable of a locational type. Those farmers that reported using Sawalha, the most popular assembly market in the valley, were more likely to be loan takers, probably because the market especially serves the southern farmers who, it has been seen, were more often borrowing money (Table 9.14). Farmers

TABLE (9.12) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST FRUIT TREE FARMING

Percent of cropped land under Fruit Trees

Count Row % Col %	Non	1-30%	31-60%	61-99%	100%	Row Total
Loan takers	128 66.7 62.1	17 8.9 70.8	17 8.9 40.5	6 3.1 20.0	24 12.5 47.1	192 54.4
Non loan takers	78 48.4 37.9	7 4.3 29.2	25 15.5 59.5	24 14.9 80.0	27 16.8 52.9	161 45.6
Column Total	206 58.4	24 6.8	42 11.9	30 8.5	51 14.4	353 100.0

Chi Square = 26.28314 with 4 degrees of freedom Significance = 0.0000

TABLE (9.13) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST VEGETABLE FARMING

Count Row % Col %	Non	1-30%	31-60%	61-99%	100%	Row Total
	Percent of cropped land under vegetables					
Loan takers	30	8	23	39	92	192
	15.6	4.2	12.0	20.3	47.9	
	49.2	26.7	43.4	61.9	63.0	54.4
Non loan takers	31	22	30	24	54	161
	19.3	13.7	18.6	14.9	33.5	
	50.8	73.3	56.6	38.1	37.0	45.6
Column Total	61	30	53	63	146	353
	17.3	8.5	15.0	17.8	41.4	100.0

Chi Square = 18.35526 with 4 degrees of freedom Significance = 0.0011

TABLE (9.14) EAST GHOR CANAL PROJECT:

TESTING CASH LOAN TAKING AGAINST FARMERS' USE OF SAWALHA MARKET

Count Row % Col %	Using Sawalha Market Non-User	 User	Row Total
Loan takers	52 27.1 38.2	140 72.9 64.5	192 54.4
Non Loan takers	84 52.2 61.8	77 47.8 35.5	161 45.6
Column Total	136 38.5	217 61.5	353 100.0

Chi Square = 22.22949 with 1 degree of freedom Significance = 0.0000

who used North Shuneh market were less often borrowers, again probably because northern farmers mainly use this market and northern farmers tended to borrow less. Irbid, as another northern market, presented a similar picture. No significant correlation was found between farmers' loans and the use of Wadi Yabis and Amman markets, the other two major markets used by ghor farmers.

9.5 Non-Loan Farmers' Viewpoint towards Loans

The writer's 1980 sample survey showed that 161 of the 353 farmers interviewed (46 per cent) reported that they did not take cash loans. These non-borrowing farmers were more common in the north of the project than in the south. Whereas nearly 70 per cent of respondents in Section I said they had never taken a cash loan, in Section IV this figure fell below 30 per cent. Table 9.15 summarizes the reasons that farmers who had never taken a loan gave in the 1980 survey. Many gave more than one reason for not taking a loan but the biggest proportion (64 per cent) gave religious objections since Islam prohibits cash borrowing if repayment is with interest. This reason was more commonly given in the north than in the south where the use of loans is more common. Almost as many said they objected to borrowing because they feared difficulty in keeping up with the repayments and feared for the security of their property if they defaulted through death or other reason.

Nearly one third of respondents gave a variety of reasons by which they felt they would not qualify for a loan or were unaware of how to get a loan. Most numerous of them were those who said that as they were not landowners they would not be able to get a loan although a chi-square test on farmers of different tenure status, has suggested that there is no correlation between loan taking and tenure status.

9.6 The Agricultural Credit Corporation (ACC)

It is clear from what has been discussed in this chapter that the three institutional loan sources - the co-operatives, the Jordan Valley Farmers Association and the Agricultural Credit Corporation - are, along

TABLE (9.15) EAST GHOR CANAL PROJECT:

REPORTED REASONS FOR NOT TAKING CASH LOANS, SAMPLE SURVEY, 1980

	Section I		Section II		Section III		Section IV		Total Project	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Religion	52	73.2	26	65.0	18	54.5	11	47.8	107	64.1
Dislikes Borrowing	45	63.4	19	47.5	28	84.8	13	56.5	105	62.9
Not Landowner	13	18.3	5	12.5	3	9.1	5	21.7	26	15.6
Loan un-available	5	7.0	3	7.5	2	6.1	3	13.0	13	7.8
Ignorant of loans	4	5.6	2	5.0	3	9.1	1	4.3	10	6.0
Other reasons	13	18.3	9	22.5	4	12.1	2	8.7	28	16.8
Total Non Loan takers										
No.	71		40		27		23		161	
%		69.6		43.0		33.7		29.5		45.6
Total Sample (No. of farmers)	102		93		80		78		353	

with the commission agents, the prime sources of credit and loans for valley farmers. By their very nature little information can be obtained on the commission agents but this does not deny the value of reviewing a little further the roles of the three institutions, especially as they are the sources for long-term borrowings for farm development. Because the co-operatives and the JVFA are the biggest loan sources and also have other important functions they are considered separately in the next chapter. But the Agricultural Credit Corporation has no other purpose than to provide farm loans so should be considered here.

The ACC has been loaning both short and longer term loans to farmers in Jordan since it was set up in 1959 to take over lending from several other governmental bodies. Much of its loaning is long term and aimed at land reclamation loans and the development of more intensive use of farmland but it is clear nationally that the numbers of farmers able in recent years to get an ACC loan have declined while the amounts lent have grown whereas for example, nationally just under half a million JD was lent out in 1960 to 4400 borrowers, by 1978 the number of loans had fallen to just over one thousand with a total value of 3.2 million JD so that the average size of the ACC loan is larger than from the JVFA or co-operatives.

The national decline in the number of farmers benefiting each year from ACC loans, at the same time as the amount loaned has increased, is reflected in the valley although, in detail, the pattern is a little less clear. The project area is covered by two offices of the Agricultural Credit Corporation. The Wadi Yabis office provides credit to farmers in the valley north of Wadi Yabis. Valley farmers further south get their ACC loans through the Salt Office but this office also includes in its area the Balqa sub-district covering the farm areas in the hill districts outside of the valley. As a result data on the loaning activities of the Wadi Yabis office are the only ones that can be used here. Table 9.16 summarizes the loan data for Wadi Yabis office for 1973-77. It can be noted that it shows the major uses of loans were for land reclamation for irrigation as well as for equipment. Only 22 per cent of the loan money was for seasonal loans although data for the same office for 1972-78, summarized in Table 9.17 showed that the number of farmers taking out medium term loans fell

TABLE (9.16) AGRICULTURAL CREDIT CORPORATION - WADI YABIS OFFICE:

LOANS GIVEN BY PURPOSE AND VALUE, 1973-1977

Loan Use (goal)	Loan Value	
	JD	%
Reclamation and construction of Irrigated Lands	467 079	58.5
Seasonal Loans	176 095	22.1
Agricultural Equipment	126 838	15.9
Agricultural Rural Buildings	17 525	2.2
Development of Livestock and Poultry	10 675	1.3
Total Loans	798 212	

Source: Compiled from the records of the Agricultural Credit Corporation - Wadi Yabis Office.

TABLE (9.17) AGRICULTURAL CREDIT CORPORATION – WADI YABIS OFFICE: LOANS GIVEN BY TYPE, NUMBER AND VALUE, 1972–1978

	Medium Loans			Seasonal Loans				TOTAL LOANS	
YEAR	No. of Loans	Value of loans JD	Loan Average JD	No. of Loans	Value of loans JD	Loan Average JD	% of the Total loans Value	No. of Loans	Value of Loans JD
1972	133	135 650	1020	104	102 386	984	43.0	237	238 036
1973	127	145 765	1148	89	17 033	191	10.5	216	162 798
1974	92	84 160	918	81	38 763	478	31.5	173	122 923
1975	92	79 468	864	114	50 534	443	38.9	206	130 002
1976	80	130 901	1636	96	35 560	370	21.4	176	166 461
1977	91	149 496	1643	125	32 705	261	17.9	216	182 201
1978	64	121 670	1901	118	55 910	474	31.5	182	177 580
Total	679	847 110		727	332 890			1406	1180 001
Annual Average	97	121 015	1247	104	47 556	458	28.2	200.9	168571.6

Source: Compiled from the records of the Agricultural Credit Corporation – Wadi Yabis Office.

while those taking out seasonal loans remained more stable. On the other hand the value of medium term loans increased, as is to be expected with inflation, whereas shortterm loans changed little. Overall the activity of the ACC in the northern valley seems to have been on a small scale, benefiting little more than 100 farmers a year.

9.7 Conclusion

In summary it appears that both governmental and private loan sources are significant to the ghor farmers but with the government agencies providing all of the longer-term farm development loans. More of these were being used in the more fully developed northern part of the project, but everywhere the low levels of income and capital accumulation by farmers, as well as other factors, seemed to restrict loan taking for farm improvement. Relatively little correlation was seen between the loan taking activities of farmers and their other characteristics suggesting also that such correlations are complex ones. Considerable efforts have been made by the authorities in recent years to strengthen loan, advice and other support to valley farmers and it is to those bodies that attention is now turned.

CHAPTER 10 FARM SERVICES III: COOPERATIVES, THE JORDAN VALLEY FARMERS ASSOCIATION AND EXTENSION SERVICES

10.1 Introduction

The previous two chapters have indicated that the provision of adequate farm supply, credit and marketing facilities in the ghor is important to the farmers, and a frequent lack of flexibility, or variety, in these may have sometimes restricted farm development. No mention has yet been made of farm advisory services. In this chapter, therefore, the growth in the loaning activities of the agricultural co-operatives and the Jordan Valley Farmers Association, and the farm advisory work of the extension services in the valley are considered as three of the major governmental responses to the need to provide a suitable institutional framework for successful farming. Again much use is made of the writer's sample surveys to establish relationships between the use of these services and other characteristics of farmers. The chapter ends with an attempt to classify the sampled farmers into four groups on the basis of their use of these services and their other characteristics. As in the classification of the same farmers made, on the basis of their crop regimes at the end of Chapter 7, the groups revealed strong spatial variations across the project area.

10.2 The Development of the Valley's Co-operatives

The co-operative movement in Jordan has grown steadily since 1952 when the Department of Co-operative Development was set up with the object of promoting co-operative societies and generally guiding their operation.[1] There were 702 co-operatives in Jordan in 1966 with a total membership of 43,000 but as they had grown up in an unco-ordinated manner, the Jordan Co-operative Organization was set up in 1968 to reorganize them into bigger multi-purpose co-operatives able to render a full spectrum of services, including the provision of credit, the supply of agricultural needs and marketing facilities.

Early development of co-operatives in the valley involved much the same pattern of haphazard growth of many small bodies followed by re-organisation, mergers and then general strengthening of their work. No detailed data could be obtained by the writer for the earliest years of co-operative development in the valley but this pattern of development meant that the number of local co-operatives has varied somewhat over the last 15 to 20 years with a recent renewed growth after earlier retrenchment.[2] There were about 45 local co-operatives in the east and west parts of the Jordan Valley in 1966, but many of these were very small and probably no more than 15 were fully active. For the 37 branches in 1966 on which data could be collected, there was a total membership of 1555. With an average of 42 members each, they were small by national standards, but with total assets of JD 308,000, they appeared to be stronger than many. Their assets-to-membership ratio (JD 198 per member) was three times that of the average co-operative nationally.

10.2.1 The Development Pattern

The programme of reorganisation of co-operatives in the late 1960's saw a temporary decline in the number of branches in the valley as inactive ones were closed or were merged with others. In more recent years, however, new branches have been opened notably in the new farming districts in the south of the project area. Some additional data is available for the co-operatives in both the northern parts for 1973-78 and southern parts of the valley for the years 1975-78.[3]

Table 10.1 summarizes the pattern of recent differential growth in the number and size of co-operatives in the northern and southern valley areas. It can be seen that between 1975 and 1978 the number of co-operatives in the valley increased from 20 to 30 and their total membership grew by 135 per cent from 1091 to 2564. The pattern of growth differed, however, from the northern valley where co-operatives were already fairly well established by the early 1970's, to the southern valley where they were more recently being set up in newer farming areas. The table shows that whereas the number of co-operatives in the northern valley fluctuated between 1973 and 1978 as weaker branches closed and new ones opened, the pattern in the south was more one of growth. The membership figures also show up this difference

TABLE (10.1) EAST JORDAN VALLEY: DEVELOPMENT OF THE AGRICULTURAL CO-OPERATIVES, 1973-78

	Northern Valley				Southern Valley			
	No. of Co-op.	No. of members	Av. no. members per co-op.	% increase in members on 1975 base	No. of Co-op.	No. of members	Av. no. members per co-op.	% increase in members on 1975 base
1973	8	704	88.0	-	No data available			
1974	16	1010	63.1	-	No data available			
1975	8	866	108.3	0	12	225	18.8	0
1976	7	1280	182.9	47.8	18	451	25.1	100.4
1977	8	1575	196.9	81.9	15	643	42.9	185.8
1978	11	1801	163.7	109.1	19	763	40.2	239.1

Source:- Compiled from the Annual Statistical Reports of the Jordanian Co-Operative Organization, 1973-1978 in that whilst total membership in the northern societies doubled during 1975-78 (109 per cent) the rate of increase was much faster in the south (239 per cent).

The average size of the southern societies also grew more rapidly over these 4 years. Whereas the average membership of a northern co-operative increased from 108 to 163 between 1975 and 1978, those in the south grew from an average of 18 to 40 members each.

This rapid growth in co-operative membership has been accompanied by a rapid expansion in the activities of the local branches. The loaning activities of societies, an aspect of co-operative services which the writer's sample surveys have shown to be one of the major attractions of co-operative membership to farmers, can, to some extent, be gauged from the annual reports of the Jordanian Co-operative Organisation.[3] Little data is available on the loan activities of individual branches but Table 10.2 gives the total loans outstanding to members and to local societies from the central co-operative organization (The Jordanian Co-operative Organization).

It can be seen that the loan capital available to co-operatives in the valley, both for dispersal to members as individual farm loans and to support the other services to members, has been expanded more rapidly than the increase in membership. Whereas, for example, the northern co-operatives had a total of less than JD 100,000 of outstanding loans to members at the end of 1975, this figure had risen close to 1 JD million by the end of 1978. This does not, however, represent a growth of long-term indebtedness by members to their co-operatives since most loans have to be repaid within a year. Rather, it reflects the increased availability of more short term credit or loans for farm supplies and more farm improvement loans for an enlarged membership. If one assumes that all members of the northern co-operatives in any one year shared this outstanding loan capital then the average individual loan would have grown from JD 108 in 1975 to JD 522 in 1978.

The southern co-operatives, although smaller, have in general done better. As Table 10.2 shows, outstanding loan amounts, if averaged across the total membership, have generally been larger for the southern societies than for the northern societies. Total outstanding loans to members have also grown in the southern co-operatives from JD 42,000 to

TABLE (10.2) EAST JORDAN VALLEY: DEVELOPMENT OF CO-OPERATIVES, MEMBERSHIP AND LOANS, 1973-78

	Northern Valley					Southern Valley				
			J. Dinar					J. Dinar		
	Average membership of co-op.	Total outstanding loans to members	per member	Total loans to societies	per society	Average membership of co-op.	Total outstanding loans to members	per member	Total loans to societies	per society
1973	88.0	26 570	37.7	56 809	7101	no data available				
1974	63.1	100 202	99.2	100 202	6262	no data available				
1975	108.3	93 893	108.4	120 703	15088	18.8	42 320	188.0	95 983	7999
1976	182.9	196 153	153.2	183 100	26157	25.1	131 904	292.5	190 038	10558
1977	196.9	593 733	377.0	614 423	76803	42.9	229 776	357.3	368 637	24576
1978	163.7	940 799	522.4	984 669	89515	40.2	504 412	661.1	561 756	29566

Source:- Compiled from the Annual Statistical Reports of the Jordanian Co-Operative Organization, 1973-1978

JD 504,000 over the four years at a rate faster than for the northern societies. As a result, while the southern societies had 30 per cent of the co-operative membership of the valley in 1978, they had 35 per cent of the outstanding loans to members in the valley and 35 per cent of total loans from the central organisation to societies in the valley. All of this suggests that the rapid re-development of co-operatives in the valley in recent years has narrowed the differences between the smaller and newer southern societies and the larger ones in the north.

10.2.2 The Middle Ghor Co-operative Society, A Case Study

Since the data examined in the previous section is generalised across many local co-operatives and only covers a maximum of six years, the author attempted during his 1980 fieldwork season to contact each co-operative in the northern part of the valley to obtain a more detailed breakdown of their activities particularly on providing loans and farm supplies. Although eight of the 11 co-operatives responded with some data for single years, only one of them - the Agricultural Co-operative Society for the Middle Ghor Area - was able to provide a reasonable range of data on its activities over a longer time period. It must be accepted that this society may not be entirely typical in being rather larger, more active and better organized than some others but a summary of its records, and what these indicate, seems worthwhile to provide more detail than is possible in other ways.

The Middle Ghor Co-operative Society is one of the oldest in the project area. As Table 10.3 and Fig. 10.1 show its membership of 56 in 1971 had grown to 245 in 1979 to make it the second largest branch in the northern valley. In 1978 at a time when there were 11 co-operatives in the northern valley, the Middle Ghor Society had 13 per cent of these members. The rate at which its membership had grown, however, was little different from the average for all 11 societies in the northern valley.

It is clear in Table 10.3 that over three-quarters of the loaning activity throughout the 1970s by the Middle Ghor Society has been linked to the provision of farm supplies to members on a credit basis with payment being made at the end of the season. Records show that most

TABLE (10.3) MIDDLE GHOR CO-OPERATIVE SOCIETY:

DEVELOPMENT OF MEMBERSHIP AND LOANING ACTIVITY, 1971-1979

		Farm Supply Loans in kind				% Value of Loan Types		
	Total members	No. loans	% members with loans	average value JD	total value	supply loans % total loans	medium loans % total loans	seasonal loans % total loans
1971	56	50	89.3	207.3	10 366	91.2	0	8.8
1972	87	75	86.2	199.8	14 987	85.5	0	14.5
1973	96	80	83.3	286.6	22 926	88.4	3.2	8.4
1974	123	105	85.4	373.5	39 217	91.1	0	8.9
1975	161	137	85.1	363.6	49 811	90.1	3.9	6.0
1976	183	162	88.5	484.2	78 450	91.6	2.8	5.6
1977	225	180	80.0	765.1	137 725	77.4	16.9	5.7
1978	240	195	81.3	710.2	138 490	67.4	29.4	3.2
1979	245	200	81.6	531.9	106 376	65.7	28.9	5.4
Total		1184		505.4	598 348	76.3	18.2	5.5

Source:- Compiled from the records of the Middle Ghor Co-Operative Society, 1971-1979.

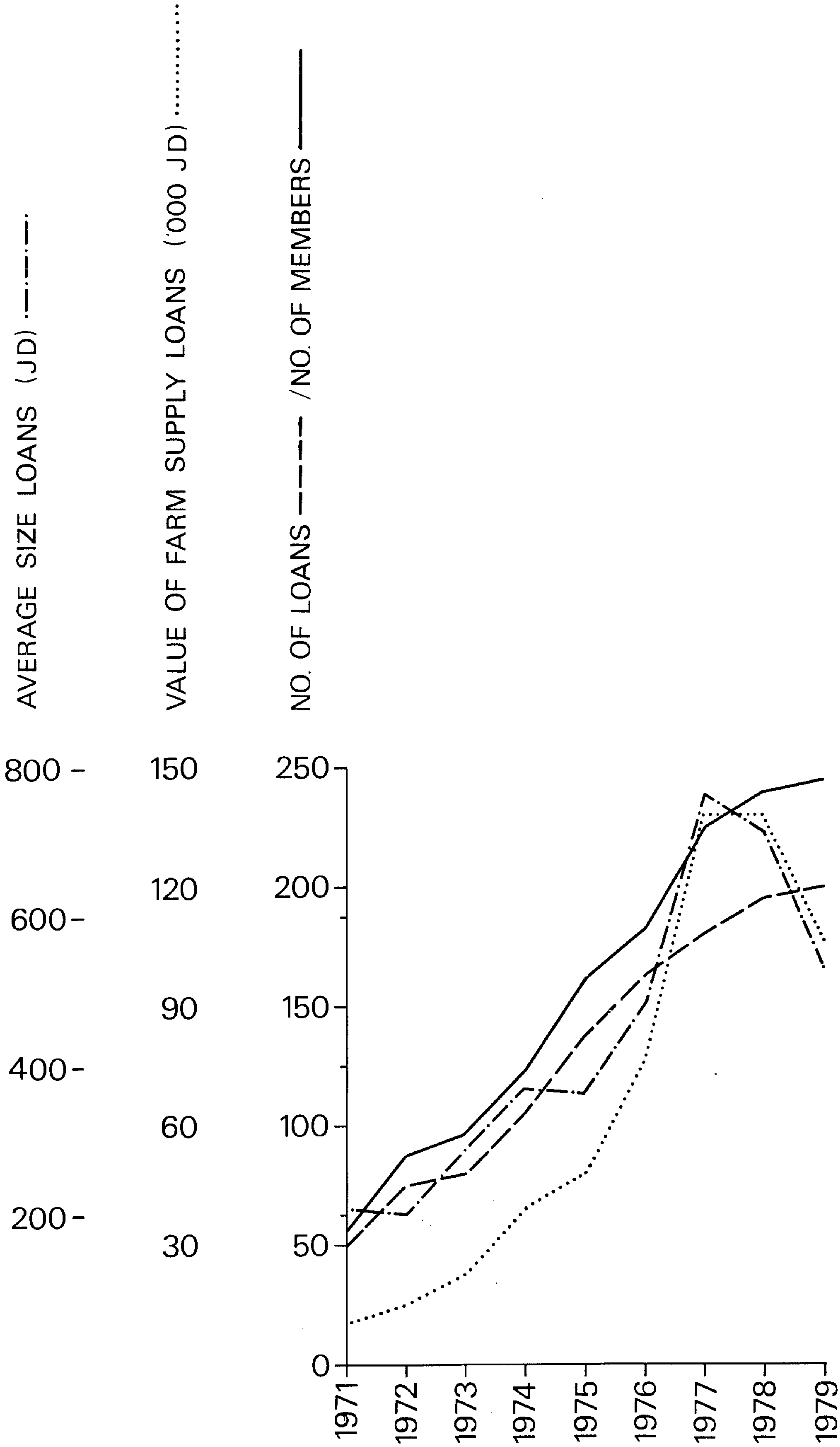


Fig. 10.1 THE MIDDLE GHOR CO-OPERATIVE SOCIETY: DEVELOPMENT OF MEMBERSHIP AND LOANS, 1971-1979

members made regular use of this facility. For each year since 1971 at least 80 per cent of members had a loan for supplies which they had obtained from the co-operative. The average size of this loan grew through the 1970s from around JD 200 at the start of the data period to over JD 500 at its end in 1979, with even higher figures in 1977 and 1978. The increase in the size of these credits, together with a 300 per cent increase in the number of those loans made over the period due to the expanded membership, meant that the total credits being provided by the Society to its members for farm supplies grew ten-fold from just over JD 10,000 in 1971 to over JD 100,000 in 1979. Over the whole period these loans, of which 1184 were provided with a total value of JD 598,000, made up 76 per cent of all loans issued by the Society to its members.

No data is available on the total value of sales of supplies to farmers by the Society. These would probably have considerably exceeded the value of the credits for supplies, since about 15 per cent of members did not use these loans but may still have purchased supplies from the Society for cash. Those taking these supply loans may have purchased some other supplies from the Society for cash, whilst the Society made some small surplus supplies available (to the value of JD 7000 in 1979) to non-members for cash.

The other two types of credit available to members of the Middle Ghor Society were medium term loans for farm improvements and seasonal cash loans for farmers suffering short term cash shortages. Table 10.3 gives data on the scale of this loaning activity by the Society. Only 44 medium term cash loans were made by the Society to its members in the study period but because they were mainly for major farm improvements their individual value was generally much higher than the Society's other lendings. As a result they made up 18 per cent of the value of all the Society's loans between 1971-79. As can be seen in Table 10.3 nearly all of these loans were made in the last three years of the nine year data period. The average size of these loans tended to increase since the first one was made in 1973.

Seasonal cash loans represented the third and smallest part of the Society's loaning activities for members. They only accounted for 5.5 per cent of the value of all loans made by the Society during 1971-79.

That short-term cash loans have not been more important probably relates to the very widespread uptake by members of loans in kind, thereby much reducing the likelihood of short-term cash shortages to meet bills for supplies. In fact the figures suggest that over the data period the proportion of the Society's total loans made as seasonal cash loans declined from 12 per cent in 1971-72 to only 5 per cent in 1978-79. Even so 341 seasonal cash loans were made during 1971-79. If one assumes that no member took more than one loan in any one year about 16 per cent of all members took a seasonal loan. In some years over 30 per cent of members had these loans but their mean individual value was small, only about JD 70 at the start of the 1970s and around JD 200 at the end.

The Middle Ghor Co-operative is therefore a much used source of farm supplies by its members, most members on average obtaining supplies to the value of several hundred JD each year from the society. Many also get these goods on short-term credit. Rather fewer members use the society as a useful source of short term cash loans. Medium term loans have been increasingly taken up by a small proportion of members.

10.2.3 Loaning and Supply Activities of the Project Area Co-operatives

It seems clear from the data for the Middle Ghor Society that the provision of farm supplies, and the credit for these, form a prime function of the co-operative with longer term and short term loans an additional function. It seems reasonable to examine, as far as the scanty data will allow, the uses of these various type of credit in the other co-operatives within the East Ghor Canal Project area. Various sets of figures collected from the Jordan Valley Co-operative Directorate for the co-operatives in its area for 1976 and 1979 are considered next.

It might be noted first in Table 10.4 the wide variation in the size of the 11 co-operatives in the Directorate in 1979 ranging from over 500 members in Wadi Yabis, down to some societies with less than 100 members. There is little correlation between the ranking of these societies, on the basis of the membership numbers, and the total amount of their loaning activities. Some co-operatives engage in much more loaning than others. On the basis of the total loans made by each

TABLE (10.4) EAST GHOR CANAL PROJECT:

CO-OPERATIVES MEMBERSHIP SIZE AGAINST LOANING VALUE, 1979

Co-operative	No. of members	%	Rank	Total Loans JD	%	Rank	Total loans members (JD)
North Shuneh	203	9.5	4	29 922	3.0	9	147.4
Shakh Husein	207	9.8	3	163 763	16.2	3	791.1
El Mashar'h	124	5.8	8	12 178	1.2	11	98.2
Wadi Yabis	533	25.1	1	193 260	19.1	1	362.6
Balalwneh	142	6.7	7	73 085	7.2	6	514.7
Ed Dyat	74	3.5	11	31 097	3.1	8	420.2
Er Rabe'h	97	4.6	10	93 536	9.2	5	964.3
El Arda Triangle	110	5.2	9	40 108	4.0	7	364.6
Middle Ghor	245	11.6	2	161 941	16.0	4	660.1
Deir Alla & Damya	192	9.1	6	191 917	18.9	2	999.6
Kriymeh	193	9.1	5	23 152	2.3	10	120.0
Total	2120	100.0		1013 959	100.2		

Source:- Compiled from the records of the Jordan Valley Co-Operative Directorate.

co-operative in relation to its membership the leading co-operatives include larger ones like Wadi Yabis, Deir Alla, Shakh Husein and Middle Ghor, but also much smaller ones like Er Rabe'h, the second smallest co-operative in the Directorate with only 97 members. Yet some of the larger and presumably stronger co-operatives seem to have provided far fewer loans in 1979, including North Shuneh, and Kriymeh, each with about 200 members. El Mashar'h Co-operative provided only one-tenth the level of funding of that of the most active co-operative of Deir Alla in terms of total loans in relation to members.

Some explanation for these very variable levels of loan activity between neighbouring co-operatives might be sought in a further analysis of the various loan types into supply credits, medium term loans and seasonal loans. The dominance of supply loans is found in the figures given in Table 10.5 for the whole Directorate area in 1976 and 1979, as it was for Middle Ghor Co-operative. But in both years the proportion of supply loans was smaller than for the Middle Ghor Co-operative in the same two years. Medium term loans made up a third of all loans by value compared with about 20 per cent in the Middle Ghor Co-operative.

Where many more of the loans are in the form of small supply credits then a smaller variation in loaning levels from year to year and from co-operative to co-operative might be expected. Unfortunately there is no data available on the loaning levels for each co-operative from year to year in order to pursue this, but Table 10.6 lists the types and total amounts of loans provided by each co-operative in 1979. Here it can be seen that at least part of the wide variation in loaning level, found between co-operatives, is explained by the availability and use of medium term and seasonal loans. All of the co-operatives with high loaning activity in 1979 had large amounts of medium term and/or seasonal loans. The table shows that Wadi Yabis, Deir Alla, Er Rabe'h, Shakh Husein and Balalwneh co-operatives, which all had high loaning activity for their membership levels, also had a smaller share of their loans as loans for supplies. No detail is available on the uses of medium term loans but they were taken out for a wide range of farm improvements especially machinery purchases, land levelling and the purchase and erection of plastic houses. Fencing, canal construction and citrus planting were other reasons for farmers taking

TABLE (10.5) EAST GHOR CANAL PROJECT:

LOANS PROVIDED BY THE CO-OPERATIVES BY TYPE AND VALUE, 1976 and 1979

	1976 Loans Value		1979 Loans Value	
	J. Dinar	%	J. Dinar	%
Kind Loans	292 558	60.2	505 074	49.1
Seasonal Loans	47 630	9.8	130 532	12.7
Medium Loans	146 100	30.0	393 000	38.2
Total Loans	486 288	100.0	1028 601	100.0

Source:- Compiled from records of the Jordan Valley Co-Operative Directorate.

TABLE (10.6) EAST GHOR CANAL PROJECT:

TYPE OF LOANS PROVIDED BY EACH CO-OPERATIVE TO ITS MEMBERS, 1979

	Seasonal Loans				Medium Loans		Total Loans	
	Cash Loans		Loans in Kind					
Co-operative	J.Dinar	Row %	J.Dinar	Row %	J.Dinar	Row %	J.Dinar	%
North Shuneh	4 792	16.0	17 940	60.0	7 190	24.0	29 922	100.0
Shakh Husein	38 265	23.4	15 918	9.7	109 580	66.9	163 763	100.0
El-Mashar'h	0	0	11 178	91.8	1 000	8.2	12 178	100.0
Wadi Yabis	35 631	18.4	83 283	43.1	74 346	38.5	193 260	100.0
Balawneh	18 669	25.6	43 786	60.1	10 360	14 2	72 815	99.9
Ed Dyat	2 550	8.2	28 547	91.8	0	0	31 097	100.0
Er Rabe'h	2 150	2.3	47 711	51.0	43 675	46.7	93 536	100.0
Al Arda Triangle	2 610	6.5	37 498	93.5	0		40 108	100.0
The Middle Ghor	8 665	5.3	106 376	65.7	46 900	29.0	161 941	100.0
Deir Alla & Damya	17 200	9.0	92 305	48.1	82 412	42.9	191 917	100.0
Kriymeh	0	0	20 527	88.7	2 625	11.3	23 152	100.0
Total	130 532	12.9	505 069	49.8	378 088	37.3	1013 689	

Source:- Compiled from the records of the Jordan Valley Co-Operative Directorate.

out loans and it is the uneven distribution of these improvements across the area from year to year which helps account for the high level of medium term loaning within some co-operatives and not in others. Unfortunately, there is no data on the make-up or use of medium term loans to individual farmers. No information is available on the use of seasonal cash loans, the dispersal of which varied markedly across the 11 co-operatives in 1979, as Table 10.6 shows, although it can be noted that in no case did these loans make up more than a quarter of all loans in that co-operative.

There is little more data on the types of supplies purchased on credit from the co-operatives except that some 1976 figures, summarized in Table 10.7, show that fertilizer purchases accounted for 75 per cent of these credits, across the co-operatives in the Directorate, with another 10 per cent for pesticides.

In summary then, although farm supplies and the provision of credit for them seems to be the dominant role of the local co-operatives, there is much variation in the level of this activity from one society to another which is not simply related to the size of its membership. The provision of other types of loans - particularly longer term farm improvement loans - may be increasing in importance, and the variable demand for these and the differing abilities of societies to provide them may help further distinguish between the societies.

10.3 The Co-operatives from the Ghor Farmer's Viewpoint

All of the data presented so far in this chapter, on the role of the farm co-operatives in the project area, have viewed their work from the side of the co-operatives and has been based entirely on their own data sources which are essentially of a financial nature in terms of their loaning activities. None of the data considers the individual farmer, or co-operative member, to see how he perceives and uses the co-operatives, in comparison with other agencies not only for the provision of loans and farm supplies but for other needs, such as gaining advice.

Since there was no other source from which the writer could obtain this type of information, he decided to include a number of questions about co-operatives in his sample farm questionnaires in 1978 and 1980.

TABLE (10.7) EAST GHOR CANAL PROJECT:

USE OF CO-OPERATIVE SUPPLY LOANS, 1976

Purpose of loans	Value of loans	
	J. Dinar	%
Fertilizers	219 758	75.1
Seeds	22 509	7.7
Sprayers	2 323	0.8
Plastic	16 400	5.6
Pesticide	31 568	10.8
Total	292 558	100.0

Source:- Compiled from the records of the Jordan Valley Co-Operative Directorate.

In his smaller pilot survey of 1978 these questions were of an exploratory nature since, at that time, it was not known what information on the co-operatives could most usefully be provided and what data could be obtained direct from the co-operatives. Because of this and because only 35 per cent of the 156 farmers sampled were found to be members of co-operatives - approximately a 2 per cent sample of valley members - the writer has not attempted to statistically test the validity of the results or any apparent correlations between co-operative membership and other characteristics of the farmers. The sample cells were seldom big enough for this. The results of the larger 1980 survey, however, allowed statistical correlations to be made. Also several of the questions to co-operative members in 1980 were modified in the light of what was learnt in the 1978 results. Most of the questions asked of the 55 members of the co-operatives surveyed in 1978 concerned their length of membership, their reasons for joining, their use of loans from their co-operative and their general level of satisfaction with it.[4] Most of the results of the fuller 1980 questionnaire are presented later, but it is convenient to make some reference to them here also to indicate possible trends.

10.3.1 Length of Membership

One of these trends, a recent growth in co-operative membership in the project area, referred to earlier in this chapter, is immediately confirmed by the results of the 1978 and 1980 surveys. Whereas 35 per cent of the 156 farmers interviewed in 1978 said that they were members of their local co-operative, in the 1980 questionnaire to 353 farmers 47 per cent claimed membership. A small part of this increased level of reported membership across the two surveys probably reflects sample error but most of it results from an actual recruitment to the co-operatives. In the 1980 survey, for example, it was found that nearly 40 per cent of members reported that they had joined within the previous three years.

Table 10.8 suggests, however, that the length of membership in 1978 differed across the project area with Section II having more members of

TABLE (10.8) EAST JORDAN VALLEY:

LENGTH OF FARMER'S MEMBERSHIP IN CO-OPERATIVE, SAMPLE SURVEY, 1978

Length of membership (Years)	East Ghor Canal Project (Stage I)								Southern Valley (Stage II)						Total East Jordan Valley	
	Section I		Section II		Section III & IV		Total Stage I		Ext. Area (Ghor Damya)		Karameh S. Shunch & Kafrain		Total Stage II			
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
1 - 3	9	60.0	5	31.3	5	38.5	19	43.2	-	-	8	88.9	8	72.7	27	49.1
4 - 6	5	33.3	1	6.2	6	46.1	12	27.3	1	50.0	-	-	1	9.1	13	23.6
7 - 9	-	-	2	12.5	1	7.7	3	6.8	1	50.0	-	-	1	9.1	4	7.3
10 +	1	6.7	8	50.0	1	7.7	10	22.7	-	-	1	11.1	1	9.1	11	20.0
Total members	15	100.0	16	100.0	13	100.0	44	100.0	2	100.0	9	100.0	11	100.0	55	100.0

longer-standing. Thus, 49 per cent and 72 per cent of members respectively reported that they had been in their co-operatives for less than four years and less than seven years. Nearly all of the 20 per cent who reported membership of 10 years or more were found in Section II where the co-operatives (like Wadi Yabis) remained particularly strong. Most sampled members in the south were of less than 4 years standing, reflecting the fact that co-operatives like South Shuneh and Kafrain were only set up in 1976. Most reporting membership in Section I, where co-operatives have been weaker, were also fairly recent recruits.

The results obtained on membership in the 1980 survey and summarized in Table 10.9 confirm these points. Section II was the only section with well over a third of the sampled members claiming membership for over six years and most of them over 10 years. All other sections had many more newer members. This table also demonstrates the rapid growth that has occurred in membership in all areas in recent years. Nearly 80 per cent of all those sampled in 1980 had been in their co-operatives for less than seven years (compared with 72 per cent of a smaller membership in 1978). The differences in levels of membership across the project area had been somewhat narrowed by more new recruits at the same time as the proportion of longer standing members had declined.

10.3.2 Motives for Affiliation

In the 1978 survey farmers gave various reasons for their joining the co-operative. As can be seen in Table 10.10 the most commonly mentioned reasons were for farm supplies or for a combination of supplies and loaning facilities. 45 per cent of sampled members gave availability of farm supplies through the co-operative as their prime reason for joining and almost as many linked the provision of supplies with loans as their reason for using co-operatives. It is noticeable that a third role for the co-operatives - to provide marketing facilities - was never mentioned as an attraction to membership since it is a poorly developed aspect of the valley co-operatives. It can be noticed that none gave loaning facilities as the sole reason for their membership and very few considered other benefits important such as

TABLE (10.9)   EAST GHOR CANAL PROJECT:

LENGTH OF FARMER'S MEMBERSHIP IN CO-OPERATIVE, SAMPLE SURVEY, 1980

Length of Membership (Years)	Section I		Section II		Section III		Section IV		Total E.G.C.P	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
1 - 3	11	26.8	16	31.4	8	25.8	32	71.1	67	39.9
4 - 6	26	65.9	16	31.4	15	48.4	9	20.0	67	39.9
7 - 9	2	4.9	4	7.8	8	25.8	1	2.2	15	8.9
10 +	1	2.4	15	29.4	0	0	3	6.7	19	11.3
Total members	41	100.0	51	100.0	31	100.0	45	100.0	168	100.0
% Farmers sampled		40.2		54.8		38.8		57.7		47.6

TABLE (10.10) EAST JORDAN VALLEY:

FARMER'S INCENTIVE FOR JOINING A CO-OPERATIVE, SAMPLE SURVEY, 1978

	East Ghor Canal Project (Stage I)				Southern Valley (Stage II)				
	Section I	Section II	Section III & IV	Total Stage I	Ext. Area (Ghor Damya)	Karameh S. Shuneh & Kafrain	Total Stage II	Total Valley Freq	%
1 Farm Supplies	11	8	4	23	0	2	2	25	45.5
2 Cash Loans	0	0	0	0	0	0	0	0	0
3 To improve skill or living standard	0	0	0	0	1	1	2	2	3.6
4 Tribal reason	0	0	0	0	0	0	0	0	0
5 Charity	0	1	0	1	0	0	0	1	1.8
1 + 2	2	7	8	17	1	6	7	24	43.6
1 + 2 + 4	2	0	1	3	0	0	0	3	5.5
Total	15	16	13	44	2	9	11	25	100.0

improving their farming skill by advice received, or their standard of living.

The availability of supplies on short-term credit is a big incentive to membership as indicated by the widespread use made of these loans in kind already referred to, and confirmed by other results of this pilot survey. 34 per cent of the interviewed members stated that they had borrowed cash from their co-operatives during the previous year (Table 10.11). That the figure was no higher than this may reflect a failure by some respondents to recognize that supply credits are a form of loan. It may also be some did not wish to admit to borrowing since paying interest on borrowings, as required by co-operatives, is really against Moslem teaching. That 89 per cent of members who had taken loans from their co-operative the previous year reported that they had already repaid them suggests that relatively few were using the co-operatives for more than the loans for the supplies obtained on short-term credit.

10.3.3 The Performance of the Co-operatives and Members' Satisfaction

A minority of those who had used co-operative loans made some complaints of the system. 32 per cent of them claimed (Table 10.11) that they had only received their loans after delays and 26 per cent complained that the loan given was insufficiently large. Although the number of respondents to these questions were too few to allow any spatial pattern that there may be to be revealed, it is worth noting that those in Section II of the project area, where most of the longer-term members are found and where the societies are better established, made as many complaints of the loaning arrangements as other areas.

In spite of these problems 60 per cent of members interviewed considered that the co-operatives were providing them with all the services they sought from them - mainly farm supplies and loans - although members in Section II were less satisfied than in other areas.[5] Members in the southern areas seemed most satisfied even though their co-operatives were newer and smaller and membership least numerous.

Part of this relatively high level of satisfaction with co-operatives may reflect interviewee bias towards the interviewer and

TABLE (10.11) EAST JORDAN VALLEY:

FARMER'S EXPERIENCE WITH HIS CO-OPERATIVE, SAMPLE SURVEY, 1978

		East Ghor Canal Project (Stage I)					Southern Valley (Stage II)			
		Section I	Section II	Section III & IV	Total Stage I Freq	%	Ext. Area (Ghor Damya)	Karameh S. Shuneh & Kafrain	Total Stage II Freq	%
Question 1	Yes	4	7	3	14	31.8	2	3	5	45.5
	No	11	9	10	30	68.2	0	6	6	54.5
Question 2	Yes	4	5	3	12	85.7	2	3	5	100.0
	No	0	2	0	2	14.3	0	0	0	0
Question 3	Yes	3	3	2	8	57.1	2	2	4	80.0
	No	1	4	1	6	42.9	0	1	1	20.0
Question 4	Yes	3	6	2	11	18.6	1	2	3	60.0
	No	1	1	1	3	21.4	1	1	2	40.0

Question 1 Did you borrow money from your Co-op last year?
Question 2 If you borrowed, have you repaid the loan?
Question 3 Did you get your cash loan without delay?
Question 4 Was the loan adequate?

TABLE (10.11) continued..

		East Ghor Canal Project (Stage I)					Southern Valley (Stage II)			
		Section I	Section II	Section III & IV	Total Stage I Freq	%	Ext. Area (Ghor Damya)	Karameh S. Shuneh & Kafrain	Total Stage II Freq	%
Question 5	All	10	8	4	22	50.0	2	9	11	100.0
	Some	5	8	8	21	47.1	0	0	0	0
	None	0	0	1	1	2.3	0	0	0	0
Question 6	Yes	15	15	10	40	90.9	2	8	10	90.1
	No	0	1	3	4	9.1	0	1	1	9.1
Question 7	Yes	12	11	6	29	65.9	2	8	10	90.1
	No	3	5	7	15	34.1	0	1	1	9.1
Question 8	Yes	8	8	7	23	52.3	2	6	8	72.3
	No	7	8	6	21	47.7	0	3	3	27.3
Total sample		15	16	13	44		2	9	11	

Question 5 Is your Co-op performing well the services it was set up for?
Question 6 Do you know any of the Co-op officials in your area?
Question 7 Have you attended a Co-op general meeting in the last year?
Question 8 Have you read or been informed of the Co-op regulations?

may also reflect the fact that co-operative members in 1978, as a minority, were a self-selected group who had positively sought out their local society for the benefits they felt it would provide. Part also probably results from a high level of involvement by these members in the workings of the co-operatives. 91 per cent of the sampled members claimed to know at least one local official of the co-operative and 71 per cent claimed to have attended a meeting of the local branch in the previous year, while several of those who had not could offer valid excuses such as lack of transport or farm work. A majority had read the regulations of their co-operative or had had them read to them.

As a result the points made by various members on the improvement of the performance of their co-operatives were generally fairly modest. These included the need to offer farmers more supplies and more mechanical services like sprayers.[6] Some requested longer-term cash loans especially in times of hardship, and lower interest rates.

10.3.4 The Non-members' Viewpoint on the Co-operatives

Apart from attempting to get information on the valley farmers who had become members of co-operatives, the writer in his 1978 survey also asked the two-thirds of the farmers in his sample who were not members why they did not belong to a co-operative. Five questions in particular were put to these 101 non-members, the results of which are detailed in Table 10.12.

There was little indication that those farmers had not joined a co-operative through lack of awareness of it or of the advantages it can offer. 96 per cent of non-member respondents stated, correctly, that there was a co-operative near them and, even though none of them were members, 86 per cent were prepared to tell the questionner that they felt there was a need for a co-operative in their village. The great majority, however, reported that they had never been approached by an official of a co-operative to join it or help set one up. There was no clear pattern spatially in those responses except that most of the few cases where former members had left their co-operatives occurred in the more northerly sections of the project area where co-operatives have been longer established.[7]

TABLE (10.12) EAST JORDAN VALLEY:

NON-MEMBERS EXPERIENCE WITH CO-OPERATIVES, SAMPLE SURVEY, 1978

		East Ghor Canal Project (Stage I)					Southern Valley (Stage II)			
		Section I	Section II	Section III & IV	Total Stage I Freq	%	Ext. Area (Ghor Damya)	Karameh S. Shuneh & Kafrain	Total Stage II Freq	%
Question 1	Yes	15	19	34	68	94.4	9	20	29	100.0
	No	4	0	0	4	5.6	0	0	0	0
Question 2	Yes	16	16	31	63	87.5	8	16	24	82.8
	No	3	3	2	8	11.1	1	2	3	10.3
	Don't Know	2	0	0	2	2.8	0	0	0	0
Question 3	Yes	2	5	3	10	13.9	0	4	4	13.8
	No	15	14	31	60	83.3	9	16	25	86.2
	Don't Know	2	0	0	2	2.8	0	0	0	0
Question 4	Yes	7	2	2	11	15.3	0	0	0	0
	No	12	17	32	61	84.7	9	20	29	100.0
Question 5	Liquidated	3	0	0	3	27.3	0	0	0	0
	Dispute	3	0	0	3	27.3	0	0	0	0
	Poor Service	1	0	1	2	18.2	0	0	0	0
	Corruption	0	1	0	1	9.0	0	0	0	0
	Other	0	1	1	2	18.2	0	0	0	0

Question 1 Is there a Co-op in your village?
Question 2 Do you feel there is a need for a Co-op in your village?
Question 3 Have you ever been approached by a Co-op official to help set up or join a Co-op?
Question 4 Have you ever joined a Co-op?
Question 5 If you joined, why did you leave?

In several cases the reasons farmers gave for not belonging to a co-operative related to the fact that they saw that it would give few clear benefits to them. As Table 10.13 shows nearly 20 per cent of the respondents - largely sharecropper farmers - claimed that they could get the benefits of membership through the membership of their landlords or a relative. A further 7 per cent were members of the Jordan Valley Farmers Association which had been providing similar facilities to the co-operatives in the four years since it had been established. A further 24 per cent said that they did not believe in co-operatives, for religious or other reasons, and another 13 per cent reported that they were not eligible to join since they had no contract with their landlords to operate the land they were using.[8] A few of those interviewed had previously been members but had allowed their membership to lapse, in some cases because of a dispute with or mistrust of co-operative officials. 28 per cent gave no reason for their non-membership. A few memberships in the northern section of the project area had lapsed when one co-operative had been disbanded.

10.4 The Inter-relationships between Co-operative Membership and other Farmer Characteristics

On the basis of the 1978 survey of farmer membership of co-operatives, it was decided in the 1980 survey to modify the questions asked not only to find out more about the use members make of the co-operatives but also to examine the relationship between co-operative membership and other farmer characteristics. 168 of the 353 farmers interviewed (47.6 per cent) were co-operative members. There was little variation in membership level across the project area although it ranged from 57 per cent of farmers sampled in Section IV to 39 per cent in Section III. The 1980 data was further analysed with the chi-square test in the same manner as outlined in the previous chapter. In each case the aim of the test was to examine and where possible reject the null hypothesis that there is no difference between the two populations against the variable under test. In this case the two populations were the co-operative members and the non-members. The significance level adopted here was 0.05 (95 per cent).

TABLE (10.13) EAST JORDAN VALLEY:

REPORTED REASON OF NON-CO-OPERATIVE MEMBER FOR NOT JOINING, SAMPLE SURVEY, 1978

	East Ghor Canal Project (Stage I)					Southern Valley (Stage II)			
	Section I	Section II	Section III & IV	Total Stage I		Ext. Area (Ghor Damya)	Karameh S. Shuneh & Kafrain	Total Stage II	
	Freq	Freq	Freq	Freq	%	Freq	Freq	Freq	%
Landlord is member	1	3	5	9	12.5	4	3	7	24.1
A relative is member	2	1	1	4	5.6	0	0	0	0
JVFA member	4	0	2	6	8.3	0	1	1	3.4
Don't believe in Co-Op	4	3	4	11	15.3	1	5	6	20.7
Religion	1	1	2	4	5.6	0	4	4	13.8
Not eligible	1	3	6	10	13.9	1	2	3	10.3
Ex. member	2	2	0	4	5.6	0	0	0	0
Dislike Managers	1	1	0	2	2.8	0	0	0	0
Dislike subscription	1	0	0	1	1.4	0	0	0	0
Other reason	2	5	14	21	29.2	3	5	8	27.6
Total Non Members	19	19	34	72	100.2	9	20	29	99.9

The tests for relationships between co-operative membership and other farmer characteristics are divided into two groups, those concerned with the use made of services by the sampled members and other characteristics of members. Significant relationships were found first between co-operative membership and the use of supply and credit services.

10.4.1 Co-operative Membership, Farm Supplies and Loans

The biggest single group of sampled farmers, whether co-operative members or not, obtained their farm supplies, as one might expect, from a combination of sources. (Table 10.14) But members rely to a considerable, but by no means exclusive, extent upon the co-operatives for their farm supplies whereas non-members get supplies from very varied sources like the village merchants, agricultural supply companies, commission agents and, to a small extent, co-operatives who will sometimes sell surpluses to non-members. From Table 10.14 it can be seen that while members rely more on their co-operatives for supplies, non-members account for most of the sales by village merchants and tend to use supply companies, commission agents and the Jordan Valley Farmers Association more than co-operative members. But about half of both members and non-members stated that they obtained farm supplies from a combination of sources rather than from any one single source.

That co-operative members use their co-operative for supplies results partly from the credit facilities this provides which allows them to defer payment till the end of the season. As Table 10.15 shows most members and non-members reported the use of mixed methods of payment but co-operative members were more likely to use credit than non-members. On the other hand 30 per cent of non-members stated that they paid cash for all of their supplies whereas only 17 per cent of co-operative members did.

It has already become clear in earlier parts of this chapter that co-operative members make considerable use of the loaning facilities of their societies. That this also means that members have more access to loans than non-members is confirmed by the results of a simple question in the survey asking members and non-members about their uptake

TABLE (10.14) EAST GHOR CANAL PROJECT:

TESTING CO-OPERATIVE MEMBERSHIP AGAINST SOURCE OF FARM SUPPLY

	Count Row % Col %	Source of Farm Supply							
		Commission Agent	Village Merchant	Co-op	J.V.F.A.	Supply Co.	Landlord	Mixed	Row Total
Non members		16	35	13	14	22	2	83	185
		8.6	18.9	7.0	7.6	11.9	1.1	44.9	
		59.3	83.3	21.3	58.3	62.9	100.0	51.2	52.4
Members		11	7	48	10	13	0	79	168
		6.5	4.2	28.6	6.0	7.7	0.0	47.0	
		40.7	16.7	78.7	41.7	37.1	0.0	48.8	47.6
Column total		27	42	61	24	35	2	162	353
		7.6	11.5	17.3	6.8	9.9	0.6	45.9	100.0

Chi Square = 44.03761 with 6 degrees of freedom Significance = 0.0000

TABLE (10.15) EAST GHOR CANAL PROJECT:

TESTING CO-OPERATIVE MEMBERSHIP AGAINST METHOD OF PAYMENT FOR FARM SUPPLY

Payment for Farm Supplies

	Count Row % Col %	Cash	End of Season	Mixed	Row Total
Non members		56 30.3 65.9	21 11.4 43.7	108 58.4 49.1	185 52.4
Members		29 17.3 34.1	27 16.1 56.2	112 66.7 50.9	168 47.6
	Column Total	85 24.1	48 13.6	220 62.3	353 100.0

Chi Square = 8.60044 with 2 degrees of freedom Significance = 0.0136

of loans. As Table 10.16 shows over two-thirds of members stated that they had used a cash loan compared with just over 40 per cent of non members.

The chi-square test was also applied to the member/non-member samples in relation to their success in obtaining farm advice but no significant difference was revealed between the samples.

10.4.2 Co-operative Membership and other Farmer Characteristics

The same member/non-member data sets were tested by chi-square to establish any significant differences between the two groups in terms of various farmer characteristics. No significant differences were found between members and non-members with regard to age, length of farm experience, tenure status, the size of farms, levels of farm investment, additional income sources or the class of land. It was thought that the settlers who had originated from Palestine might have a higher level of co-operative membership than those from Jordan but this did not show up. Nor was any significant difference in educational experience found although there did seem to be more secondary and college educated farmers amongst those who were members of co-operatives.

Significant relationships were, however, demonstrated between co-operative membership and farm income and farm expenditure with more of the richer farms being worked by members. As Table 10.17 shows, 65 per cent of all farmers sampled with an agricultural income of over JD 5000 a year were members whereas, at the other end of the scale 69 per cent of farmers getting no more than JD 2000 a year were non-members. In fact only 20 per cent of co-operative members had an income as low as this. Not surprisingly a significant relationship was then found between membership and levels of farm expenditure with 77 per cent of the farms with outgoings of over JD 3000 a year run by co-operative members (Table 10.18).

There is some evidence to suggest that members of co-operatives run technically more advanced farms in that significant correlations were found between membership and the use of machines, plastic culture and drip irrigation. As Table 10.19 shows 25 per cent of co-operative

TABLE (10.16) EAST GHOR CANAL PROJECT:

TESTING CO-OPERATIVE MEMBERSHIP AGAINST TAKING CASH LOANS

	Count Row % Col %	Accepting Loans No	 Yes	Row Total
Non members		108	77	185
		58.4	41.6	
		67.1	40.1	52.4
Members		53	115	168
		31.5	68.5	
		32.9	59.9	47.6
	Column Total	161	192	353
		45.6	54.4	100.0

Chi Square = 24.48006 with 1 degree of freedom   Significance = 0.0000

TABLE (10.17) EAST GHOR CANAL PROJECT:

TESTING CO-OPERATIVE MEMBERSHIP AGAINST ANNUAL FARM INCOME

Count Row % Col %	Annual Agricultural Income (J. Dinar) 2000 and less	2001-3000	3001-5000	Over 5000	Row Total
Non members	78 42.2 69.6	55 29.7 50.9	33 17.8 42.3	19 10.3 34.5	185 52.4
Members	34 20.2 30.4	53 31.5 49.1	45 26.8 57.1	36 21.4 65.5	168 47.6
Column Total	112 31.7	108 30.6	78 22.1	55 15.6	353 100.0

Chi Square = 23.65961 with 3 degrees of freedom Significance = 0.0000

TABLE (10.18) EAST GHOR CANAL PROJECT:

TESTING CO-OPERATIVE MEMBERSHIP AGAINST ANNUAL FARM EXPENDITURE

Count Row % Col %	1000 and less	Annual Farm Expenditures (J. Dinar) 1001-2000	2001-3000	Over 3000	Row Total
Non members	77 41.6 60.6	85 45.9 56.3	16 8.6 36.4	7 3.8 22.6	185 52.4
Members	50 29.8 39.4	66 39.3 43.7	28 16.7 63.6	24 14.3 77.4	168 47.6
Column Total	127 36.0	151 42.8	44 12.5	31 8.8	353 100.0

Chi Square = 19.95373 with 3 degrees of freedom Significance = 0.0002

TABLE (10.19) EAST GHOR CANAL PROJECT:

TESTING CO-OPERATIVE MEMBERSHIP AGAINST TOTAL MACHINES OWNED

No. of machines owned by the Farmer

Count Row % Col %	None	One	Two	Three	Four	Five & More	Row Total
Non members	110 59.5 64.0	33 17.8 45.2	26 14.1 52.0	4 2.2 16.0	6 3.2 37.5	6 3.2 35.3	185 52.4
Members	62 36.9 36.0	40 23.8 54.8	24 14.3 48.0	21 12.5 84.0	10 6.0 62.5	11 6.5 64.7	168 47.6
Column Total	172 48.7	73 20.7	50 14.2	25 7.1	16 4.5	17 4.8	353 100.0

Chi Square = 27.42203 with 5 degrees of freedom Significance = 0.0000

members had three or more machines compared with 9 per cent of non-members. On the other hand about 37 per cent of the members did not own any machines, compared with 60 per cent of non-members. Table 10.20 demonstrates the strong correlation between the co-operative membership and the application of plastic culture and drip irrigation. Three-quarters of the 13 farmers who used both plastic culture and drip irrigation were members of the co-operatives and members were also dominant amongst those who used either of these techniques.

Overall these results suggest that the co-operative society member is often a different farmer from non-members, in making more use of loans and in being a little more progressive and successful as a farmer. It is appropriate now to turn to consider the Jordan Valley Farmers Association in a similar but briefer manner, to assess the relationship of its membership to other farmer variables.

10.5 The Jordan Valley Farmers Association (JVFA)

10.5.1 General Description and Development

The Jordan Valley Farmers Association has seen a rapid expansion in its membership and activities since it was established by the government in 1974 to further develop farming in the valley. Its membership had reached 3600 one year after its formation and stood at 4360 in 1978/1979. 46 per cent of the writer's sample of farmers in 1980 claimed membership, putting its membership strength in the valley on a par with the co-operatives, with which it almost competes for services. The Association was set up to provide services to its members in the marketing, supply and loaning fields like the co-operatives but it is in the last two areas that most progress has been made. It supplies seeds, fertilizers, and equipment ranging from tools to tractors, some of which can be hired by members. It will also undertake certain farm operations such as pest control. Plans exist to offer members transport facilities to markets as well as the erection of packing, processing and storage facilities and the provision of advisory services.[9] It is in the loaning field, however, that it is, perhaps, most important. Although it only drew in through subscriptions in 1978 about JD 10,000 it loaned out JD 155,000 to 336 of its members.

TABLE (10.20) EAST GHOR CANAL PROJECT:

TESTING CO-OPERATIVE MEMBERSHIP AGAINST APPLICATION OF ADVANCED TECHNIQUES

Count Row % Col %	None	Drip or Plastic	Drip and Plastic	Row Total
Non members	170 91.9 55.2	12 6.5 37.5	3 1.6 23.1	185 52.4
Members	138 82.1 44.8	20 11.5 62.5	10 6.0 76.9	168 47.6
Column Total	308 87.3	32 9.1	13 3.7	353 100.0

Chi Square = 8.29443 with 2 degrees of freedom Significance = 0.0158

In 1979 it made loans totalling JD 238,000 to 431 members giving an average loan size of JD 552, mainly for small farm improvements. In this way it had become more important than the Agricultural Credit Corporation but, overall, was less important than the co-operatives.

10.5.2 The Inter-relationships between the JVFA Membership and Other Farming Characteristics

In the writer's 1980 survey he examined the characteristics of Association members using the chi-square test to seek significant correlations. From this it is clear that Association members represent more of the older, better-established owner-occupiers who used the Association more for its loans than its supplies. Membership varied across the valley. As Table 10.21 shows, level of membership was highest, at 57 per cent of the farmers sampled, in Section IV and lowest, at 36 per cent of the farmers questioned in Section II. This variation in Association membership levels between different sections of the project area seems to reflect the relative strength of the co-operatives in the various sections since they provide much the same services to members. Thus membership of the Jordan Valley Farmers Association was higher amongst farmers in Section IV, in the south of the project area where co-operatives were weakest and where the headquarters of the Association and its supply depot is located. On the other hand Association membership was weakest in Section II, where co-operative membership is high. Even so it must not be assumed that membership of the Association and of a co-operative were mutually exclusive since the questionnaire showed that many of the more progressive farmers were members of both organisations. 70 per cent of the farmers sampled who reported that they were members of a co-operative also stated that they were members of the Association.

Although membership of the Association is equally open to all who farm in the valley, whether as owner-occupiers, tenants or sharecroppers, the chi-square test on the questionnaire data showed a very strong relationship between membership and tenure. As Table 10.22 shows 62 per cent of the owner occupiers found in the sample were members of the Association whereas only 31 per cent and 25 per cent respectively of

TABLE (10.21) EAST GHOR CANAL PROJECT:

TESTING J.V.F.A. MEMBERSHIP AGAINST FARMER LOCATION

Count / Row % / Col %	Location of Farmer: Section I	Section II	Section III	Section IV	Row Total
Members	46	34	39	45	164
	28.0	20.7	23.8	27.4	
	45.1	36.6	48.7	57.7	46.5
Non members	56	59	41	33	189
	29.6	31.2	21.7	17.5	
	54.9	63.4	51.2	42.3	53.5
Column Total	102	93	80	78	353
	28.9	26.3	22.7	22.1	100.0

Chi Square = 7.86589 with 3 degrees of freedom Significance = 0.0489

TABLE (10.22)   EAST GHOR CANAL PROJECT:

TESTING J.V.F.A. MEMBERSHIP AGAINST TENURE STATUS

Count / Row % / Col %	Form of Land Tenure: Owner	Share Cropper	Cash Tenant	Others	Row Total
Members	120	28	13	3	164
	73.2	17.1	7.9	1.8	
	62.2	25.7	31.0	33.3	46.5
Non members	73	81	29	6	189
	38.6	42.9	15.3	3.2	
	37.8	74.3	69.0	66.7	53.5
Column	193	109	42	9	353
	54.7	30.9	11.9	2.5	100.0

Chi Square = 42.75533 with 3 degrees of freedom   Significance = 0.0000

cash rent tenant and sharecroppers had membership since these were often less interested in joining.[10]

There are other ways in which Association membership appeared to be more common amongst the better established and more prosperous valley farmers. A significant relationship was shown between Association membership and the length of a farmer's experience and the length of time he had lived in the valley. As Table 10.23 shows over 50 per cent of sampled farmers, who had over 20 years farming experience, were members of the Association, but membership levels fell to 44 per cent for farmers of 10-20 years' standing and only 29 per cent of those with up to 10 years experience. Similarly 59 per cent of the sampled farmers who had lived in the valley for more than 40 years were members of the Association. But this degree of affiliation dropped for each year group to only 30 per cent membership amongst those who had lived in the valley for under 20 years. This was not, however, a simple reflection of the age of the farmers, with the older ones or the more progressive younger ones more likely to be Association members, since no correlation could be established between farmer age and Association membership. Nor did a test for correlation between Association membership and the level of education experienced by the farmers indicate any significant relationship. This suggests that membership depends much more on how the farmer perceives it might benefit his farm enterprise rather than membership automatically appealing to the younger or better educated farmer. Indicative of this is also a significant relationship established betweeen Association membership and national origin where a larger proportion of the Jordanian settlers, who are generally poorer-educated, were members than of the Palestinian farmers who are generally better educated.

Although no significant relationship was established between Association membership and farm size, or capital investment in their farms, to give more support to the view that the better established owner-occupiers most clearly perceive the benefits to be derived from membership, a strong correlation was found between farm income and expenditure levels and Association affiliation suggesting that those farmers who farm most intensively or on a larger scale are most likely to have Association membership. As Table 10.24 shows, 58 per cent of

TABLE (10.23) EAST GHOR CANAL PROJECT:

TESTING J.V.F.A. MEMBERSHIP AGAINST FARMER AGRICULTURAL EXPERIENCE

Count Row % Col %	Farmer's Experience in Agriculture (in Years) 10 & less	11-20	21-30	Over 30	Row Total
Members	16	64	54	30	164
	9.8	39.0	32.9	18.3	
	29.6	44.4	53.5	55.6	46.5
Non members	38	80	47	24	189
	20.1	42.3	24.9	12.7	
	70.4	55.6	46.5	44.4	53.5
Column Total	54	144	101	54	353
	15.3	40.8	28.6	15.3	100.0

Chi Square = 10.17304 with 3 degrees of freedom Significance = 0.0172

TABLE (10.24) EAST GHOR CANAL PROJECT:

TESTING J.V.F.A. MEMBERSHIP AGAINST ANNUAL FARM INCOME

Count Row % Col %		Annual Farm Income (J. Dinar) 2000 & Less	2001-3000	3001-5000	Over 5000	Row Total
Members		41	48	43	32	164
		25.0	29.3	26.2	19.5	
		36.6	44.4	55.1	58.2	46.5
Non members		71	60	35	23	189
		37.6	31.7	18.5	12.2	
		63.4	55.6	44.9	41.8	53.5
	Column	112	108	78	55	353
	Total	31.7	30.6	22.1	15.6	100.0

Chi Square = 9.94161 with 3 degrees of freedom Significance = 0.0191

the farmers with an annual farm income of over JD 5000 were members of the Association and this level of affiliation fell with each lower income class. 64 per cent of the sampled farmers with outgoings of over JD 3000 a year were Association members but this level of affiliation dropped with each class to those poorer farmers with the smallest outgoings (under JD 1000 per year) where only 35 per cent were members (Table 10.25).

Some support for this view that the Association member is typical of the more intensive land users enjoying a higher return on their holdings was also suggested by their use of machinery. For example the questionnaire data showed that 13 of the 17 farmers sampled who had five or more pieces of machinery were Association members whereas only 37 per cent of the 172 farmers with no machines had membership. Those farmers with between one and four machines, however, were just as likely to be members or non-members. But no significant relationship seemed to exist between the use of advanced techniques such as plastic greenhouses or drip irrigation.

Beyond showing that Association members are often the better established farmers it has not been possible to much more clearly specify the types of farmers most likely to be members of the Jordan Valley Farmers Association. Testing of the data with chi-square did not reveal any significant correlation between association membership and the crop emphasis of farmers, although in the case of vegetable growing a strong significant inverse relationship was found between a total dependence on vegetable production and association membership. 63 per cent of the 61 farmers in the sample who reported that they grew no vegetables also stated that they were Association members. On the other hand only 39 per cent of the 146 farmers who only grew vegetables reported that they were Association members even though one might expect these to benefit most from membership.

Lastly it is worth noting the apparent use made by Association members of its various facilities in view of their similarity to those offered by the co-operatives. The availability of short term cash loans is clearly of much value to members. 67 per cent of the members sampled had made use of cash loans from the Association. A rather lesser benefit of membership is the provision of farm supplies. While

TABLE (10.25) EAST GHOR CANAL PROJECT:

TESTING J.V.F.A. MEMBERSHIP AGAINST ANNUAL FARM EXPENDITURE

Count Row % Col %		Annual Farm Expenditure (J. Dinar) 1000 or Less	1001-2000	2001-3000	Over 3000	Row Total
Members		45	68	31	20	164
		27.4	41.5	18.9	12.2	
		35.4	45.0	70.5	64.5	46.5
Non members		82	83	13	11	189
		43.4	43.9	6.9	5.8	
		64.6	55.0	29.5	35.5	53.5
	Column	127	151	44	31	353
	Total	36.0	42.8	12.5	8.8	100.0

Chi Square = 20.57878 with 3 degrees of freedom Significance = 0.001

13 per cent of members obtained all of their farm supplies through the Association another 44 per cent got their supplies from more than one source. The largest single source of supply for Association members, however, were co-operatives, because of the high level of dual membership and the greater development of the system of co-operative supplies. Even so, the Association was the second most important single source of supplies for members after co-operatives, although considerable minorities of members reported that they got their supplies solely from village merchants, agricultural supply companies and the commission agents. Certainly some Association members make use of the opportunity to obtain their farm supplies from the Association and to pay for them at the end of the season, so enjoying a short term loan not available to all of those who get supplies from other sources.

10.6 The Agricultural Extension Services

To complete this consideration of the use made of major government agencies to support the development of agriculture in the valley, some attention is now given to the agricultural extension services and the use made of them by farmers. As almost no data was available on these services, the writer during his 1978 and 1980 fieldwork season visited the different offices of the extension services throughout the valley and included various questions in his farmer survey on the use made of these services. These results show that a considerable degree of contact appears to be maintained between the extension services and farmers although significant minorities of sampled farmers in all areas seem to exclude themselves from the system.

10.6.1 The Growth of the Services

The Extension Department of the Jordan Ministry of Agriculture was set up to provide farm advice and other help in 1952 with financial assistance from US-AID which continued partial support until 1965 when the extension services were fully integrated into the Ministry of Agriculture.[11] In the eastern valley these services were operated, at the time of the writer's 1980 survey, from 11 offices of which seven cover the project area. These offices are listed in Table 10.26 which

TABLE (10.26) EAST JORDAN VALLEY:

LOCATION AND COMPOSITION OF AGRICULTURAL EXTENSION SERVICES, 1980

Office	Staff	Vehicles	Spraying Tractors	Development Areas	Project Blocks
North Shuneh	6	3	2	1–6	1–10
Qleiat	3	0	0	7–9	11–14
El Mashar'h (partly closed in 1980)	1	0	0	10	15–17
Wadi Yabis	2	1	2	11	18–19, part 20
Kriymeh	3	0	0	12–14	part 20 21–22, part 23
Deir Alla (regional office)	7	several	3	16–17	part 23
Ma'di	2	1	1	18–19	part 23, 24
El Masri	2	1	1	20–21	
Karameh	2	0	0	22–24	areas south of project
South Shuneh	10	2	3	25–26	
Kafrain		no data available		27–33	

Source:- Author's fieldwork.

also indicates the number of staff, vehicles and spraying tractors available at each office together with details of the development areas as outlined by the JVFA, and the equivalent project blocks covered from each office. That the extension services have developed rapidly in the area is seen by the fact that until the late 1960s there was only one regional office in the valley at Wadi Yabis with a branch in the south at South Shuneh. With the expansion in the staff and services of the extension offices, Deir Alla replaced Wadi Yabis as the regional office and other offices of various sizes were opened to bring advisers closer to the farmers. As Table 10.26 shows several of the offices are larger than others and cover larger areas. For example, the North Shuneh office has a staff of three agronomists, two animal husbandry inspectors and a director to cover the northern ten blocks of the project area as well as the farm lands adjacent to, but outside of, the project. On the other hand the next office to the south, at Qleiat, only has a staff of three agronomists to cover Blocks 11 to 14. For farm visits it relies on vehicles provided from the North Shuneh office. Similarly the spraying tractors based on several of the offices can be used from other offices or can be hired out to individual farmers.

10.6.2. Agricultural Extension Services from the Farmer's Viewpoint

Because no recently published data was available on the farmers' use of extension services in the eastern valley, the writer, in his 1978 survey, included ten questions in his farmer questionnaire on attitudes towards advice on farming problems to see to what extent the interviewed farmers considered the extension services useful. These and the other questions in the questionnaire are listed in Appendix 1.

It can immediately be seen from Table 10.27 that about a half of all the farmers in the Stage I area and rather less to the south said they would look to the farm adviser to deal with a particular farm problem that confronted them, although there were some spatial variations in these response levels. In particular it can be noted that a majority of the farmers sampled in Section II said they would

TABLE (10.27) EAST JORDAN VALLEY: MAIN SOURCES OF ADVICE FOR FARMERS, SAMPLE SURVEY, 1978

	East Ghor Canal Project (STAGE I)										Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total EGCP		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Southern Valley	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
1. Agricultural Advisor	18	52.9	11	31.4	18	62.1	10	55.6	57	49.1	2	18.2	10	34.5	12	30.9
2. Neighbouring Farmer	3	8.8	16	45.7	6	20.7	4	22.2	29	25.0	2	18.2	7	24.1	9	22.5
3. Agricultural Supply Co.	6	17.6	3	8.6	1	3.4	2	11.1	12	10.3	1	9.0	4	13.8	5	12.5
4. Others	1	2.9	1	2.8	-	-	-	-	2	1.7	2	18.2	2	6.9	4	10.0
5. Ask No-one	3	8.8	1	2.8	-	-	-	-	4	3.4	-	-	4	13.8	4	10.0
6. 1 + 3	2	5.9	1	2.8	1	3.4	-	-	4	3.4	-	-	1	3.4	1	2.5
7. 1 + 2	1	2.9	1	2.8	3	10.3	1	5.6	6	5.2	4	36.4	-	-	4	10.0
8. 2 + 3	-	-	1	2.8	-	-	1	5.6	2	1.7	-	-	-	-	-	-
9. 1 + 2 + 4	-	-	-	-	-	-	-	-	-	-	-	-	1	3.4	1	2.5
Total Observations	34		35		29		18		118		11		29		40	

seek the help of a neighbour instead. It will also be noted later that the farmers questioned in Section II in 1978 had a much lower opinion of the value of the extension services, as they also did of the co-operatives. A minority of farmers questioned in all areas said that they would seek advice on particular farm problems from other sources such as the agricultural supply companies, or would rely on their own experience.

Table 10.28 summarizes the responses received to the other questions asked about use of extension services. 70 per cent of farmers claimed to have tried at some time in their career to get advice or help from the extension service and the same proportion reported that they had received such help, suggesting that the advisers are widely available to give help. Not surprisingly nearly all farmers said that they would be prepared to accept such assistance although it should be noted that fewer farmers in Section II, than in other sections, had sought or received extension help. Over 60 per cent of the farmers questioned claimed to have visited the local extension office at some time and a surprisingly large number of farmers claimed to have made more than one visit in the previous year. Again the degree of use made of extension services amongst the Section II farmers was much lower than in the other sections in Stage I and more comparable to the situation in the more recently developed southern extension area. Similarly a majority of farmers in all areas, except Section II, had been visited on their farms by an extension adviser at some time. In over a quarter of cases more than one visit had been made to the respondent's farm by an extension officer in the previous year so that it does appear that for many farmers the advisory service works fairly well. This is also confirmed in Table 10.29 by well over half of the sampled farmers rating the extension services as being either fair, good or excellent. Nevertheless this left a large minority of the sample who rated it poorly, particularly again in Section II.

Rather than repeat the same questions in his 1980 survey, the writer sought any relationships there may be between users of the advisory services and their other characteristics. The chi-square test was again used for this in the same way as previously reported,

TABLE (10.28) EAST JORDAN VALLEY: FARMERS' EXPERIENCE OF EXTENSION SERVICES, SAMPLE SURVEY, 1978

		East Ghor Canal Project (STAGE I)										Southern Valley (STAGE II)					
		Section I		Section II		Section III		Section IV		Total EGCP		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Stage II	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Question 1:	Yes	27	79.4	22	62.9	19	65.5	14	77.8	82	70.7	6	54.5	22	75.9	28	70.0
	No	7	20.6	13	37.1	10	34.5	4	22.2	34	29.3	5	45.5	7	24.1	12	30.0
Question 2:	Yes	23	67.6	18	51.4	22	75.9	15	83.3	78	67.2	10	90.9	20	69.0	30	75.0
	No	11	32.4	17	48.6	7	24.1	3	16.7	38	32.8	1	9.1	9	31.0	10	25.0
Question 3:	Yes	31	91.2	34	97.1	28	96.6	17	94.4	110	94.8	11	100.0	26	89.7	37	92.5
	No	3	8.8	1	2.9	1	3.4	1	5.6	6	5.2	-	-	3	10.3	3	7.5
Total Observations		34		35		29		18		116		11		29		40	

Question 1 Have you ever tried to seek help from the Agricultural Extension Services?

Question 2 Have you ever received help or advice from the Agricultural Extension Services?

Question 3 Would you accept the Agricultural Extension Services advice or help?

TABLE (10.28) continued..

		East Ghor Canal Project						(STAGE I)				Southern Valley (STAGE II)					
		Section I		Section II		Section III		Section IV		Total EGCP		Ext. Area (Ghor Damya)		Karameh S. Shuneh Kafrain		Total Stage II	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Question 4:	Yes	25	73.5	19	54.3	19	65.5	10	55.6	73	62.9	5	45.5	20	69.0	25	62.5
	No	9	26.5	16	45.7	10	34.5	8	44.4	43	37.1	6	54.5	9	31.0	15	37.5
Question 5:	None	11	32.3	26	74.3	14	48.3	11	61.1	62	53.4	9	81.8	13	44.8	22	55.0
	Once	2	5.9	1	2.9	2	6.9	1	5.6	6	5.2	1	9.1	3	10.3	4	10.0
	Twice	9	26.5	3	8.6	5	17,2	-	-	17	14.7	-	-	4	13.8	4	10.0
	Three times	4	11.8	4	11.4	1	3.4	3	16.7	12	10.3	1	9.1	4	13.8	5	12.5
	Four+	8	23.5	1	2.9	7	24.1	3	16.7	19	16.4	-	-	5	17.2	5	12.5
Total Observations		34		35		29		18		116		11		29		40	

Question 4 Have you ever visited the Agriculture Extension Office?

Question 5 How many times did you visit the Agricultural Extension Services office last year?

TABLE (10.28) continued..

		East Ghor Canal Project						(STAGE I)				Southern Valley (STAGE II)					
		Section I		Section II		Section III		Section IV		Total EGCP		Ext. Area (Ghor Damya)		Karameh S. Shuneh & Kafrain		Total Southern Valley	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Question 6:	Yes	24	70.6	14	40.0	19	65.5	11	61.1	68	58.6	8	72.7	20	69.0	28	70.0
	No	10	29.4	21	60.0	10	34.5	7	38.9	48	41.4	3	27.3	9	31.0	12	30.0
Question 7:	None	13	38.2	29	82.9	14	48.3	10	55.6	66	56.9	4	36.4	11	37.9	15	37.5
	Once	3	8.8	2	5.7	8	27.6	1	5.6	14	12.1	1	9.1	4	13.8	5	12.5
	Twice	9	26.5	3	8.6	4	13.8	2	11.1	18	15.5	4	36.4	6	20.7	10	25.0
	Three times	5	14.7	1	2.9	2	6.9	1	5.4	9	7.8	1	9.1	4	13.8	5	12.5
	Four+	4	11.8	-	-	1	3.4	4	22.2	9	7.8	1	9.1	4	13.8	5	12.5
Total Observations		34		35		29		18		116		11		29		40	

Question 6 Has the Agricultural Advisory ever visited your farm?

Question 7 How many times did he or any Agricultural Extension Services agent visited your farm last year?

TABLE (10.29) EAST JORDAN VALLEY:

FARMERS' EVALUATION OF THE AGRICULTURAL EXTENSION SERVICES, SAMPLE SURVEY, 1978

	East Ghor Canal Project (STAGE I)										Southern Valley (STAGE II)					
	Section I		Section II		Section III		Section IV		Total EGCP		Ext. Area (Ghor Damya)		Karameh S. Shuneh Kafrain		Total Stage II	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Excellent	3	8.8	1	2.9	-	-	3	16.7	7	6.0	-	-	1	3.4	1	2.5
Good	8	23.5	3	8.6	10	34.5	3	16.7	24	20.7	6	54.5	12	41.4	18	45.0
Fair	8	23.5	11	31.4	7	24.1	7	38.9	33	28.4	1	9.1	6	20.7	7	17.5
Poor	11	32.4	20	57.1	12	41.4	5	27.8	48	41.4	4	36.4	9	31.0	12	32.5
No Answer	4	11.8	-	-	-	-	-	-	4	3.4	-	-	1	3.4	1	2.5
Total Observations	34		35		29		18		116		11		29		40	

with a significance level set at 0.05, or 95 per cent. Unfortunately the results of the 1980 questionnaire on this provided little confirmation of the results obtained in the 1978 survey. A far smaller proportion (27 per cent) of the 1980 sample claimed to have taken advice or help from the extension services (Table 10.30). In this sample also, the farmers questioned in Section II reported a higher level of advice seeking or help (along with farmers in Section I) than in the other sections, the reverse of the situation in 1978.

Significant correlations were also established between advice-seeking amongst farmers and their methods of payment for farm supplies, (.0019 significance level), levels of annual farm expenditure (.0121), the extent to which vegetables are farmed (.0187), and the use made of Irbid, Wadi Yabis and Sawalha markets (.0030, .0222 and .0282 significance levels). No simple reason can be given for some of these correlations which probably involve a third untried variable although it can be noted that farmers who ran pure vegetable enterprises, common in the south, were infrequent advice seekers. While the test of the relationship between advice-seeking and citrus growing was not valid, it strongly suggested that most of these, on the other hand, did make use of the extension services, particularly spraying services.

10.7 Farm Services as a Classificatory Base

To complete this chapter it seems appropriate to try to group the 353 sampled farms in the 1980 survey into a small number of relatively homogeneous groups on the basis of a selection of the various farm service characteristics that have been considered in the previous chapters. It was decided that 11 variables from the range of farm service attributes of the farms needed to be fed into the classification. This in turn required the use of a computer-based cluster and discriminant analysis of the data which finally created four groups of farms as shown in the computer-based dendrogram in Fig. 10.2. Details of the cluster and discriminant analysis methods are given in the next chapter, rather than here, because this classification exercise was partly run in order to see if an even more elaborate grouping of the farms on a wider range of attributes would be possible. Since this

TABLE (10.30) EAST GHOR CANAL PROJECT:

TESTING ADVICE/HELP SEEKING FROM THE AGRICULTURAL EXTENSION SERVICES AGAINST LOCATION

Count Row % Col %	Section I	Section II	Section III	Section IV	Row Total
Advice-seekers	34 33.3 35.8	38 40.9 40.0	11 13.7 11.6	12 15.4 12.6	95 26.9
Non-seekers	68 66.7 26.4	55 59.1 21.3	69 86.2 26.7	66 84.6 25.6	258 73.1
Column	102 28.9	93 26.3	80 22.7	78 22.1	353 100.0

Chi Square = 23.65228 with 3 degrees of freedom Significance = 0.0000

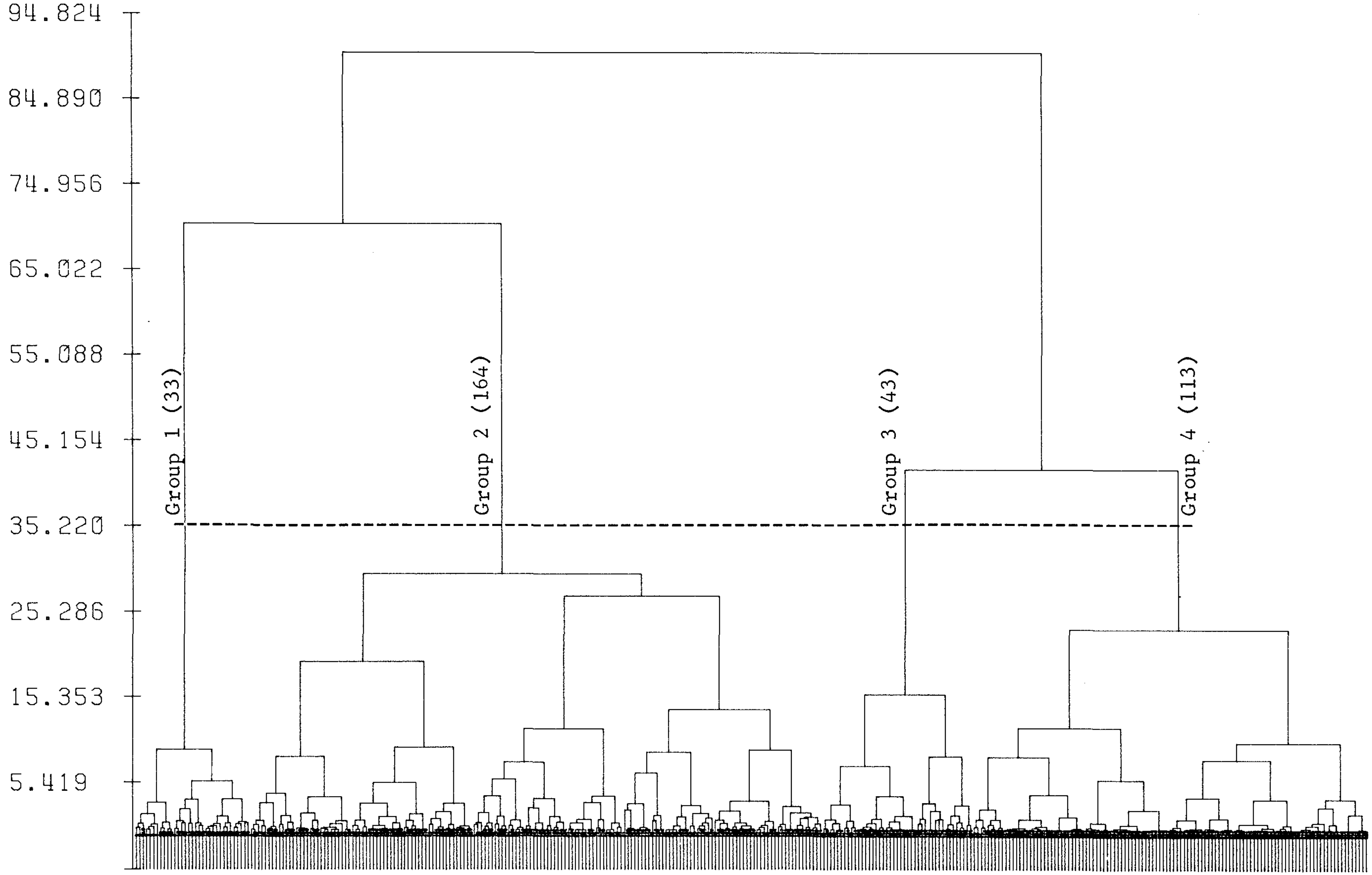


Fig. 10.2 EAST GHOR CANAL PROJECT: DENDROGRAM OF FARM SERVICES

proved to be the case, and this larger classification is the basis of the next chapter, further explanation of the method is reserved until then.

It is sufficient here to report that the 11 variables used in this preliminary classification covered a range of farm service attributes of the 353 sampled farms including the use of farm suppliers, methods of payment for supplies, use of local urban markets and various other services such as loan taking and advice-seeking. The full list of variables is given in Table 10.31, where the frequency distribution of farms giving positive responses to those attributes are listed for the four classes created. Table 10.32 shows the distribution of the farms in the four groups according to their location in the four sections of the project area. Finally Table 10.33 shows that the actual classification of farms obtained by this method of cluster analysis is close to the membership predicted by discriminant analysis. It can be seen, for example, that all farms in Group 1 fell into that group as predicted and even in Group 2 - a more varied group - 88 per cent fell into the correct group which still suggests the classification was effective. Fig. 10.3 shows the distribution of these types of farms across the project area.

It is not necessary to consider every feature of the group characteristics but one can briefly note the attributes that seem to give some identity to each group. It is immediately noticeable that two groups are much larger than the others. If one considers the two smaller groups first, it is clear that the 33 farms in Group 1 farms are, with only 1 exception, entirely found in the northern section of the project area. It is not, then, perhaps surprising also to find that they all used North Shuneh as their local market but were also strong users of the two urban markets - Irbid and Amman - outside of the valley. Mixed sources of farm supplies were used by most farmers in this group although significant minorities reported the use of the co-operative, agricultural supply companies and village merchants. Mixed methods of payment for farm supplies were most commonly used, as in all other groups, but considerable numbers of cash and end of season payments were also made. Moderate levels of membership of co-operatives and the Jordan Valley Farmers Association were reported amongst this group.

TABLE (10.31) EAST GHOR CANAL PROJECT:

GROUP FEATURES OF THE FARM SERVICES CLASSIFICATION, SAMPLE SURVEY, 1980

	Group 1		Group 2		Group 3		Group 4	
	Freq	%	Freq	%	Freq	%	Freq	%
Loan takers	12	36.4	57	34.8	39	90.7	84	74.3
Required advice	7	21.2	61	37.2	12	27.9	15	13.3
Co-op member	16	51.5	60	63.4	39	9.3	53	53.1
JVFA member	15	54.5	54	67.1	31	27.9	63	44.2
Amman Market user	20	60.6	106	64.6	38	88.4	57	50.4
Irbid Market user	26	78.8	128	78.0	34	79.1	6	5.3
N. Shuneh market user	33	100.0	1	0.6	–	–	–	–
W. Yabis Market user	–	–	93	56.7	6	14.0	1	0.9
Sawalha Market user	1	3.0	81	49.4	25	58.1	109	96.5
Total Farmers in the Group	33		164		43		113	

TABLE (10.31) continued..

Farm Supplies	Group 1		Group 2		Group 3		Group 4	
	Freq	%	Freq	%	Freq	%	Freq	%
A) Sources of Farm Supplies								
Commission Agent	–	–	3	1.8	3	7.0	21	18.6
Village Merchant	6	18.2	25	15.2	2	4.7	9	8.0
Co-operative	7	21.2	17	10.4	12	27.9	25	22.1
JVFA	–	–	8	4.9	6	14.0	10	8.8
Agricultural Supply Companies	6	18.2	21	12.8	4	9.3	4	3.5
Landlord	–	–	1	0.6	–	–	1	0.9
Mixed	14	42.4	89	54.3	16	37.2	43	38.1
Total Farmers in the Group	33	100.0	164	100.0	43	100.0	113	100.0
B) Methods of Payment for Supplies								
Cash	11	33.3	68	41.5	6	14.0	–	–
End of Season	7	21.2	27	16.5	10	23.3	4	3.5
Mixed	15	45.5	69	42.0	27	62.7	109	96.5
Total Farmers in the Group	33	100.0	164	100.0	43	100.0	113	100.0

TABLE (10.32) EAST GHOR CANAL PROJECT: DISTRIBUTION OF FARM SERVICES BY GROUPS, SAMPLE SURVEY, 1980

	Section I			Section II			Section III			Section IV			Total Project		
	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %
Group I	32	31.4	97.0	–	–	–	1	1.2	3.0	–	–	–	33	9.3	100.0
Group 2	62	60.8	37.8	73	78.5	44.5	24	30.0	14.6	5	6.4	3.0	164	46.5	99.9
Group 3	5	4.9	11.6	18	19.3	41.9	13	16.3	30.2	7	9.0	16.3	43	12.2	100.0
Group 4	3	2.9	2.6	2	2.2	1.8	42	52.5	37.2	66	84.6	58.4	113	32.0	100.0
Total	102	100.0		93	100.0		80	100.0		78	100.0		353	100.0	

TABLE (10.33) EAST GHOR CANAL PROJECT:

TESTING THE FARM SERVICES CLASSIFICATION BY DISCRIMINANT ANALYSIS

Actual Group	No of Cases	Predicted Group Membership: Group 1	Group 2	Group 3	Group 4
Group 1	33	33 100.0%	0 0.0%	0 0.0%	0 0.0%
Group 2	164	1 0.6%	144 87.8%	9 5.5%	10 6.1%
Group 3	43	0 0.0%	2 4.7%	39 90.7%	2 4.7%
Group 4	113	0 0.0%	1 0.9%	4 3.5%	108 95.6%

Percent of "Grouped" Cases correctly classified: 91.78%

The other small group, Group 3, stands in some marked contrast to the previous group. Fig. 10.3 shows that members of this group are much more dispersed across the project area than the farms in Group 1 although most are found in the northern half of the area. More varied sources of farm supplies were also reported with co-operatives and the JVFA together more important than mixed sources, a pattern not found with any of the other groups. On the other hand these farmers did not always appear to be strong supporters of those co-operative bodies. They have very high levels of loan activities and are strongly dependent on the urban markets.

One might expect the farms in the largest group containing nearly half of all the farms - Group 2 - to be the most varied and although this is the case there are identifiable attributes which clearly allow them to be grouped together. They are geographically widely dispersed across the project area but most occur in Sections II and III. They also have very varied sources of farm supplies. Mixed sources are clearly dominant but village merchants, agricultural supply companies and co-operatives play some part. Cash methods of payment are, perhaps surprisingly, almost as important as other methods of supply payment. All markets are used except for North Shuneh even though over one third of these farms are in the northern section of the project. Membership levels of the co-operatives and the Jordan Valley Farmers Association are higher than for any other group.

Lastly farms in Group 4, the second largest group, are distinctive in several ways. They are more commonly found to the south with more in Sections III and IV than any other group. Their sources of farm supplies are, like farmers in Group 2, very varied but with more use being made of co-operatives and village merchants. Their payments for farm supplies are almost entirely by mixed methods with no sole cash settlements. Also indicative of a greater dependence on credit than farmers in other groups is the high level of loan activity and moderately high levels of co-operative membership or membership of the Jordan Valley Farmers Association. Sawalha market, the southern market in the valley, is used almost exclusively, although Amman is also an important market outlet.

There is then considerable variety within, and hence considerable overlap between, the four groups thrown up by this classification of

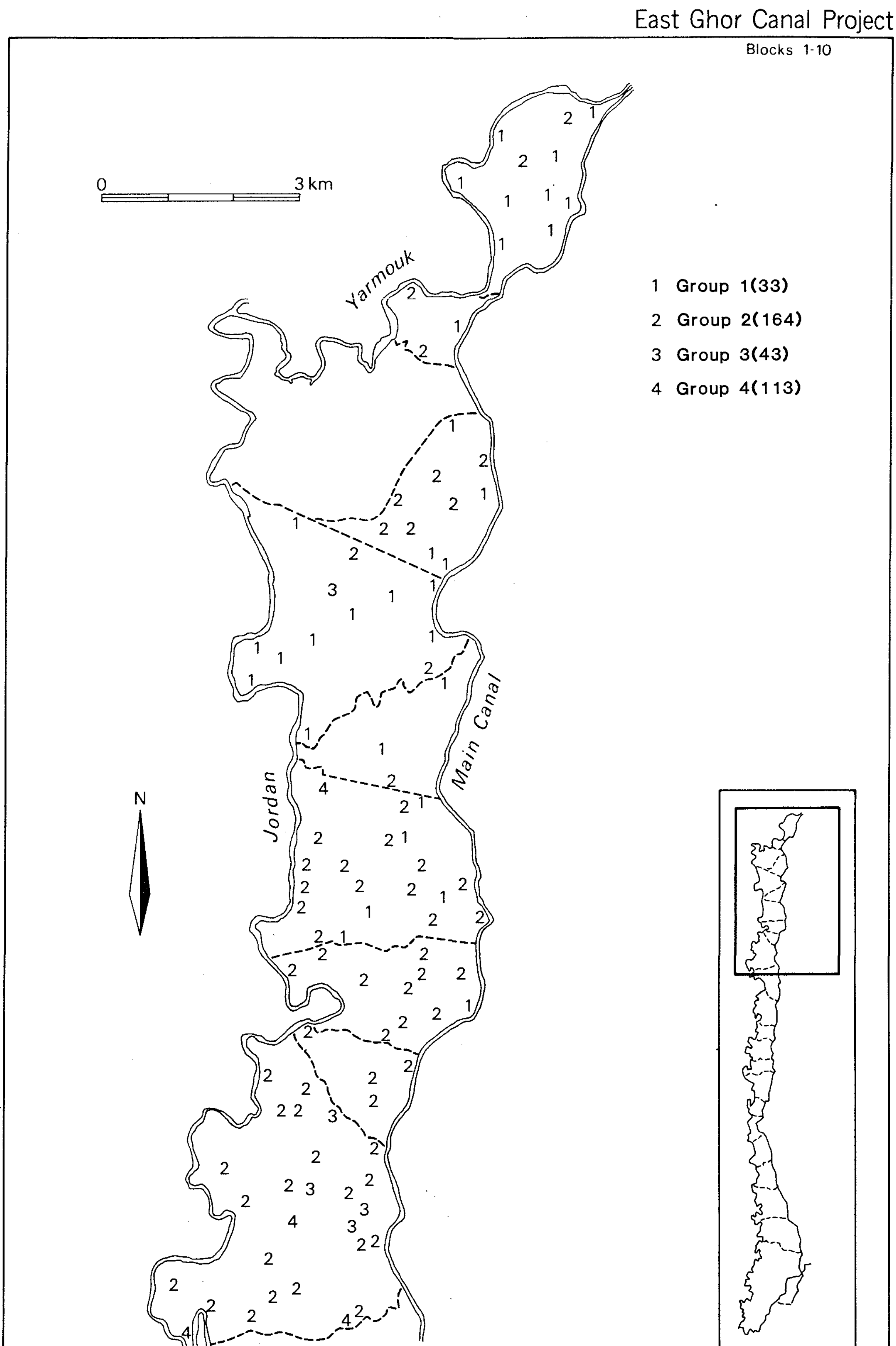


Fig. 10.3 EAST GHOR CANAL PROJECT: DISTRIBUTION OF FARMS ACCORDING TO THE FARM SERVICES CLASSIFICATION

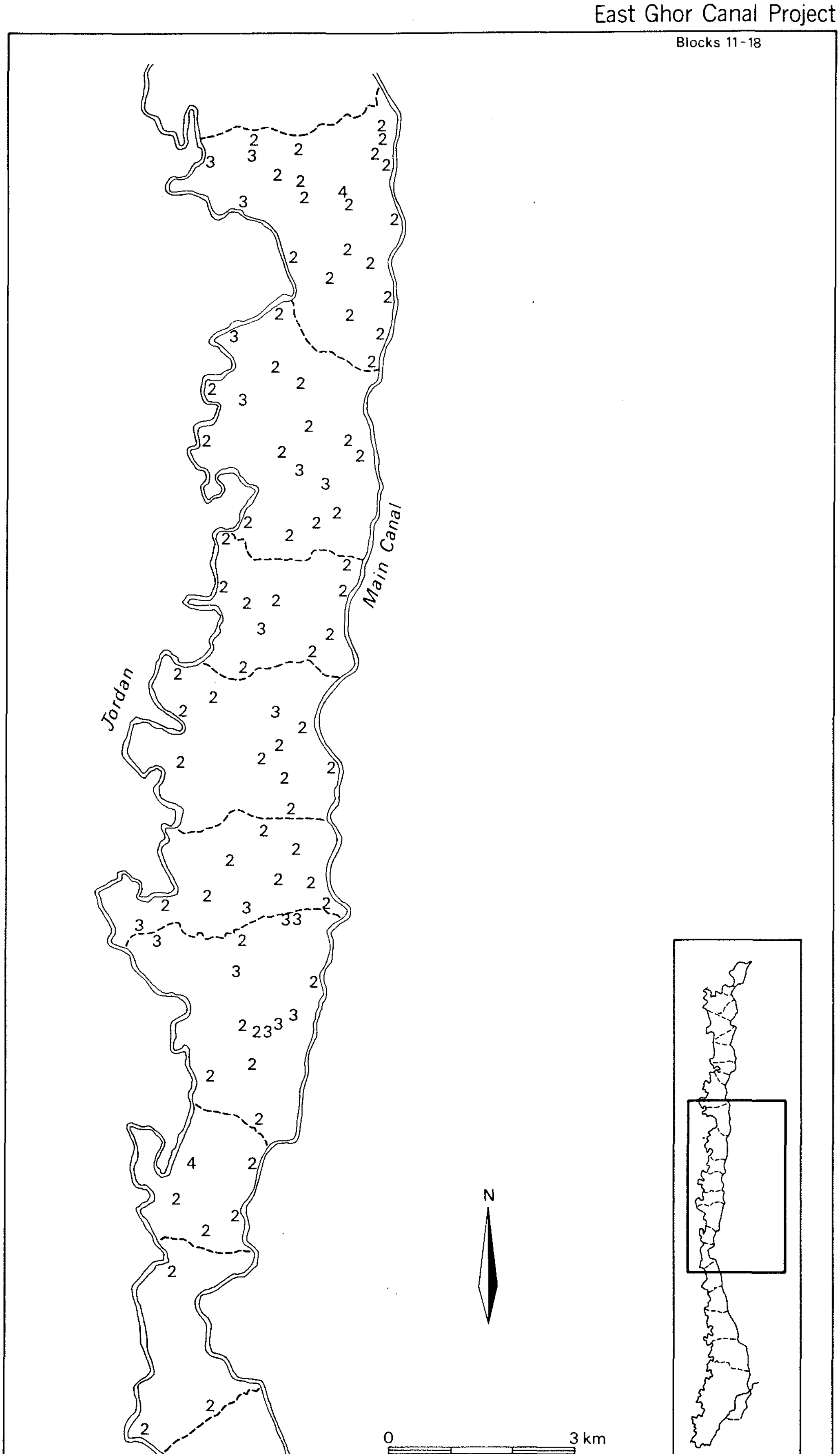


Fig. 10.3 continued

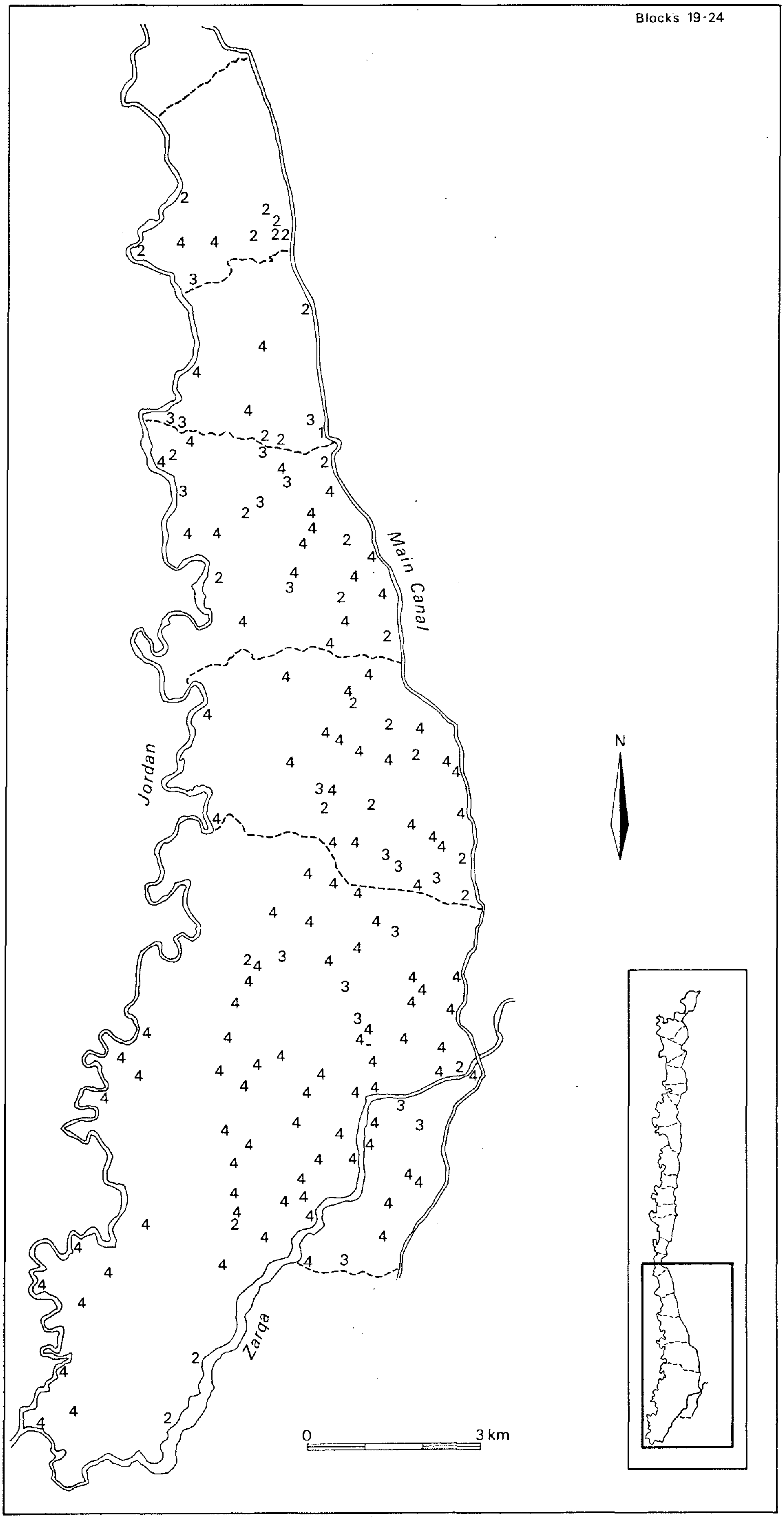


Fig. 10.3 continued

farms and their use of various services. It is of interest that two main groups - one well dispersed and the other more southern - are distinguished together with two smaller subgroups. This suggests a spatial element to this aspect of the farm economy in the project area.

Notes and References

1. Dar Al-Handaseh et al (1969) Jordan Valley Project: Agro- and Socio-Economic Study, Final Report, Vol. IV, Annex KI. Dar Al-Handaseh Consulting Engineers, Beirut and Netherlands 1-2. The legislative and institutional framework of the Jordan Co-operative movement has been amended several times since 1952. In particular the movement was strengthened in 1959 by the formation of the Jordan Central Co-operative Union. This was given the tasks of: arranging finance and acting as the bank for the registered co-operative societies; making bulk purchases of agricultural requirements distributed by societies to farmers; assisting the Department of Co-operative Development with the organization, inspection and supervision of co-operative societies; facilitating the marketing of produce gathered in from members or registered societies; representing the co-operative movement in Jordan at the international level.
   In 1963 a Co-operative Institute was formed with the role of conducting training and information programmes and providing accountants and managers for co-operatives. The Co-operative Audit Union was established in 1964 with responsibility for auditing the books of member societies and developing appropriate accounting and recording procedures for them. In 1968 the Jordan Co-operative Organisation was set up and took over all the functions of the aforementioned organizations and government agencies.
2. Until 1974 the co-operatives in the northern valley were known as the North Ghors district but were re-organised as the Jordan Valley Directorate covering the whole project area from the Yarmouk River as far south as Ghor Damya including the first 8 km of the extension area. In the case of the southern valley no useful data was available before 1975 because, until then, the co-operatives in that area were grouped in the district of the Balqa Co-operative Directorate which included co-operatives outside the valley. In 1975 the southern co-operatives were re-organized into a new district covering the area from Ghor Damya to the Dead Sea based on South Shuneh. The Jordan Valley Directorate is based on Wadi Yabis.

3. Jordanian Co-operative Organization (1973-78) The Statistical Annual Report About the Jordanian Co-operative Movement. The Jordanian Co-operative Organization, Amman, (in Arabic).
4. The questions are listed in full in Appendix 1.
5. The dissatisfaction of Section II members may reflect their rising expectations compared with the much lower expectations of members in newer and smaller branches.
6. Spray equipment can be hired, however, from the extension services in the valley.
7. It should be expected that there would be more complaints amongst members of older-established co-operatives.
8. To become a member of a co-operative a farmer needs to present either a land ownership certificate or a farming contract from his landlord. Since many tenants and sharecroppers have no written contract they are not eligible to join a co-operative.
9. According to JVFA rules members can be obliged to sell their produce through it. This may be a reason why the JVFA has not attracted more members although this rule is not enforced because marketing facilities are not yet properly developed by the Association.
10. Some questioned sharecroppers explained that they were uninterested in joining the JVFA because they could obtain the same benefits through their landlord's membership.
11. The main objectives of the agricultural extension services are to provide "the education and guidance of the farmer to enable him to pursue modern agricultural methods conducive to raising efficiency and (to give him the) ability to better exploit his land, this to be achieved through the diffusion of modern agricultural knowledge, the conduct of demonstrations and the provision of agricultural services". Dar Al-Handaseh (1969) op. cit. Vol. IV., Annex K VI, 101.

CHAPTER 11 A GENERAL CLASSIFICATION OF FARMS IN THE EAST GHOR CANAL PROJECT

11.1 Introduction

Having demonstrated that there is a considerable degree of variety in the types of farms and in farmer behaviour across the project area, a variety that reflects numerous factors, it seems appropriate to conclude this study by attempting to classify the sampled farms in such a way as to form the basis for a new regional subdivision of the project. It is not envisaged that this regionalization could, or should, replace the existing four sections and 23 blocks under which the project has been administered because much of the data used in this study is based on only a small sample of the ghor farms, but it is hoped that it might serve to summarize what this thesis has revealed about the farms in the project.[1] It is also hoped that it might offer a foundation for future studies of farm and agricultural development in the area.

In order to create a classification of the 353 sampled farms that is sufficiently sophisticated to take account of the range of variables already considered in other parts of the thesis, but is simple enough to produce a few fairly discrete geographical subdivisions, the author has used computation techniques combining cluster and discriminant analyses. On this basis nine groups of farms have been identified and this chapter summarizes this work and concludes by describing these groups of farms, and their distribution.

11.2 Classification

A few geographers such as Harvey, King and Tarrant have been amongst the many taxonomists and others who have written on the problems and purposes of classifying data. King pointed out that in geography "classification is an important step in the ordering of information and the deriving of generalizations."[2] Harvey has described classification as "perhaps the basic procedure by which we impose some sort of order or coherence upon the vast inflow of information from the real world" and continued, "We can represent classification as a set of rules for assigning data to their appropriate classificatory boxes."[3] Davis, a geologist, pointed out that by placing objects in more or less homogeneous groups "the relationships between groups is revealed",[4] while Tarrant defined classification as "a filter which allows data to be ordered so as to permit further work on it ... or to provide the basis for hypothesis-testing."[5] It seems clear, then, that in classification one is concerned with within-group homogeneity, in the degree of difference and similarity between groups and in having a well-defined set of rules to control the classificatory process.

But there is the further problem of the purposes of classification, as to whether it is a mere grouping of data as an end in itself, or is intended to serve several diverse ends, or is to act as the starting point for other work such as hypothesis-testing. Here one might usefully distinguish between general purpose and special purpose classifications. Because the utility of any system of classification cannot be assessed independently of its purpose and because there can be several purposes for classifying information, such as to group an unweildy mass of data, to derive generalizations, or to provide the basis for hypothesis-testing, Harvey has grouped classifications and their purposes into two main families:

a) the general, or natural, classifications, a notion developed by Mill, where the classification is based on a variety of criteria and is of such a form that it can serve several purposes at once but probably never serves any at more than a relatively low level of efficiency.[6] Sokal and Sneath, for example, have criticised taxonomic classification in biology as being a general purpose system that tries to fulfil several functions but fails to serve any of them well. As they have put it, "it attempts to classify, to name and to indicate the degree of affinity and to show relationship between descent - all at the same time ..." They continue "it is impossible not only in practice but also in theory for the current system to perform these tasks adequately."[7]

b) alternatively there are artificial, or purpose-specific, classifications which are devised very much for the needs of particular functions, such as the testing of an hypothesis, where the problem at hand determines the criteria to be used in the classification. These classifications often use fewer criteria. Such a special purpose can often also be served by a general purpose classification, perhaps with suitable modifications, although its specific purpose frequently demands that rather fewer and more clearly defined variables are built into the classification than would be common in many more general types of classification.

Such a two-fold grouping of classifications is far from perfect as can be seen in the fact that the classification of farms adopted here might be considered an artificial one, in that it has been devised for a specific purpose and only considers a certain number of variables. On the other hand the number and type of variables used is much wider than in the case of the classification of farm enterprises and services given at the end of Chapters 7 and 10, so that this is a more general form of artificial classification. Furthermore its specific purpose is of a rather broad-based or general nature in attempting to provide a regionalization of farms which could be suitable for future farm studies in the area.

11.3 Cluster Analysis

The principal classificatory technique that has been used on the 353 sample farms is cluster analysis, a multivariate technique which Davis has described as "an efficient way of displaying complex relationships among many objects" in that"it provides a way to classify objects that is relatively simple and direct, and it presents the results in a manner that is both familiar and easily understood."[8] Cluster analysis allows one to arrange a considerable number of objects into a smaller number of mutually exclusive groups where each group has as much internal homogeneity as possible based on a considerable number of variables.

While one can have both divisive and agglomerative cluster analysis the one used here is an agglomerative, hierarchical type. The advantages of this are two-fold. First, an agglomerative method of grouping objects, which builds up the classification from the individual objects and their variables, takes up less computer time than divisive methods which attempt to split a whole population into groups in stages using one variable at a time.[9] Second, agglomerative methods, some of which produce nucleated groups of information, can also be of a hierarchical form, with each group forming a sub-group of a bigger group at a higher level of generalization in the classification. In this way one could, if necessary, use the classification at several levels of generalization without fear of omitting any of the individuals or groups.

It could be argued that this appears to be an unwieldy process in order to group only 353 farms into a few groups, but it must be remembered that it has been found desirable to use a considerable number of characteristics by which to classify these farms in order to reflect their considerable diversity of attributes. If one was classifying farms on a small number of characteristics, as has already been done in Chapter 7 with crop combinations, there would be little problem of grouping them and labelling that group on the basis of the dominant features. But 31 variables have been used in this classification and these cover various physical, human, economic and locational attributes. Furthermore in the case of two thirds of the variables the data was of a nominal type, that is giving more than a simple yes/no answer.

In order to arrange the objects, in this case the farms, into a hierarchical classification by cluster analysis, the data needed to be arranged in the form of a matrix of m (the characteristics) times n (the objects). The data in the matrix also needed to be standardized prior to any similarity co-efficients being used on it because if some variables were given greater weight, or importance, than others they would distort the measurement of similarity between the objects. This standardization is achieved by transforming all variables to a Z-score.[10] The 31 variables, the attributes of the 353 farms, were put into the matrix to give a 31 times 353 matrix. These 31 variables are listed in Table 11.1.

The cluster classification technique is based on the idea that objects that are less similar will give a larger similarity co-efficient. Or, to put it in terms of a visual display of the results in the form of a hierarchy or dendrogram, a greater distance will separate individuals and groups with a greater degree of dissimilarity, while a closer distance or smaller co-efficient indicates a stronger resemblance

TABLE (11.1) THE GENERAL CLASSIFICATION OF FARMS: VARIABLES USED FOR CLUSTER ANALYSIS

1. Age of the farmer
2. Educational level of the farmer
3. Level of the farmer's experience
4. Number of years the farmer has spent in the valley
5. Origin of the farmer
6. Level of additional non-farm income
7. Use of family labour on the farm
8. Form of land tenure
9. Farmer's use of cash loans
10. Use of advice by the farmer
11. Use of advanced techniques on the farm
12. Method of payment for farm supplies
13. Source of farm supplies
14. Size of the farm
15. Level of annual farm income
16. Annual expenditures on the farm
17. Level of machine ownership
18. Co-operative membership
19. Membership of the Jordan Valley Farmers Association
20. Farmer's use of Amman Market
21. Farmer's use of Irbid Market
22. Farmer's use of North Shuneh Market
23. Farmer's use of Wadi Yabis Market
24. Farmer's use of Sawalha Market
25. Percentage of class 1 and 2 land on the farm
26. Percentage of class 3 land on the farm
27. Percentage of class 4 land on the farm
28. Percentage of class 6 land on the farm
29. Percentage of cropland under fruit/trees
30. Percentage of cropland under vegetables
31. Percentage of cropland under cereals

between objects and between groups. Similarity co-efficients such as correlation co-efficients and standardized Euclidian distance co-efficients can serve to depict these degrees of resemblance between objects within the hierarchy.

This clustering procedure was carried out using the Southampton University Computer Service CLUSTAN package which prints out the co-efficients in a tabular form of linkage orders.[11] By using the PLINK procedure in the CLUSTAN package a visual interpretation of the hierarchy can be produced in the form of a dendrogram which also shows the linkages and linkage orders.

To commence the process of grouping, the first step carried out by the computer is the selection of two objects as a subset (of n subsets) so that the remaining objects can be examined for (n-1) subsets to see whether the third and subsequent objects should join the first subset or whether they should form new groups. After the first cycle of clustering of all the individual objects has created a number of groups, the similarity matrix is recomputed treating each group of objects now as a single object for the second and later cycles of the classification. So the hierarchy is built up.

The choice of similarity co-efficients on which the grouping is based depends on the nature of the data and whether that data is interval or ratio-scaled. The Euclidian distance co-efficient has been widely employed with both types of data and is used here.[12] There are eight variants of it available in the CLUSTAN package for hierarchical clustering of data.[13] These are:

Nearest Neighbour (single linkage)
Furthest Neighbour (complete linkage)
Group Average (average linkage)
Centroid
Median or Gower's Method
Ward's Method
Lance Williams Method
McQuitty's Similarity Analysis

All eight methods were used in this first stage of the classification of the farms and the resulting dendrograms are shown in Appendix 6. From these the Ward method was selected as giving the clearest and most appropriate pattern of clustering. Developed in 1963 the Ward method is based on the idea of producing the smallest within-group sum of the squares, or the smallest distance (i.e. difference) from each individual in the group to the centre of that group, and so on up the hierarchy. As Mather has put it "the two groups to be combined at any given level are those whose fusion produces the least increase in the within-group sum of squares."[14]

11.4 Discriminant Analysis

With all forms of cluster analysis where the population is grouped in an hierarchical form, a decision has finally to be made by the user on which is the optimum number of groups to take by deciding where it is most appropriate to cut into the hierarchy. As can be seen in Fig. 11.1 at the top of the hierarchy there are only two groups and one could simply consider the data as made up of these two groups. As one moves down the hierarchy it splits into further groups as the coefficients of similarity gets smaller (i.e. objects become more similar within the groups) so that one moves through positions where there are first 3, then 4, 5, 6, 7, 8, 9, 13, 15, 16 groups and so on down to the 353 individual farms. Here discriminant analysis can help decide the appropriate cut-off point. In fact by applying this technique to the data for all possible groupings between 2 and 16 a 9-fold classification was selected as the most satisfactory.

Discriminant analysis begins with the desire to statistically distinguish between two or more groups of cases. To distinguish between the groups the researcher selects a collection of discriminating variables that measure characteristics on which the groups are expected to differ. The mathematical objective of discriminant analysis is "to weight and linearly combine the discriminating variables in some fashion so that the groups are forced to be as statistically distinct as possible."[15] A computer-based multivariate step-wise technique, discriminant analysis was used to help distinguish the degree of dissimilarity between groups and hence to decide at what point the hierarchy gave the clearest pattern of differentiation of the 353 sample farms. To use this technique a number of discriminating variables

Fig. 11.1 EAST GHOR CANAL PROJECT: DENDROGRAM OF THE GENERAL CLASSIFICATION OF FARMS

are selected on the basis of those characteristics by which the groups are expected to differ most. In the present case the 31 variables used in the original cluster analysis were subjected to this step-wise procedure to select out the most discriminating amongst them. In this procedure the single most discriminating variable gets selected first, followed by that variable most able, in combination with the first, to best improve on the discrimination. This step-wise process is continued until no further improvement occurs in the discrimination. In the present case 26 variables were selected out by the procedure and those are listed in order of their power of discrimination in Table 11.2. Each subsequent additional variable added less and less.[16]

The last few variables which added nothing were rejected as discriminators. Furthermore the fourth most important discriminator - the percentage of farmland under fruit trees - was later rejected since it lost its discriminating power in the last stages of the step-wise process. As a result the 25 listed discriminants were used and on this basis the 9-fold classification was established.

Not only can discriminant analysis identify the most useful variables and hence the membership features of each group but it can test the adequacy of the discriminating functions. By classifying the cases used in the first place to derive the functions and comparing the actual membership of groups with a predicted membership, one can assess the success of the classification process.[17] Table 11.3 shows the results of this where it can be seen that as many as 91 per cent of the classified farms fell into groups in the predicted manner. Furthermore all groups came near to this level of correctness of grouping with the exception of the 29 farms in Group 5 of which only 25 (72 per cent) appeared to be grouped as predicted. Overall, however, a 91 per cent level of agreement is high for this type of analysis, and suggests the effectiveness of the classification. Table 11.3 also shows that some of the groups created by the cluster analysis are much larger than others. Groups 7, 2 and 9 together have 64 per cent of the total sample whereas at the other end of the scale the three smallest groups - 6, 8 and 4 - only contain 9 per cent of the total sample.

TABLE (11.2) THE GENERAL CLASSIFICATION OF FARMS: VARIABLES USED FOR DISCRIMINANT ANALYSIS LISTED IN ORDER OF THEIR DISCRIMINATING POWER

After Step No.	
1.	Farmer's use of North Shuneh Market
2.	Percent of Class 4 land on the farm
3.	Percent of Class 1 and 2 land on the farm
*4.	Percent of cropland under fruit trees
5.	Percent of cropland under cereals
6.	Annual expenditure on the farm
7.	Farmer's use of Wadi Yabis Market
8.	Use of advanced techniques on the farm
9.	Origin of the farmer
10.	Size of the farm
11.	Educational level of the farmer
12.	Use of advice by the farmer
13.	Farmer's use of Sawalha Market
14.	Level of Annual farm income
15.	Form of land tenure
16.	Co-operative membership
17.	Farmer's use of Irbid Market
18.	Source of farm supplies
19.	Farmer's use of Amman Market
20.	Level of machine ownership
21.	Level of additional non-farm income
22.	Level of the farmer's experience
23.	Age of the farmer
24.	Percent of Class 6 land on the farm
25.	Percent of cropland under vegetables
26.	Farmer's use of cash loans
27.	Number of years the farmer has spent in the valley
28.	Use of family labour on the farm
29.	Method of payment for farm supplies
30.	Membership of Jordan Valley Farmers' Association
31.	Percent of Class3 land on the farm

*The last five variables listed (27-31) were not selected by discriminant analysis and after step 26 they were joined by variable 4.

TABLE (11.3) EAST GHOR CANAL PROJECT:

TESTING THE GENERAL CLASSIFICATION OF FARMS BY DISCRIMINANT ANALYSIS

		Predicted Group Membership								
Actual Group	No of Cases	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Group 1	32	32 100.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
Group 2	75	1 1.3%	66 88.0%	1 1.3%	0 0.0%	3 4.0%	0 0.0%	4 5.3%	0 0.0%	0 0.0%
Group 3	35	0 0.0%	0 0.0%	32 91.4%	0 0.0%	0 0.0%	0 0.0%	3 8.6%	0 0.0%	0 0.0%
Group 4	18	0 0.0%	0 0.0%	0 0.0%	18 100.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
Group 5	29	1 3.4%	1 3.4%	1 3.4%	1 3.4%	21 72.4%	1 3.4%	0 0.0%	0 0.0%	3 10.3%
Group 6	6	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	6 100.0%	0 0.0%	0 0.0%	0 0.0%
Group 7	90	0 0.0%	2 2.2%	1 1.1%	0 0.0%	1 1.1%	0 0.0%	85 94.4%	0 0.0%	1 1.1%
Group 8	9	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	9 100.0%	0 0.0%
Group 9	59	0 0.0%	2 3.4%	2 3.4%	0 0.0%	0 0.0%	0 0.0%	1 1.7%	2 3.4%	52 88.1%

Percent of "Grouped" Cases correctly classified: 90.93%

11.5 General Characteristics and Spatial Distribution of the Groups

Table 11.4 gives the distribution of the farms in their various groups across the four sections of the project area and these are plotted in Fig. 11.2. It can be seen from the 'column' figures in Table 11.4 that some groups are spatially fairly discretely distributed whereas others are more widely scattered across all sections. It will be noticed, for example, that Section I in the north has 70 per cent of its farms in Groups 1 and 2. Similarly in Sections III and IV in the south over 70 per cent of their sampled farms were found in only Groups 7 and 9. On the other hand Section II contains considerable numbers of farms belonging to several of the groups, including both those more typical of sections to the north and to the south. This section, however, contains no farms belonging to Groups 6 and 8, both small groups whose farms are entirely confined to the southern two sections of the project areas. Nor does Section II contain any farms of Group 1 which are completely confined to Section I to the north.

Using the 'row' figures given in the table one can see that not only are Group 1 farms entirely restricted in their distribution to the northern section but the Group 8 farms, admittedly few in number, are entirely confined to the southernmost section. Over 85 per cent of farms classified as Groups 2 and 3 are found in the two northern sections whereas Group 6, 7 and 8 farms are essentially southern in their distribution. Only farms in Groups 4, 5 and 9 appear to be distributed more widely suggesting that there is a strong geographical element in the operation of several variables used to classify the sampled farms. In a similar way Fig. 11.1 suggests that the common Groups 7 and 2 are quite distinctive from each other with Groups 1, 3 and 4 related to Group 2 while the tiny Group 8 is closely related to Group 7. Group 9 is a large and fairly distinctive group.

Appendix 7 lists the nine group of farms against selected variables by which they were classed into these groups. It is not necessary nor possible to examine all the relationships between the classes created by the analysis and the influencing variables but the following points are worth noting for each group.

TABLE (11.4) EAST GHOR CANAL PROJECT:

DISTRIBUTION OF THE GENERAL CLASSIFICATION OF FARMS

	Section I			Section II			Section III			Section IV			Total Project		
	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %	Freq	Column %	Row %
Group 1	32	31.4	100.0	–	–	–	–	–	–	–	–	–	32	9.1	100.0
Group 2	39	38.2	52.0	27	29.0	36.0	8	10.0	10.7	1	1.3	1.3	75	21.2	100.0
Group 3	9	8.8	25.7	21	22.6	60.0	5	6.3	14.3	–	–	–	35	9.9	100.0
Group 4	6	5.9	33.3	8	8.6	44.4	–	–	–	4	5.1	22.2	18	5.1	99.9
Group 5	8	7.8	27.6	12	12.9	41.4	6	7.5	20.7	3	3.8	10.3	29	8.2	100.0
Group 6	–	–	–	–	–	–	4	5.0	66.7	2	2.6	33.3	6	1.7	100.0
Group 7	1	1.0	1.1	11	11.8	12.2	40	50.0	44.4	38	48.7	42.2	90	25.5	99.9
Group 8	–	–	–	–	–	–	–	–	–	9	11.5	100.0	9	2.5	100.0
Group 9	7	6.9	11.9	14	15.1	23.7	17	21.2	28.8	21	26.9	35.6	59	16.7	100.0
Total	102	100.0		93	100.0		80	100.0		78	99.9		353	99.9	

Group 7

Since one might expect the most common type of farm within the project area to be based on a simple crop enterprise operated on a small, often owner-occupied holding by a farmer with limited means and education, it is not surprising to find that this stereotype is well-represented by this first group. With 90, or 25.5 per cent of all the sampled farms, Group 7 is the largest to come out of the classification. Most were found in the southern part of the project area. Two-thirds of all the farms in this group were simple vegetable-growing enterprises with the others being vegetable producers supported by some fruit or cereals. Good quality land and small farm area were also common features of farms in this part of the sample. 71 per cent of all the farms in this group were on Class I or II land and 89 per cent of them were no larger than 35 dunums in extent, none of them being larger than 50 dunums. Along with this it was found that about 60 per cent of the units were owner-occupied with most of the rest being share-cropped.

The small-scale simplicity of these farms is also reflected in the limited horizons of this group of mainly young to middle-aged farmers. Although all levels of educational attainment were represented in this group, easily the largest number (48 per cent) were classed as illiterate and another 39 per cent had received an elementary education only. Over three-quarters of them had originated on the East Bank and more than two thirds had lived there for more than 30 years although only a third had had more than 20 years of farming experience. Different levels of farm income were reported but low to moderate levels of both income and expenditure were most frequently reported. Only 8 per cent reported high levels of income and expenditure and very few had any other income source than their farms.

Use of ancillary facilities and services varied but generally again reflected the farmers limited horizons. Nearly a half used family labour. 95 per cent of them marketed their produce through Sawalha, the market in the southern part of the valley close to where most farmers in this group were located, and less than a third used either Amman or Irbid markets. About a half of the farmers were members of the local co-operative or the Jordan Valley Farmers Association which they supported at a level a little above average for the whole project sample. They appeared, however, to make rather cautious use of the benefits of such membership. Levels of farm advice-seeking were low. A wide range of farm supply sources was reported. Over a third of farmers reported getting supplies from more than one source with co-operatives and commission agents being in common use. Even so there was a high level of cash-loan taking which was reported by nearly 70 per cent of the farmers in this sample. Nearly a quarter reported that they used either drip irrigation or plastic-house culture and 61 per cent owned at least one machine, indicating that even members of this group of small and relatively conservative farm owners have not been slow to accept modernization where it clearly benefits them.

Lastly, since one might recognize this to be one of a series of subgroups of small peasant-irrigators found throughout the project area, it should be noted that this group is the typical southern variant. As Table 11.4 and Fig. 11.2 show, almost the entire group was found in the two southern sections. In Sections III and IV, farms in this group made up about a half of all the units sampled. On the other hand far fewer were found in Section II to the north and only one was so classified in the northern section.

Group 2

This is the second largest group picked out by the classification with 75 farms, or 21.2 per cent of the total sample. In many ways this group can be seen as a northern counterpart to the southern group of farmers just considered. Not only are most of them running simple small-scale enterprises but the majority of the farmers who both own and operate their land have had limited education, apply rather few modern techniques and get only a restricted income from their farms.

Table 11.4 shows that 88 per cent of the units in this sample were found in the two northern sections, in each of which they formed the single largest group. On the other hand they were found far less frequently in Section III and only one occurred in Section IV. As with

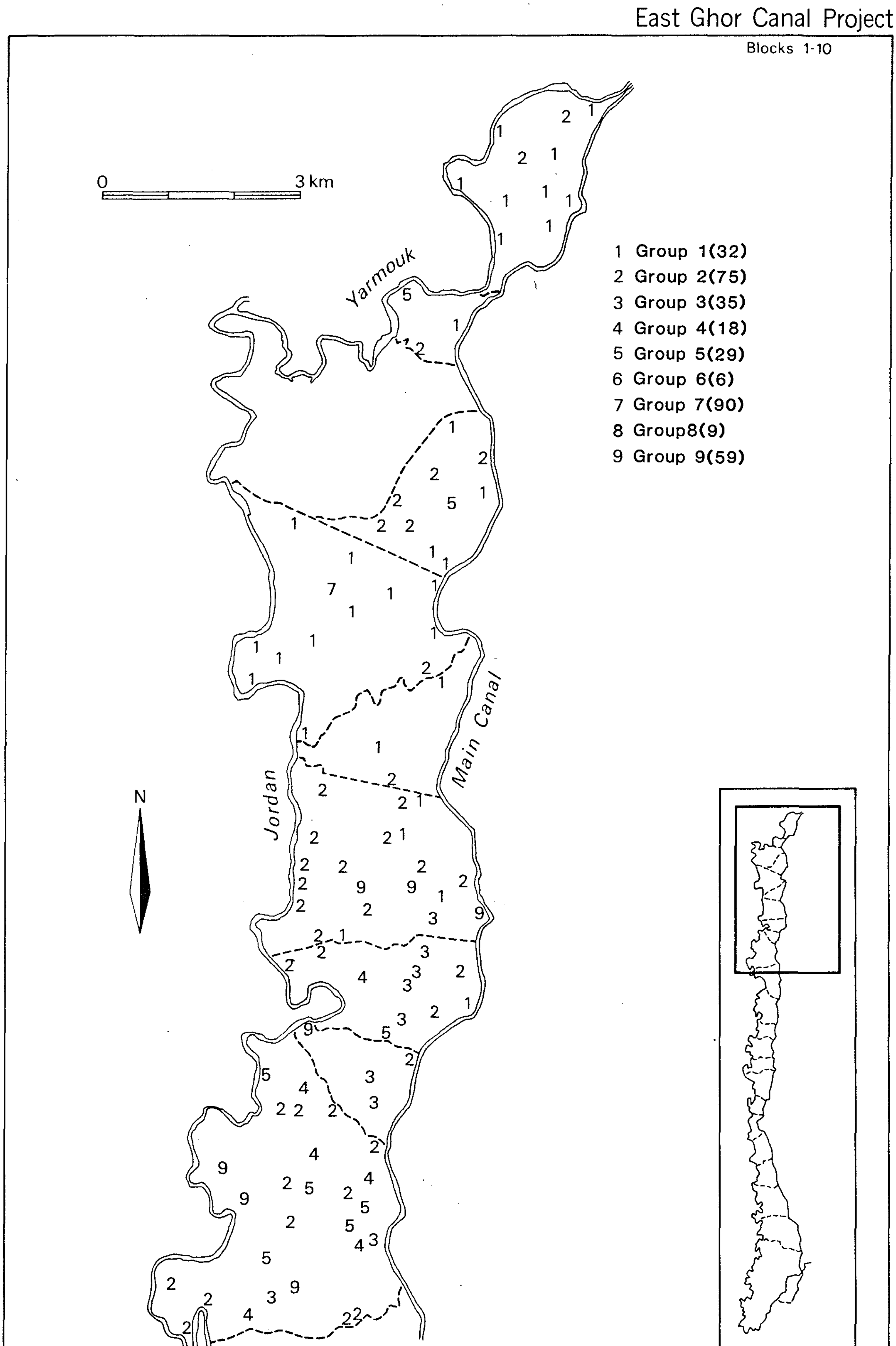


Fig. 11.2 EAST GHOR CANAL PROJECT: DISTRIBUTION OF FARMS ACCORDING TO THE GENERAL FARM CLASSIFICATION

East Ghor Canal Project

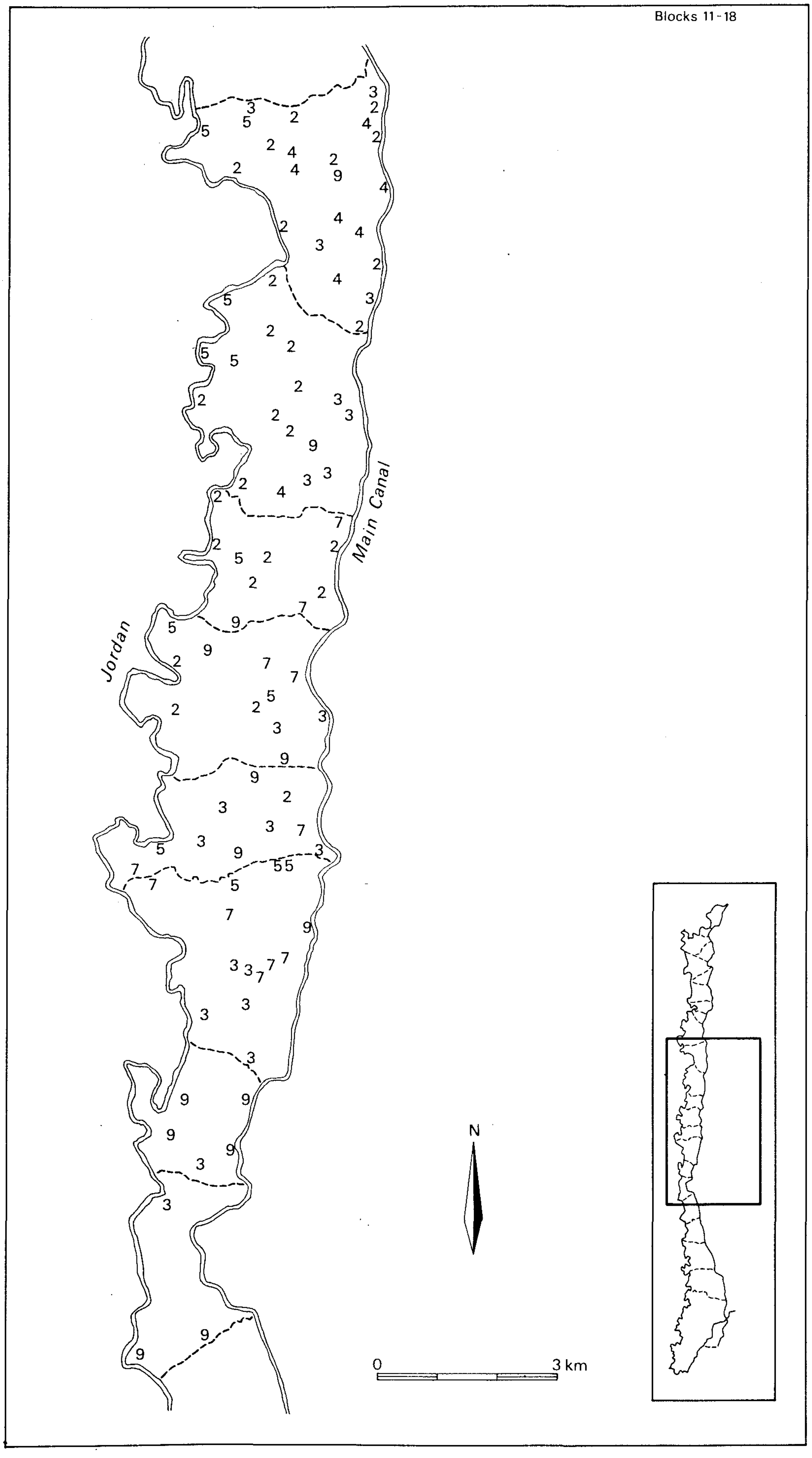


Fig. 11.2 continued

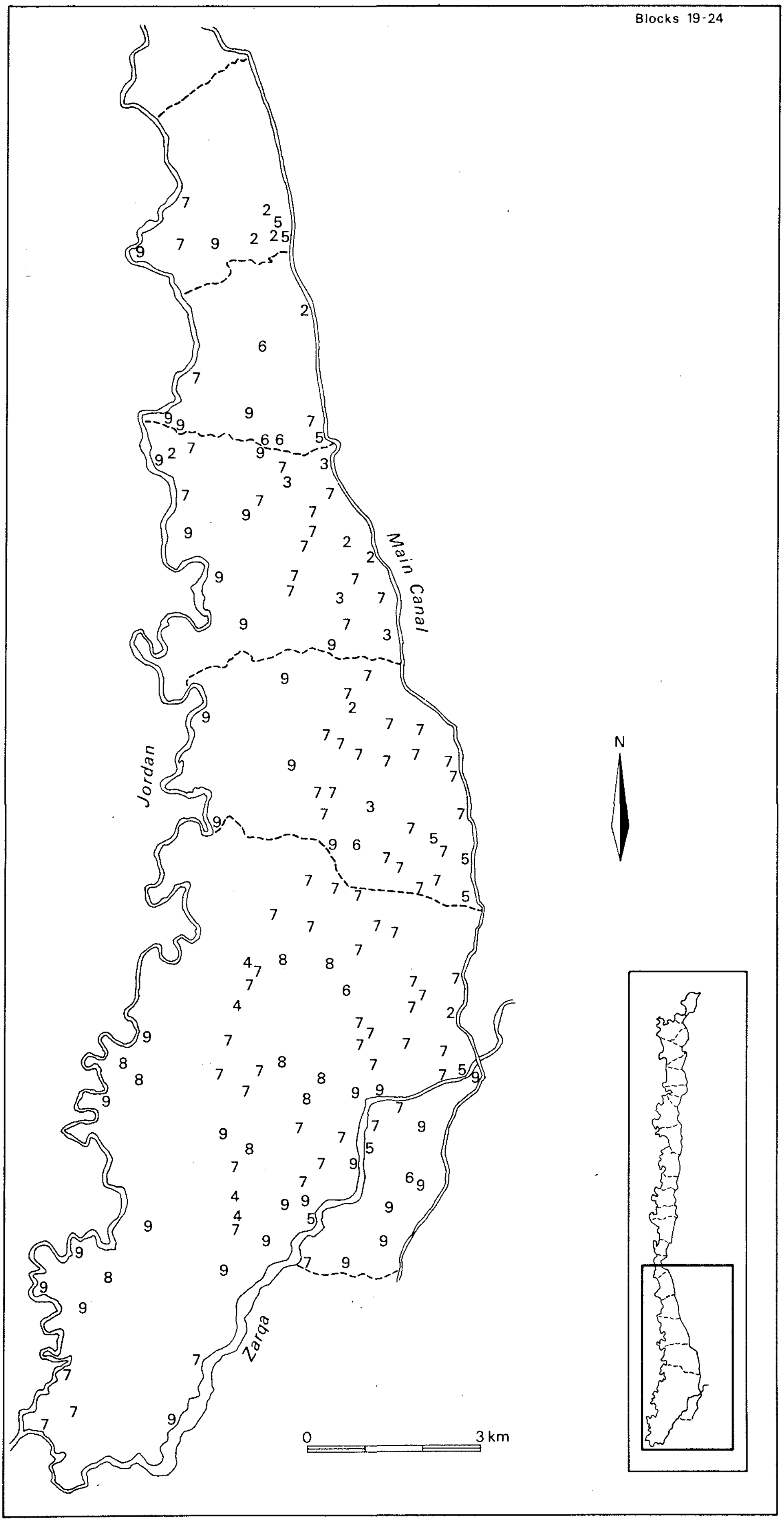


Fig. 11.2 continued

the southern farms in the previously discussed group, most of the features of these farms and their operators were fairly simple. Most of the farms were engaged in fruit tree culture which was commonly supported by vegetable production. A half of all the farms lay entirely on Class I or II land and most others were predominantly on land of these classes. Farm size was small but not as small as for the Group 7 farms. Two thirds of the farms in this group were under 35 dunums compared with 89 per cent in Group 7. Owner-occupance levels, at 72 per cent of the sample, were the highest of all groups. On the other hand, levels of use of family help and of loan-taking were rather low compared with several other groups. Farm income and expenditure levels were varied across the group but were, on average, a little higher than for Group 7 farms and more farmers in this group reported outside sources of income. Levels of membership of co-operatives and of the Jordan Valley Farmers' Association were close to the average for that of the whole project sample, whereas levels of advice-seeking amongst this group of farmers was the second highest for all groups. Varied sources of farm supplies were noted with the agricultural supply companies and co-operatives being commonly used. A wide range of markets was used including Irbid and Amman but also, to a lesser extent, Wadi Yabis and Sawalha in the south.

The over-riding impression gained, therefore, is of a group of farms and farmers operating on a small-scale and in an even more conservative way than the Group 7 farmers in the south. This is reflected in several ways in the character of the farmers. They were, on average, at the time of the survey rather older than the farmers in Group 7 and with a longer period of residence in the valley. 70 per cent were over 40 years old compared with 59 per cent of the Group 7 farmers. 56 per cent had had 21 years or more of farming compared with 33 per cent of the farmers in Group 7. Most were from the East Bank, like those in Group 7, but had more farming experience since they had settled earlier in the longer-established northern part of the project. At the same time 86 per cent of them were either illiterate or had no more than an elementary education, a proportion with low educational attainments very similar to the Group 7 farmers.

Even so in most ways they appeared to have been rather less progressive in their farming. Often with moderate sized farms in a well-established part of the project they were producing rather modest returns. Related to this it can be seen that 54 per cent owned no machines and only two of them had adopted either drip irrigation or plastic culture in order to improve their farm output.

Group 1

It is convenient to next consider some of the other much smaller groups, none of which made up more than 10 per cent of the total sample. These can best be examined at this point because they appear to be local variants of either the Group 2 northern farms just considered or the Group 7 southern farms with which we began this classification.

With 32 farms, or 9.1 per cent of the total sample, Group 1 can be seen by its character and location to be a group closely related to Group 2. All of the farms in Group 1 were found to be in Section 1 in the northern part of the project where they formed 31 per cent of the total sample. As for Group 2, the farms in Group 1 were predominantly small, owner-occupied fruit tree units with some vegetable production, but in several respects these characteristics were even more clearly represented in this group. For example, a third of the farms were 30 dunums or less in extent compared with 21 per cent in Group 2; three-quarters of them were entirely on Class I or II land compared with 53 per cent of farms in the larger Group 2. On the other hand while most were owner-occupied, there was a rather larger minority of share-croppers.

What seems most significant about this group, to distinguish them from Group 2, is their even less developed nature, possibly related to a tendency for their operators also to rely more than those in other groups on income from non-farm sources. 62 per cent of them claimed to have an additional income source, a proportion significantly higher than for other groups.

At the same time in several ways these farmers did not appear to have done much to improve their farms. 59 per cent of them reported that they owned no farm machines and only one farmer reported the use of drip irrigation or plastic culture. Levels of co-operative membership, of loan-taking and advice-seeking were also rather low. Nearly all used either Irbid or Amman markets, as one might expect, but all also used North Shuneh market, the one closest to them, and a local market that farmers in other groups virtually never used. That two-thirds of the farmers in this group also relied only on family labour points to the small scale of their farming, and a tendency to treat their farms as only one of their income sources. Yet these farmers, on average a little younger and less experienced than those around them in Group 2, were more varied in their educational backgrounds with a quarter of them reporting schooling to a secondary or graduate level.

Group 3

Group 3 farms form another small northern group made up of only 35 units, or 9.9 per cent of the total sample. This group often differs somewhat, however, from the much more numerous northern Group 2 and its related Group 1, which was considered last, in being made up of small, often tenant farmers or share croppers who have had less farming experience and little education. They also differ in that the majority of them are found in Section II which contained 60 per cent of this group, unlike Group 1 which was restricted to Section I.

In some respects, of course, there is little to distinguish them from other farmers, especially northern farmers in the project sample. Their farms are small, produce a small income and are characterized by almost no mechanization but in other ways they can be differentiated, through this classification technique, from their northern neighbours. Many of the farms in this group are very small indeed, with 40 per cent of them under 30 dunums, compared with 21 per cent of those in Group 2. No less than 83 per cent of them are no bigger than 35 dunums in area. These farms, unlike those in the other two northern groups so far considered, emphasise vegetable production with some fruit growing in support. This emphasis probably reflects the predominant rental and sharecropping status of most farmers in this group. Only 11 per cent of farms placed into this group were owner-occupied. Related in turn to this is the preponderance of Palestinians amongst the farmers who outnumbered the Jordanians by more than two to one so that most in this group had had a relatively short period of farming experience. 80 per cent of the sample had farmed for less than 20 years compared with 44 per cent of those in Group 2.

While farmers in this group made use of supply sources, method of payments for supplies and markets that appeared to differ little from their neighbours in other groups, their farming behaviour did differ quite markedly in other respects, often indicating their use of less advanced farming methods. 68 per cent of them reported the ownership of no machines and none reported the use of drip irrigation or plastic culture. 40 per cent of them earned less than JD 2000 per year from their farms compared with 28 per cent of those in Group 2. Their level of co-operative society or Jordan Valley Farmers' Association membership was the lowest of all groups.

Related to this were low levels of loan-taking and advice seeking. Not surprisingly in view of these features of their farms, it was found that about a half of these farmers were illiterate and none claimed more than a preparatory level of education. Few had any other income source so that these clearly form a lower income group, both in lacking their own land, in having very small units and in often having no other income source, than the other two northern groups already considered.

Groups 6 and 8

It is now appropriate to turn to consider two small southern groups, one of which (Group 8) can be viewed as a variant of Group 7, the major southern group identified at the start of this section. The other is a variant of Group 5. Groups 6 and 8 are easily the smallest groups picked out by the classification with a total of 15 farms between them. This is only 4.2 per cent of the total. In both cases all farms in each group are found in the southern sections of the project area with all 9 farms in Group 8 being in Section IV and the 6 farms in Group 6 being in Section III (4 farms) and IV (2 farms).

In most respects the 9 farms that make up Group 8 seem little different from the much bigger southern Group 7. Like them they were vegetable farms, sometimes supported by some cereal production. They were all small, two being less than 30 dunums in area and none being bigger than 50 dunums. Most, but not all, were owner-occupied. Of the farmers most were middle-aged with varied levels of farm experience and varied levels of education up to preparatory schooling. Some had additional income sources, most used cash loans and farm advisory services, and were members of the local co-operatives or the Jordan Valley Farmers' Association. Some owned machines and used the listed advanced farming techniques. In these respects this group of farmers seemed no different from those in Group 7. What distinguished their farms, however, apart from all of them being in Section IV, was that most of them occurred on poorer land. 8 of the 9 farms in this group had 40 per cent of their land in Class 4 as a result of which most of the farms reported low incomes, with farm expenditures being an unusually high proportion of the incomes. All of these farmers were from the East Bank which may also account for their much wider use of markets than the southern farmers in Group 7. Not only did they all use the local market at Sawalha but most also reported using Irbid and some also used Amman.

The 6 farmers who formed Group 6 shared some of those characteristics of Group 8 in being owners or tenants on pure vegetable farms or vegetable farms supported with some fruit or cereal production. But they differed in several respects. While all the farms were small with none over 50 dunums, none were smaller than 30 dunums. Most included some poorer land yet all of the farmers reported annual incomes of over JD 5000 paralleled by levels of expenditure higher than amongst farmers in any other group. That these should form a tiny minority of rather richer farmers may also be related to their rather greater age and level of farm experience than is common for the other groups. Four of the six farmers reported their ages as between 51 and 60 and none was under 30 years of age. Half of them had had 30 years' experience in farming although in most cases this had not been spent in the valley because four of the six were Palestinians. There was little unusual in much of their farming behaviour although it should be noted that none reported any other income source than their farming. All took cash loans and most had several farm machines and all used the listed advanced farming techniques. The group reported high levels of co-operative or association membership and a wide range of markets were used. All used the local market at Sawalha and Amman and half used Irbid. Surprisingly the educational levels of the six farmers in this group greatly varied, ranging from one who had enjoyed a university education through to another who was illiterate. Nevertheless this group appears to represent a small number of very successful farmers in the southern part of the valley.

Group 9

It is now convenient to return to consider one of the larger groups which, unlike the groups so far considered, was neither confined to the southern or northern parts of the project. Fig. 11.1 shows this to be a distinctive group in this way. The 59 farms that make up this group form 16.7 per cent of the total sample and are dispersed throughout the project area but with rather more in the southern than the northern sections (Fig. 11.2). These are either pure vegetable-growing units or vegetable production supported with either cereals or fruit trees. Unlike the other larger groups already considered, none of the farms in this group occupied entirely better quality land. A quarter of them had at least 40 per cent of their land in Class 6. As a result the farms in this group are rather larger with more than two-thirds of them being over 50 dunums. They had low levels of machine use and very little was of the advanced techniques.

In spite of these farm differences the farmers appeared little different from the farmers that made up the other larger groups. A half were owner-occupiers with most of the rest being share-croppers; most were from the East Bank; they were mainly middle-aged and over a half had had more than 20 years of farming experience. They reported the use of a wide range of markets, as is to be expected with their wide dispersal throughout the project area, but had levels of co-operative and association membership little different from the other groups. With generally low levels of education - nearly 60 per cent were illiterate - and with low incomes, the farmers in this group appear to be the equivalent of the common northern and southern farmers described in Groups 2 and 7 and distinctive only in their farm features and locations.

Group 4

The 18 farms in this small group, shown in Fig. 11.1 as closely related to Group 3, are reasonably well dispersed across the project area with two thirds of them in Section II but none in Section III. They are particularly distinctive from the much more numerous groups already considered by their lower incomes and by having a strong cereal support to their vegetable production. In the case of a third of these farmers they were pure cereal growers, generally on good quality land. 61 per cent of the farmers reported an income of less than JD 2000 per year. Farmers' ages were varied but generally below average. 44 per cent were less than 40 years old. Most of these relatively young and low income farmers were sharecroppers or tenants and all of their farms, except one, were less than 35 dunums in extent and many were less than 30 dunums. Not surprisingly, levels of loan-taking, of outside income sources and of co-operative membership were below average, while levels of machine ownership and use of advanced techniques were very low. Two thirds of the farmers reported that their educational level had reached no higher than the elementary.

Group 5

The last group which was found well-dispersed across the project area were 29 farms which were mainly fruit tree growers, sometimes with supporting vegetable production, like many other northern farms in other groups. What particularly characterised this group of farmers was their relatively high income level with over a half reporting an income of over JD 5000 per year and many also reporting that they had other non-farm income sources. Three quarters of the farmers were from Palestine and had a long farming experience. Farm size was varied. As owners and share-croppers for the most part they had higher levels of co-operative and association membership and made use of varied markets, particularly those in Amman and Irbid outside of the valley. Their success as farmers can also be seen in their high levels of machine use with 30 per cent owning as many as four implements but levels of use of the listed advanced techniques were not high. This group was also the best educated of all groups with only 14 per cent rated as illiterate and over a half educated at least to secondary level.

11.6 Conclusion

In conclusion it does seem that the classification attempted here has some validity both in distinguishing various types of farms across the project area as well as pinpointing farms that differ from each other within different sections of the project. It has been possible, for example, to elaborate on the simple distinction on a land use basis, made earlier in the study, between the predominance of fruit tree producers in the north and vegetable growers in the south. Within each class there are farms and farmers that seem to fall, on some features, into other groups than the one to which they are allotted but it does seem that differences in farmer background, experience, educational level and other characteristics are as relevant to a classification of the project farms as are other operational features such as size of holding, use of co-operatives, advice, loans and family labour. This grouping has, of course, been derived from the analysis of only a sample of all the farms in the project so that a classification of all of them might create more groups and the need for more criteria, but at least this would suggest that both social and economic characteristics of the farms, and physical conditions in the valley, would be relevant to such a study.

References and Notes

1. The four sections of the East Ghor Canal Project are really composed of blocks 1 to 23 of which Block 3 is inactive. Block 24 was also included in this study for convenience and because it has been in operation like other southern blocks since the completion of the southern part of the main canal.
2. King, L. (1969) Statistical Analysis in Geography, Englewood Cliffs, Prentice Hall , 194.
3. Harvey, D. (1973) Explanation in Geography, London, Arnold , 326.
4. Davis, J.C. (1973) Statistics and Data Analysis in Geology, New York, Wiley , 456.
5. Tarrant, J. (1974) Agricultural Geography, Newton Abbot, David and Charles , 106.
6. Mill, J.S. (1950) The Philosophy of Scientific Method, New York, Hanfer, quoted in Harvey, supra, 326.
7. Sokal, R.R. and Sneath, P.H.A. (1963) Principles of Numerical Taxonomy, San Francisco, Freeman , quoted in Harvey, supra, 331.
8. Davis supra, 460, 467.
9. Mather, P. (1976) Computational Methods of Multivariate Analysis in Physical Geography, London, Wiley , 310-11.
10. The Z-score variable transformation is a universally used method to standarize the scale of the variables of interval level measurement. It generates a new variable to replace the original one with a mean of zero and standard deviation of one. The formula for calculating Z-score is

$$\frac{xi - \bar{x}}{SD}$$

where: xi is the original value of the variable (row score of x)

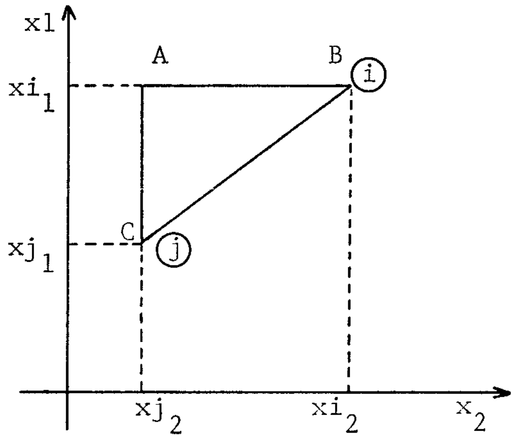
$\bar{x}$ is the mean for all values of x

SD is the standard deviation of x

11. Wishart, D. (1978) CLUSTAN, Cluster Analysis Manual, University of Edinburgh , 32.
12. The Euclidian distance coefficient can be calculated for two individuals i and j, according to the formula:

$$dij = \left(\sum_{k=1}^{p} (xik - xjk)^2\right)^{\frac{1}{2}}/P$$

The distance can be shown geometrically as:



BC is the Euclidian distance, which can be calculated using Pythagoras' theorem. Because variables (axes) x_1 and x_2 are orthogonal, ABC is a right triangle, therefore:

$$BC = (AC^2 + BA^2)^{\frac{1}{2}}$$

But $$AC^2 = (xi_1 - xj_1)^2$$

and $$BA^2 = (xi_2 - xj_2)^2$$

so $$BC = ((xi_2 - xj_2)^2 + (xi_1 - xj_1)^2)^{\frac{1}{2}} = dij$$

The value of dij ranges between 0.0 (perfect similarity) and infinity (complete dissimilarity), (Mather, supra, 313).

13. These methods have been detailed by Mather, supra, 316-21 and Wishart, supra, 32-4.
14. Mather, supra, 320-1.
15. Nie, N.H. et al (1975) SPSS Statistical Package for the Social Sciences, New York, McGraw Hill , 435.
16. Since it is a step-by-step procedure it is clear that a variable which at first appears to discriminate well between the members of the population may become less so as further variables are fed into the analysis. An example of this is seen in the present case where, in Table 11.2 it can be seen that the percentage of a farmers' land under fruit trees appeared at first to be the fourth most discriminating variable. However, as other variables were introduced this variable became less important and was finally rejected as a useful variable for classification purposes.
17. Nie, N.H. et al (1975) SPSS, Statistical Package for the Social Sciences, New York, McGraw Hill, 444.

CHAPTER 12 CONCLUSION

This thesis did not set out to demonstrate a particular principle in geography or to establish a new view of any part of the subject. Rather it aimed, more modestly, to examine recent changes in a rapidly-developing project area in part of the Middle East and to better understand those changes. As such the conclusions reached only represent the point which the writer has reached at this time, after several years of data collection on, and analysis of, the East Ghor Canal Project. Rather than summarize the main points of the study one by one, it might be more useful to consider them under three parts.

12.1 First, at an early point in the study it was shown that the East Ghor Canal Project should be viewed as but one step in a succession of attempts to more fully utilize the water, soil and climatic advantages of the Jordan Valley. Not only had irrigation been developing piecemeal for centuries in the valley before the project was formerly launched in 1958, but numerous modifications and additions have been made to the project since it was drawn up on the basis of the original Baker-Harza proposals. Under later national plans, for example, the main canal has been extended further southwards and more controlled water supplies have been made available by damming some of the side wadis. Further control of the main Yarmouk River source will follow when that river is dammed so making it possible to irrigate a much larger part of the ghor. In fact the area on which this study has been based is now merely Stage I of the present irrigation zone and more rapid changes are now to be seen occuring south of the area examined here.

Within the project area as well, as defined for this study, rapid change has been more characteristic of its short history than stability. These changes have been demonstrated throughout the thesis in several ways, particularly at the local level. Some of the middle chapters of the thesis considered, for example, the quite dramatic changes which have occurred in the cropping patterns in the project area between 1965 and 1979 as certain crops, notably citrus and some vegetables, became more important, while others, such as bananas and cereals, were less commonly grown. The rising importance of vegetable production in the southern blocks, often leading to long crop combinations, contrasted with the short combinations in some of the northern blocks where farms often specialised in a few fruit products. Major differences also emerged over the years between northern and southern districts in seasonal cropping with the more water-rich north emphasising all-year cropping while winter cropping was more characteristic of the arid south. The impact of these changes on land use intensities and farm enterprises was also considered at the farm level in selected blocks.

12.2 Much of the rest of the thesis was focused on farming behaviour in the project area at the level of the individual farmer because of the central role that the author's two farm questionnaire surveys played in the study. Conducted in 1978 and 1980, each on a different sample base, they were insufficiently spaced out to reveal much actual change in farming behaviour, but in several respects the results of the surveys did show that at the individual level farming was undergoing major changes. The increasing use of more advanced techniques, like drip irrigation and plastic culture, and of more farm machines; and the expanding use made of co-operatives and other organizations for farm supplies, advice, credits and farm development loans all point to processes of modernization amongst some farmers in the project area.

Most of the analysis of the questionnaire surveys was concerned, however, with establishing farm and farmer interrelationships, and hence possible explanations for farmer behaviour, particularly in terms of farmer use of the various services being developed in the project area. Here it became clear that certain services were, as yet, less well developed than others and that quite marked variations spatially could be found in farmer behaviour. One might note that most project farmers appeared to have far less choice of marketing outlet compared with sources of farm supplies or credits. Farmers generally appeared to pay too little attention to marketing, while the strong role of the commission agents in the southern areas, acting as marketing, loaning and supply sources, generally appeared detrimental to farm development there. On the other hand, farmers who were members of their local co-operative or the Jordan Valley Farmers Association generally appeared to adopt more progressive farming methods.

These more successful farmers were not found, however, only in the older established, northern parts of the project. One of the more interesting results of both the classification of the sampled farms by their use of services (chapter 10) and by the wider range of variables (chapter 11), is that the various types of small, rather poor, traditional farmer were common in all parts of the project, and the rather fewer progressive ones were also well-dispersed. Whereas an original intention of the study had been to study the diffusion of more progressive farming behaviour southwards across the project area, as the irrigation scheme developed, it soon became clear that this did not, in fact, occur. Indeed, it has been shown that the introduction of some modern techniques, like drip irrigation and plastic culture, occurred in the south where the need for water conservation was greater. In only a few respects did some of the northern farmers appear more advanced than those in the south in spite of the longer time that most of them have been settled on their farms. Changes in farming activity appeared to occur, therefore, in a more complex way, creating more complex spatial patterns. The nine-fold grouping of farms, with which this study ends, may indicate this and might act as the starting point for another study in the future to see how those farms have changed.

12.3 This study might point to several areas for further useful study. Most obviously, levels of efficiency of water utilization, remain low, with much water in winter flowing through the project area unused by farmers. While increased water management will be provided by further dams to reduce this problem, there does appear to be insufficient consideration given to balancing the water needs of farmers, water costs and available supplies. Less obviously the study has pointed to the possible conflict which could arise as a result of the plans by the Project Authority to switch most of the irrigation to sprinkler methods, in place of traditional surface-watering. Many farmers have already independently developed drip irrigation systems on their farms which seem to offer better yields and returns.

Overlap between the services provided by the various government agencies, especially in the farm supply and loaning fields, may weaken these supports given to farmers, whilst, at the same time, farmers suffer from insufficient help with marketing opportunities provided by those organizations. This study has also demonstrated the complex links between farmers' use of these and other services and their other characteristics. Resolution of problems of farming backwardness may well involve the further study of the social, economic, educational and psychological background of the farmers. Lastly one might note that a small part of the survey showed that many more project farmers rely on paid rather than family labour, so that in spite of the general success of the land reform programme, it has neither fully introduced the family working farm unit, as intended, nor eradicated the landless farm worker.

After a spate of studies of the East Ghor Canal Project made some years ago, when it was still a new development, it has since received little critical examination. Yet on the basis of this study it could be argued that important changes are still occurring in the patterns of farming and farmer behaviour in the project and that these deserve our continuing attention.

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Appendix 1

Agricultural Survey of the East Jordan Valley 1978/79*

(All information given in this questionnaire is strictly confidential and for research purposes only).

Basic information

Agricultural Area ....

Village Name ....

Block No. ....

Plot No. ....

Name of landowner ....

Address ....

Name of landholder ....

Address ....

* Part of this questionnaire has been derived from:
Awartani, H. (1968) Progress Appraisal of the East Ghor Rural Development Project, Amman, The Co-operative Institute.

Farm Supplies and Marketing

1. Where do you get your farm supplies?

   (Please arrange them in order of importance if you use more than one source)

   a) the Commission Agent

   b) the Village Merchant

   c) the Co-operative Society

   d) others (name)

2. How do you pay for your farm supplies?

   (Please arrange them in order of importance if more than one method of payment is used)

   a) in cash

   b) by instalments

   c) end-of-season

3. Are the farm supplies always available when required?

   a) yes

   b) no

   c) most of the time

4. Where do you sell your crops?

   (Please arrange them in order of importance if more than one method is used)

   a) on the wholesale market (through a commission agent)

   b) on the farm

   c) through a co-operative

5. If you sell through a commission agent (on the wholesale market), would you sell through:

   a) a specific agent

   b) any agent

6. If you sell through a commission agent, when do you get paid for your crops?

   (Please arrange them in order of importance if more than one method of payment is given)

   a) on the sale day

   b) within a week of the sale

   c) at the end-of-season

   d) others (name)

7. Are you interested in market news and prices?

   a) yes

   b) no

   c) little interest

Co-operatives

General

1. Does your village have a co-operative?
   a) yes
   b) no

2. Are you a co-operative member?
   a) yes
   b) no

Special Questionnaire for the Co-operative Members

1. How long have you been with your co-operative? ...... years.

2. Why did you join the co-operative?
   (Please arrange them in order of importance if more than one reason applicable)
   a) to improve your crop marketing
   b) to obtain cash credits
   c) to get farm supplies
   d) for charity purposes
   e) family or tribal reasons
   f) others (name)

3. Do you find your co-operative is providing the services for which it was established?
   a) yes
   b) no
   c) little

4. Do you know any co-operative official in your area?
   a) yes
   b) no

5. Did you have any credit from your co-operative last year?

   a) yes
   b) no

6. If yes, have you repaid your loan?

   a) yes
   b) no

8. Was the loan you received sufficient?

   a) yes
   b) no

9. The co-operative loan was provided:

   a) in time
   b) after a long delay

10. Did you attend the last general assembly of your co-operative?

    a) yes
    b) no

11. Have you read the by-laws of your co-operative, or have had them read to you?

    a) yes
    b) no

12. What would you suggest to improve the performance of your co-operative?

<u>Special Questionnaire for the Non-Co-operative Members</u>

1. Have you ever joined a co-operative society?

   a) yes
   b) no

2. If yes, why did you leave it?

   a) dispute with the management
   b) corruption in the co-operative
   c) liquidation of the co-operative
   d) disappointment with the co-operative services (below your expectations)
   e) others (name)

3. Do you know whether the co-operative in your village provides its members with services?

   a) yes
   b) no

4. Why have you not joined a co-operative?

5. Do you believe that establishing a co-operative in your village would be useful and necessary?

   a) yes
   b) no

6. Has a co-operative official ever contacted you with regard to joining a co-operative or establishing one?

   a) yes
   b) no

Agricultural Credit

1. Do you borrow cash loans?

   a) yes

   b) no

2. Do you get farm supplies on credit?

   a) yes

   b) no

3. What are the present sources of credit in your area?

4. Are you now indebted with a seasonal loan?

   a) yes

   b) no

5. Where do you get your cash credit from?

   (Please arrange them in importance of order if more than one source is used)

   a) co-operative society

   b) commission agent

   c) relative or friend

   d) village merchant and money lenders

   e) landlord

   f) other (name)

6. Do you face difficulty in obtaining seasonal loans?

   a) yes

   b) no

7. Have you ever had an intermediate or long-term loan?

   a) yes

   b) no

8. Have you ever failed to obtain an intermediate or long-term loan?

   a) yes

   b) no

9. Are you now in need for such a loan?

   a) yes
   b) no

10. Is it difficult to obtain such a loan?

   a) yes
   b) no

11. If you are an Agricultural Credit Corporation (ACC) customer, would you say:

   a) the loan was made without delay? a) yes b) no
   b) payment schedule was made in view of your payment ability a) yes b) no
   c) the loan was adequate for your needs. a) yes b) no
   d) do you recommend ACC loans? a) yes b) no

Agricultural Extension Services

1. Whose advice do you seek when you have a farming problem?
   (If more than one source is selected, please arrange them in order of importance)

   a) neighbouring farmer

   b) agricultural adviser (extension services)

   c) agricultural suppliers and their agents

   d) others (name)

2. Have you ever visited the extension services office in your area?

   a) yes

   b) no

3. If yes, how many times last year? .... visits

4. Have you ever been visited by the agricultural adviser of the extension services,

   a) yes

   b) no

5. If yes, how many times last year? .... visits

6. Would you accept the help given by the extension services office in order to promote your farming skill and ability?

   a) yes

   b) no

7. Have you ever received help or services from the agricultural extension office?

   a) yes

   b) no

8. How useful has the extension services office been in your view in the past three years?

   a) excellent
   b) good
   c) fair
   d) poor

9. Have you ever tried to seek help from the extension services office?

   a) yes
   b) no

10. What would you suggest to improve the function and performance of the extension services in your area?

Questions included in the questionnaire but not used for the study:

1. Where do you get irrigation water from?
   a) East Ghor Main Canal b) wells c) springs and side wadis
   d) Jordan River e) other?

2. Are you: a) owner b) cash tenant c) sharecropper d) other?

3. How many workers do you normally have?
   a) holder and his family ....
   b) paid workers ....

4. How many plots do you hold?

5. Do you apply an agricultural rotation?

6. Do you have any reason for cropping certain crops?

7. How long have you been working in agriculture?

8. How long have you been living in the valley?

9. Where did you come from?

10. Do you have any problem with:
    a) irrigation b) salinity c) marketing d) weather (e.g. frost, strong wind) e) other?

11. Do you have any additional source of income beside your farm?

12. Do you work on Friday (i.e. the weekend)?

13. Do you work full time in the summer?

Diffusion

14. How has your main cropping policy changed since you started farming in the valley?

15. Why did these changes occur?

16. Have you introduced any new field, vegetable and fruit cropping techniques in the last three years?

17. Where did you learn about these?

18. How have you changed your irrigation methods in the last three years?

19. Where did you learn about these new methods?

20. Where do you get your farming information from:

    a) extension services b) radio c) newspaper d) other?

Appendix 2

Agricultural Survey of the East Ghor Canal Project area 1979/80

(All information given in this questionnaire is strictly confidential and will be used for research purposes only)

Basic information

Farm Unit No ( )

Block No. ( )

Total farm area ( ) dunums

Land quality of the farm in dunums:

a) classes 1 & 2 ( )

b) class 3 ( )

c) class 4 ( )

d) class 6 ( )

General information about the farmer

1. How old are you? .... years

2. What is your educational level?

   a) illiterate
   b) elementary
   c) preparatory
   d) secondary
   e) diploma
   f) university graduate

3. How long have you been working in agriculture? .... years

4. How long have you been living in the valley? .... years

5. Where did you come from?

   a) West Bank
   b) when Palestine was occupied in 1948
   c) East Bank
   d) the Jordan Valley itself
   e) other (name)

Economic conditions

1. Do you have any other source of income?

   a) yes

   b) no

2. Form of land tenure. Are you:

   a) owner operator

   b) sharecropper

   c) cash tenant

   d) foreman manager

   e) other (name)

3. Do you get cash loans?

   a) yes

   b) no

4. If yes, what is the source of your loans?

   (Please arrange them in order of importance if more than one source is used)

   a) the Agricultural Credit Corporation (ACC)

   b) the co-operative society

   c) the Jordan Valley Farmers' Association (JVFA)

   d) landlord

   e) village merchant

   f) commission agent

   g) relatives and friends

5. If you do not take cash loans, why?

   a) lack of guarantee because you are not an owner

   b) it is forbidden by the Islamic law

   c) do not like borrowing money

   d) cannot find moneylenders who will offer you a loan

   e) do not know where to get such a loan from

   f) other reason (name)

6. Do you hire labour at your farm?

   a) yes

   b) no

7. Do you get help from your family?

   a) yes

   b) no

8. On which do you rely more?

   a) family work

   b) hired labour

9. Do you own any machines?

   (Please tick them and give the number if you own more than one piece of the same type of machine)

   a) tractor

   b) rotary hoe

   c) sprayer

   d) water pump

   e) lorry

   f) pick-up

   g) tractor-trailor

10. Would you please state the farm expenditures for the previous crop year 1978/79, in J.D.

a) labour wages	....
b) irrigation water	....
c) fertilizers	....
d) pesticides & herbicides	....
e) ploughing	....
f) transport & marketing	....
g) seeds & seedlings	....
h) land rent (if any)	....
i) other expense	....
Total Farm Expenditures	....

11. What was the total gross income of your farm last year?

Farm Supply and Marketing

1. Where do you get your farm supplies?

   (Please arrange them in order of importance if more than one source is used)

   a) the commission agent

   b) the village merchant

   c) the co-operative society

   d) the Jordan Valley Farmers' Association (JVFA)

   e) the supply companies in the urban centres

   f) the landlord

2. How do you pay for your farm supplies?

   a) in cash

   b) end-of-season

   c) mixed

3. Are the farm supplies always available when required?

   a) yes

   b) no

4. Where do you sell your farm produce?

   (If more than one method is used, please arrange them in order of importance)

   a) on the farm (directly to the merchants and exporters)

   b) at the wholesale market (through a commission agent)

   c) through the co-operative society

   d) through the marketing corporation

5. If you sell on the wholesale market, do you sell through:

   a) a specific commission agent

   b) any commission agent

6. If you sell through a specific commission agent, is that because:

   a) the commission agent is owned by your landlord or one of his relatives and/or friends

   b) you trust the specific commission agent

   c) he provides you with farm supplies and cash credits

d) he pays for your produce without delay

e) others

(If more than one reason is selected, please arrange them in order of importance)

7. Which wholesale market do you use?

a) Amman

b) Irbid

c) North Shuneh

d) Wadi Yabis

e) Sawalha

Co-operatives and Agricultural Extension Services

1. Are you a co-operative member?

a) yes

b) no

2. If yes, how long have you been a member? .... years

3. Are you a member of the Jordan Valley Farmers' Association?

a) yes

b) no

4. If yes, how long have you been a member? .... years

5. Do you seek help or advice from the Agriculture Extension Services?

a) yes

b) no

6. How many times did you visit the Extension Services office in your area last year? .... visits

7. How many visits did you have from the Extension Services agent (agricultural adviser) last year? .... visits

8. Are you satisfied with the Extension Services performance?

a) yes

b) no

9. If not, why?

Special Questionnaire to the Drip Irrigation Farmers

1. How long have you been using drip irrigation? .... years

2. Why have you adopted the drip irrigation?

   (Please arrange them in order of importance if more than one reason is selected)

   a) it saves labour

   b) it saves water

   c) it is more suitable for plastic culture

   d) it is more profitable

   e) to decrease salinity

   f) others (name)

3. Where did you learn this innovation?

   (Please arrange them in order of importance if more than one source is selected)

   a) other farmers

   b) agricultural advisers (Extension Services)

   c) agricultural research station

   d) others (name)

4. Would you accept switching to the sprinkler method of irrigation, if the Project Authority asked you to do so?

   a) yes

   b) no

5. What type of problems has the drip irrigation created for you?

Special Questionnaire to the Plastic Culture Farmers

1. How long have you been practising plastic culture? ..... years

2. Why have you adopted the plastic culture?

   (Please arrange them in order of importance if more than one reason is selected)

   a) more profitable (the produce comes in abnormal season)
   b) more profitable (it gives higher productivity per unit of land)
   c) it has become fashionable
   d) others (name)

3. Where did you learn the use of plastic culture?

   (Please arrange them in order of importance if more than one source is selected)

   a) other farmers
   b) agricultural advisers (Extension Services)
   c) agricultural research station
   d) others (name)

4. If the answer is a or c, where are they?

5. Are you intending to:

   a) maintain the same level of plastic culture on your farm?
   b) to reduce it
   c) to expand it

Appendix 3

Computer Programme for Analysis of Land Use Data

The programme given here was written by the author in BASIC language and stored on the Southampton University PDP/11 computer. It was written to calculate the crop area variances in each block of the project upon which the crop combinations are defined. It does this by calculating the percentage area of each block under each crop and arranges these in descending order. It then calculates their variance from the theoretical areal percentage for any length of crop combinations up to the number of crops listed. The lowest variance defines the correct combination. The programme also calculates the total cropped area in a block which was used in the land use intensity measurements. The programme analyses up to 15 years of data for each block and while it was, in this case, run for 1965-79, the starting date can be altered as required at line 39. After calling up the programme, each run requires the following information:

1) block number
2) month number
3) total area of block
4) total number of years of analysis required

Stating the number of crops to be analysed, data for each is fed in for the year, as requested on the display, in any order up to a maximum of 39 crops. If typing in errors are made at this stage the whole year's data set can be removed and replaced before moving on to the next year. Results are displayed or printed out.

```
2 OPEN "PVCROP" FOR OUTPUT AS FILE1
5 &"PROGRAM TO FIND PERCENTAGES & ARRANGE THEM & FIND VARIANCES"
6 DIM A(80),C(80),H(80),X(80),B1(80),C1(80),Y(80)
8 &
9 &"NOTICE: THE NO. OF CROPS MUST BE LESS THAN 40 CROPS "
10 &
11 &"IMPORTANT NOTE: PRESS THE RETURN KEY AFTER EVERY DATA !!!"
12 &
13 &"BLOCK NO. ";:INPUT B2
14 &"MONTH NO ";:INPUT M2
15 &"TOTAL BLOCK AREA IN DUNUMS";:INPUT B3:&:&
16 &"NUMBER OF YEARS TO ANALYSE";:INPUT E1:&:&
17 &#1"  CROP COMBINATIONS ANALYSIS IN THE EAST GHOR CANAL PROJECT"
19 &#1"  $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$"
23 &#1
25 &#1"              BLOCK NO.  ";B2;"        MONTH NO.  ";M2
27 &#1"             ==========================================="
32 &#1
33 &#1"NUMBER","PERCENTAGES","% ARRANGED","              VARIANCES"
35 &#1"######","###########","##########","              #########"
36 &#1
37 FOR Z=1 TO E1
39 &:Z1=1964+Z
40 &"Y E A R  ";Z1
41 &"=============="
43 &"TYPE IN NUMBER OF CROPS ";:INPUT L
44 &:IF L>40 THEN &"ERROR! NUMBER OF CROPS MUST BE LESS THAN 40":GOTO 39
45 &"TYPE IN DATA & PRESS RETURN KEY AFTER EVERY DATA."
47 &
51 B=0
53 FOR I=1 TO L
55 INPUT A(I)
60 B=B+A(I)
63 NEXT I
65 &"IS THE DATA CORRECT ?  IF YES TYPE Y, IF NO TYPE N "
68 &"TYPE : Y  OR  N ";:INPUT Z$
72 IF Z$="N" GOTO 39
75 IF Z$<>"Y" GOTO 68
77  REM***********************************************************
79  REM CALCULATION OF PERCENTAGES
80 FOR K=1 TO L
90 C(K)=(A(K)/B)*100
95 X(K)=C(K)
110 NEXT K
160 REM**********************************************************
170 REM ARRANGING THE PERCENTAGES
175  FOR D=1 TO L
180 H(D)= X(D)
190 M=0
200 FOR E=1 TO L
210 IF X(E)<H(D) GOTO 250
230 H(D)=X(E)
240 M=E
250 NEXT E
260 IF M=0 THEN X(D)=0
265 IF M>0 THEN X(M)=0
270 NEXT D
300 REM**********************************************************
301 REM CALCULATION OF VARIANCES
320 FOR Q=1 TO L
330 X1=0
340 FOR S=1 TO Q
350 B1(S)=H(S)-100/Q
360 C1(S)=B1(S)^2
370 X1=X1+C1(S)
380 NEXT S
390 T=Q+1
400 FOR R=T TO L
405 B1(R)=H(R)-0
410 C1(R)=B1(R)^2
420 X1=X1+C1(R)
430 NEXT R
440 Y(Q)=X1/L
450 NEXT Q
475 REM**********************************************************
480 REM PRINTING THE RESULTS
485 &#1"Y E A R  ";Z1
490 &#1"=============="
492 &
494 &
500 FOR U=1 TO L
510 &#1 A(U),C(U),H(U),"FOR";U;"DOMINANT CROPS=";Y(U)
515 NEXT U
516 &#1
517 &#1
520 B4=B*100/B3
527 &#1"TOTAL CROPPED AREA=";B,"      % OF LAND UNDER CROPS=";B4
530 &#1
540 &#1"*****************************************************************
"
1000 NEXT Z
2000 END
```

Appendix 4

The complete results of the Crop Combination Analysis by Block and Season in the East Ghor Canal Project Area, 1965-1979.

BLOCK 1: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Banana Citrus	Citrus Banana	Banana Citrus	Banana Citrus	Banana Citrus	Banana Citrus	Citrus Banana	Citrus Banana	Citrus Banana	Citrus Banana	Citrus Banana Cauliflower	Citrus Banana	Citrus	Citrus	Citrus
APRIL	Banana Citrus	Banana Citrus	Citrus Banana	Banana Citrus	Banana Citrus	Banana Citrus	Citrus Banana	Citrus Banana	Citrus Banana	Citrus Banana	Citrus Banana	Citrus Banana	Citrus	Citrus	Citrus
JULY	Banana Citrus	Banana Citrus	Banana Citrus Eggplant	Banana Citrus	Banana Citrus	Banana Citrus	Citrus Banana	Citrus Banana	Citrus Banana	Citrus	Citrus	Citrus	Citrus	Citrus	Citrus
OCTOBER	Banana Citrus Eggplant	Citrus Banana	Banana Citrus	Banana Citrus	Banana Citrus	Banana Citrus	Citrus Banana	Citrus Banana	Citrus Banana	Citrus Banana Cauliflower	Citrus Banana	Citrus	Citrus	Citrus	Citrus

BLOCK 2: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Banana Cereals	Banana	Banana Cereals	Banana	Banana Cabbage Cauliflower	Banana	Banana	Eggplant Banana	Banana Eggplant Cabbage	Banana Citrus Cabbage Eggplant Cauliflower	Citrus Banana Potato Eggplant	Citrus Eggplant Banana Potato	Citrus Cereals	Citrus	Citrus
APRIL	Banana	Banana Cereals	Banana Cereals	Banana	Banana	Banana	Banana	Banana Eggplant J. Mallow Tomato	Banana Eggplant Melon	Banana Cereals Citrus Eggplant	Citrus Banana Melon Potato Eggplant	Citrus Eggplant Potato	Citrus Cereals Potato	Citrus Melon	Citrus Lettuce
JULY	Banana	Banana	Banana	Banana	Banana	Banana	Banana	Banana	Banana	Banana Citrus	Citrus Banana	Citrus	Citrus	Citrus	Citrus
OCTOBER	Banana Eggplant	Banana	Banana Eggplant	Banana	Banana	Banana	Eggplant Banana	Banana Eggplant Cabbage	Banana Cabbage Eggplant Cauliflower Citrus	Banana Citrus Cauliflower	Citrus Eggplant Banana	Citrus	Citrus	Citrus	Citrus Eggplant

BLOCK 4: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972
JANUARY	Cereals Banana Citrus Eggplant Tomato	Cereals Citrus Tomato Eggplant Cabbage Cauliflower	Cereals Eggplant Citrus Cauliflower Banana	Eggplant Citrus Cereals Cauliflower Cabbage Banana	Eggplant Citrus Cauliflower Cabbage Cereals	Eggplant Citrus Cereals	Eggplant Citrus Cereals Cauliflower	Cereals Citrus Eggplant
APRIL	Cereals Citrus Banana Melon Eggplant J. Mallow	Cereals Citrus Eggplant Banana	Cereals Citrus Eggplant J. Mallow Banana	Eggplant Cereals Citrus Banana	Eggplant J. Mallow Citrus Cereals	Eggplant Citrus	Citrus Cereals J. Mallow	Cereals Citrus Eggplant J. Mallow
JULY	Citrus Banana J. Mallow Eggplant	Citrus Melon J. Mallow Banana	Citrus Eggplant Banana	Citrus J. Mallow Eggplant	Citrus J. Mallow	Eggplant Citrus J. Mallow	Eggplant Citrus J. Mallow	Citrus Eggplant J. Mallow
OCTOBER	Eggplant Citrus Cabbage Banana Cauliflower	Eggplant Citrus Banana Cabbage Cauliflower	Eggplant Cabbage Cauliflower Citrus Banana	Eggplant Citrus Cabbage Cauliflower	Eggplant Citrus	Eggplant Citrus Cauliflower	Citrus Eggplant Cabbage Cauliflower	Eggplant Citrus Cauliflower Cabbage

	1973	1974	1975	1976	1977	1978	1979
JANUARY	Citrus Eggplant Cauliflower Cabbage	Cereals Eggplant Citrus Cabbage Cauliflower	Cereals Citrus Cauliflower Eggplant	Citrus Cereals Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant Cabbage
APRIL	Cereals Melon Citrus J. Mallow	Cereals Eggplant Citrus	Cereals Citrus Eggplant	Cereals Citrus J. Mallow	Citrus Eggplant Cereals	Citrus Eggplant J. Mallow	Citrus Eggplant J. Mallow Cereals
JULY	Corn Citrus Eggplant J. Mallow	Citrus J. Mallow Eggplant	Citrus Eggplant	Citrus J. Mallow	Citrus Cabbage	Citrus Eggplant J. Mallow	Citrus J. Mallow
OCTOBER	Eggplant Citrus Cabbage Cauliflower	Citrus Cabbage Cauliflower Eggplant	Citrus Eggplant Cauliflower Cabbage	Citrus Cabbage	Cabbage Citrus Eggplant	Citrus Cabbage Eggplant	Citrus Eggplant Cabbage

BLOCK 5: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Banana Cereals Citrus Eggplant Tomato	Banana Cereals Citrus Eggplant	Banana Citrus Eggplant Cereals	Banana Citrus Eggplant	Banana Eggplant Citrus Cabbage	Banana Citrus Eggplant	Banana Eggplant Citrus	Banana Citrus Eggplant Cabbage Cereals	Banana Eggplant Citrus Cereals Cabbage	Banana Eggplant Citrus Cereals Cabbage	Citrus Banana Eggplant Cabbage	Citrus Eggplant Banana	Citrus Eggplant Banana	Citrus Eggplant Banana	Citrus Eggplant Banana Cabbage
APRIL	Banana Cereals Citrus Eggplant	Banana Cereals Eggplant Citrus	Banana Cereals Citrus Eggplant J. Mallow	Banana Cereals Citrus Eggplant	Banana Eggplant Citrus	Banana Citrus Eggplant	Banana Cereals Citrus J. Mallow	Cereals Banana Eggplant Citrus	Banana Cereals Citrus Eggplant J. Mallow	Banana Cereals Eggplant Citrus	Citrus Cereals Eggplant Banana	Cereals Citrus Eggplant Banana	Citrus Banana Cereals	Citrus Eggplant Banana	Citrus Eggplant J. Mallow
JULY	Banana Citrus	Banana Citrus	Banana Citrus	Banana Citrus	Banana Citrus	Banana Citrus Eggplant	Banana Eggplant Citrus	Banana Citrus Eggplant	Banana Citrus Eggplant J. Mallow	Citrus Banana	Citrus Banana	Citrus Banana	Citrus Banana Cabbage	Citrus Banana	Citrus Banana
OCTOBER	Banana Cabbage Citrus	Banana Eggplant Citrus Cabbage	Banana Citrus Cabbage Eggplant	Banana Citrus Eggplant Cabbage	Banana Citrus Eggplant	Banana Citrus Eggplant	Banana Citrus Cabbage Eggplant	Banana Eggplant Citrus Cabbage	Banana Eggplant Citrus Cabbage	Citrus Banana Cabbage Eggplant	Citrus Eggplant Banana Cabbage	Citrus Banana	Citrus Eggplant Banana	Citrus Banana Eggplant Cabbage	Citrus Eggplant Cabbage Banana

BLOCK 6: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Banana Citrus Cabbage Eggplant	Cereals Citrus Banana Eggplant Cabbage	Cereals Citrus Banana	Citrus Cereals Banana Eggplant Cabbage	Citrus Eggplant Banana	Citrus Cereals Banana Eggplant	Citrus Eggplant Banana Cabbage	Citrus Eggplant Cereals Banana	Cereals Citrus Banana	Citrus Cereals Eggplant Banana	Citrus Cereals Eggplant	Citrus Eggplant Cereals	Citrus Cereals Eggplant	Citrus Eggplant Cabbage	Citrus Eggplant
APRIL	Cereals Banana Citrus	Cereals Citrus Banana Eggplant	Cereals Citrus J. Mallow Banana Eggplant	Citrus Cereals Banana Eggplant J. Mallow	Citrus Eggplant Banana J. Mallow	Citrus Banana Cereals Eggplant	Citrus Eggplant Cereals Banana Corn J. Mallow	Cereals Citrus Eggplant Banana	Cereals Citrus Banana	Citrus Cereals Eggplant Banana J. Mallow	J. Mallow Citrus Eggplant Cereals	Citrus Cereals Eggplant J. Mallow	Citrus Cereals J. Mallow Eggplant	Citrus Eggplant J. Mallow	Citrus Eggplant Cereals
JULY	Banana Citrus Eggplant	Citrus Banana Corn J. Mallow	Citrus Banana J. Mallow Eggplant	Citrus Banana Eggplant J. Mallow	Citrus Banana J. Mallow	Citrus Banana Eggplant	Citrus Banana J. Mallow	Citrus Eggplant Banana	Citrus Banana J. Mallow Corn	Citrus Eggplant J. Mallow	Citrus J. Mallow	Citrus Eggplant	Citrus	Citrus Eggplant J. Mallow	Citrus Eggplant
OCTOBER	Banana Citrus Cabbage Eggplant	Citrus Banana Eggplant	Citrus Banana Cabbage Eggplant	Citrus Banana Eggplant Cabbage	Citrus Banana Eggplant	Citrus Banana Eggplant Cabbage	Citrus Eggplant Banana Cabbage	Citrus Eggplant Banana	Citrus Eggplant Banana	Citrus Eggplant Cabbage	Citrus Eggplant	Citrus Cabbage	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant Cabbage

BLOCK 7: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Banana Citrus	Cereals Banana Citrus	Cereals Banana Citrus	Cereals Banana	Banana Citrus	Citrus Banana Eggplant	Banana Citrus Eggplant	Citrus Eggplant Banana	Cereals Citrus Banana	Citrus Cereals Eggplant Banana	Citrus Cereals Eggplant	Citrus Cereals Eggplant Spinach Banana Lettuce Potato	Citrus Cereals Eggplant	Citrus Eggplant	Citrus Eggplant Potato
APRIL	Cereals Banana Citrus	Cereals Banana Citrus	Cereals Banana Citrus	Cereals Banana Citrus	Banana Citrus	Banana Citrus Eggplant	Citrus Banana Eggplant Cereals J. Mallow Corn	Cereals Citrus Banana J. Mallow	Cereals Citrus Banana J. Mallow	Citrus Cereals J. Mallow Banana Eggplant	Citrus Cereals	Citrus Cereals J. Mallow	Citrus Cereals Eggplant	Citrus Eggplant J. Mallow	Citrus Eggplant
JULY	Banana Citrus	Banana Corn Citrus	Banana Citrus Corn	Banana Citrus	Banana Citrus	Citrus Banana	Citrus Banana Eggplant J. Mallow	Citrus Banana	Citrus Corn Banana J. Mallow	Citrus J. Mallow Banana	Citrus J. Mallow	Citrus	Citrus	Citrus J. Mallow	Citrus Eggplant
OCTOBER	Banana Citrus Cauliflower	Banana Citrus	Banana Citrus	Banana Citrus	Banana Citrus	Citrus Banana Eggplant	Citrus Banana Eggplant	Citrus Banana Eggplant	Citrus Eggplant Banana	Citrus Eggplant Banana	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant

BLOCK 8: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Banana	Cereals Banana Citrus	Cereals Banana	Cereals Banana	Banana Cereals B. Beans Citrus	Banana Cereals B. Beans Citrus	Banana Cereals B. Beans Citrus Eggplant	Cereals Banana Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus Eggplant B. Beans	Cereals Citrus Eggplant B. Beans	Cereals Citrus Eggplant B. Beans Potato	Citrus Cereals Eggplant B. Beans Potato	Citrus Eggplant Potato Tomato Marrow
APRIL	Cereals	Cereals	Cereals Banana	Cereals Banana	Banana Cereals Corn Citrus J. Mallow	Cereals Banana Citrus Corn	Cereals Citrus Banana Corn J. Mallow Eggplant	Cereals Citrus Corn	Cereals Citrus	Cereals Citrus	Cereals Citrus Corn	Cereals Citrus J. Mallow	Cereals Citrus Eggplant Potato	Citrus J. Mallow Cereals Tomato Eggplant	Citrus Eggplant J. Mallow Tomato
JULY	Corn Banana Citrus	Corn Banana	Banana Citrus Corn	Banana Citrus	Banana Citrus Corn J. Mallow	Banana Citrus J. Mallow	Banana Citrus J. Mallow Eggplant Corn	Citrus Banana Corn	Corn Citrus	Citrus Eggplant J. Mallow Corn	Citrus Corn J. Mallow	Citrus Corn Eggplant J. Mallow	Citrus J. Mallow Corn Eggplant	Citrus J. Mallow Corn	Citrus J. Mallow
OCTOBER	Banana Corn B. Beans Citrus	Banana Citrus B. Beans	Banana Citrus B. Beans	Banana Citrus B. Beans	Banana Citrus B. Beans	Banana Citrus B. Beans Eggplant	Banana Citrus Eggplant	Citrus Banana Eggplant	Eggplant Citrus Corn B. Beans Cabbage Banana	Citrus Eggplant B. Beans Corn	Citrus Eggplant	Citrus Corn Eggplant	Citrus Eggplant B. Beans	Citrus Eggplant	Citrus Eggplant Marrow B. Beans

BLOCK 9: CROP COMBINATIONS, 1965-1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals	Cereals	Cereals	Cereals	Cereals B. Beans* Citrus Banana	Cereals Citrus Banana	Cereals Citrus Banana	Cereals	Cereals	Cereals	Cereals Eggplant Citrus	Cereals Citrus Eggplant Tomato B. Beans*	Cereals Banana Eggplant B. Beans* Tomato Cabbage	Citrus Cabbage Cereals Tomato Eggplant Cauliflower Marrow	Eggplant Citrus Tomato Marrow Cereals Spinach
APRIL	Cereals	Cereals	Cereals	Cereals	Cereals	Cereals	Cereals Citrus	Cereals	Cereals	Cereals Eggplant Citrus	Cereals Corn Citrus J. Mallow Eggplant	Cereals Citrus J. Mallow Tomato	Cereals Citrus J. Mallow Eggplant Tomato	Cereals Citrus Marrow J. Mallow Tomato Eggplant	Citrus Eggplant Pepper Tomato
JULY	++	Corn	Corn Citrus J. Mallow Banana Eggplant Tomato	Banana Citrus J. Mallow Eggplant	Corn Citrus J. Mallow Banana	Citrus Banana J. Mallow	Citrus Banana J. Mallow Eggplant Corn	Corn J. Mallow Citrus Sesame	Corn Eggplant Citrus J. Mallow	Eggplant Citrus J. Mallow Corn	Citrus Corn J. Mallow Eggplant	Corn Citrus J. Mallow Eggplant	J. Mallow Citrus Eggplant Corn Tomato	Corn Citrus J. Mallow Eggplant	Citrus J. Mallow Cabbage Eggplant
OCTOBER	Corn Citrus B. Beans	Citrus B. Beans Banana Eggplant Cauliflower	Corn Banana Citrus Eggplant Tomato	B. Beans Cereals Citrus Banana Eggplant	Citrus Banana	Citrus Banana	Eggplant Citrus Banana	Citrus Eggplant Corn Banana Cabbage	Eggplant Citrus Corn Cabbage	Eggplant Cabbage Citrus B. Beans	Citrus Eggplant B. Beans	Eggplant Citrus Cabbage Corn	Eggplant Citrus Cabbage Pepper	Eggplant Citrus Cabbage Marrow	Citrus Eggplant Marrow

* B. Beans and Beans are recorded as one.

++ No data available.

BLOCK 10: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus Cauliflower	Cereals Citrus Banana	Citrus Cereals	Cereals Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Citrus Cereals	Citrus Cereals	Citrus Cereals	Citrus Eggplant
APRIL	Cereals Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Citrus Cereals	Citrus Cereals	Citrus Tomato Cereals Marrow J. Mallow Eggplant	Citrus Tomato
JULY	Citrus Corn Eggplant Banana	Corn Citrus	Citrus Eggplant	Citrus	Citrus Corn J. Mallow	Citrus	Citrus Eggplant J. Mallow Tomato	Citrus Corn Eggplant	Citrus Corn Eggplant	Citrus Eggplant	Citrus	Citrus Eggplant	Citrus	Citrus	Citrus
OCTOBER	Citrus Cauliflower Corn Eggplant Banana	Citrus Eggplant Cauliflower Banana Pepper	Citrus Cauliflower Eggplant Banana	Citrus Cauliflower	Citrus	Citrus	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus	Citrus Eggplant	Citrus	Citrus Eggplant	Citrus

BLOCK 11: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals	Cereals Cauliflower	Cauliflower Cereals Citrus Banana B. Beans	Cereals Cauliflower	Cereals Citrus Banana	Eggplant Citrus Banana Pepper Cauliflower	Cereals	Cereals	Cereals	Cereals Citrus	Cereals Citrus Cauliflower B. Beans	Cereals Citrus B. Beans Marrow	Cereals Citrus B. Beans	Citrus Cereals B. Beans Marrow Tomato	Citrus B. Beans Marrow Cereals Cauliflour
APRIL	Cereals	Cereals	Cereals	Cereals	Cereals Citrus Banana	Corn Banana Citrus Marrow	Cereals	Cereals	Cereals	Cereals Citrus Tomato	Cereals Citrus Tomato Melon Marrow Eggplant	Citrus Tomato Eggplant Cereals Marrow	Cereals Tomato Citrus Eggplant	++	Tomato Citrus Cereals
JULY	Corn Citrus Eggplant Sesame Banana Pepper	Corn Citrus	Corn Eggplant Citrus Banana Pepper	Citrus Banana Corn Eggplant	Banana Citrus Eggplant	Corn Banana Citrus Marrow	Eggplant Citrus Corn Banana	Corn Citrus Eggplant Pepper	Corn Citrus Eggplant	Citrus Eggplant Tomato	Citrus Tomato Eggplant Corn	Citrus Tomato Eggplant	Citrus Eggplant Pepper	Citrus Eggplant	Citrus Eggplant
OCTOBER	Cauliflower Corn Eggplant Citrus B. Beans Marrow Pepper	Tomato B. Beans Cereals Marrow Citrus	Cauliflower Eggplant Citrus Banana B. Beans Pepper	Citrus Banana Cauliflower Eggplant Cabbage B. Beans	Eggplant Citrus Banana Pepper Cauliflower	Citrus Eggplant Banana Pepper	Eggplant Corn Citrus B. Beans Cauliflower Pepper Banana Marrow	Citrus Corn Eggplant Pepper Banana Okra	Citrus Eggplant Cabbage B. Beans Corn	Citrus Cauliflower B. Beans Eggplant	Citrus B. Beans Marrow Cauliflower	Citrus Eggplant B. Beans	Citrus Eggplant B. Beans Cauliflower	Citrus B. Beans Marrow	Citrus Marrow B. Beans Eggplant

++ No data available.

BLOCK 12: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Citrus Cereals	Citrus	Cereals Citrus	Cereals Citrus	Citrus Cereals	Citrus Cereals	Citrus Cereals Cauliflower	Citrus Cereals B. Beans	Citrus Cereals	Citrus B. Beans	Citrus B. Beans
APRIL	Cereals Citrus	Cereals Citrus	Cereals Citrus	Citrus Cereals	Citrus Cereals	Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus	Citrus Cereals Eggplant Tomato	Cereals Citrus Tomato	Citrus Cereals	Citrus Cereals Tomato	++	Citrus Tomato
JULY	Citrus Corn	Citrus Corn	Citrus Eggplant	Citrus	Citrus	Citrus	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus	Citrus	Citrus
OCTOBER	Citrus Eggplant	Cereals Citrus	Citrus Cauliflower Eggplant	Citrus	Citrus	Citrus	Citrus Eggplant	Citrus Eggplant Cauliflower	Citrus Cauliflower B. Beans Cabbage Eggplant	Citrus Cauliflower Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus B. Beans	Citrus B. Beans	Citrus Marrow

++ No data available.

BLOCK 13: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cauliflower Citrus	Cereals Citrus	Cereals Citrus	Cereals Citrus Cabbage Cauliflower	Cereals Citrus Potato Eggplant Cabbage	Eggplant Citrus Cauliflower Potato Marrow Cabbage	Cereals Citrus Tomato	Cereals	Cereals	Cereals Citrus Cabbage	Cereals Potato Citrus	Cereals Citrus Potato Tomato	Cereals Citrus Marrow Potato B. Beans	Citrus Cereals Potato Marrow	Citrus Tomato Cereals Marrow B. Beans
APRIL	Cereals	Cereals Citrus Potato	Cereals	Cereals Citrus	Cereals Citrus Marrow Eggplant	Citrus Corn Cereals Marrow	Cereals Citrus Marrow Tomato Potato	Cereals Citrus Marrow	Cereals Marrow Citrus Eggplant	Cereals Citrus Eggplant Tomato Potato	Cereals Citrus Tomato Marrow	Cereals Citrus Marrow Tomato Potato	Cereals Citrus Tomato Marrow	++	Tomato Citrus Cereals Marrow Eggplant
JULY	Corn Eggplant Citrus	Corn Eggplant Citrus	Eggplant Citrus	Citrus Corn Eggplant	Citrus	Citrus Corn	Eggplant Citrus Cowpea	Eggplant Citrus Corn	Eggplant Citrus Corn	Eggplant Citrus	Eggplant Citrus	Eggplant Citrus Tomato	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant
OCTOBER	Citrus Eggplant Cabbage Beans Tomato Corn Potato	Cereals	Cauliflower Eggplant Citrus Marrow	Citrus Eggplant Potato Cauliflower Cabbage	Eggplant Citrus Cauliflower	Citrus Eggplant Cabbage	Eggplant Citrus Cabbage	Eggplant Citrus	Eggplant Citrus Cauliflower	Eggplant Citrus Cabbage Potato	Citrus Eggplant Potato Marrow B. Beans	Citrus Eggplant Potato Cabbage	Citrus Eggplant Cabbage Potato	Citrus Eggplant B. Beans Cabbage Marrow	Citrus B. Beans Eggplant Marrow

++ No data available.

BLOCK 14: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Citrus	Cereals	Cereals Citrus	Cereals Citrus Tomato	Citrus Cereals Eggplant Potato Tomato	Citrus Eggplant	Cereals Citrus Tomato	Cereals Citrus Tomato	Cereals Citrus	Cereals Citrus Tomato Potato	Citrus Cereals Potato	Citrus Cereals Potato	Citrus Cereals B. Beans	Citrus Tomato Potato Marrow	Citrus Tomato B. Beans Marrow Cereals
APRIL	Cereals Citrus	Cereals Citrus Potato	Cereals Citrus	Cereals Citrus Eggplant Tomato	Citrus Cereals	Citrus Eggplant	Cereals Citrus Tomato	Cereals Citrus Tomato	Cereals Citrus Tomato	Cereals Tomato Citrus	Citrus Cereals Tomato	Citrus Tomato Cereals Marrow	Citrus Cereals Tomato Marrow	++	Citrus Tomato
JULY	Citrus Corn Eggplant	Citrus Corn Eggplant	Eggplant Citrus Corn	Citrus Eggplant	Citrus	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant	Citrus	Citrus Eggplant
OCTOBER	Citrus Corn Cabbage Cauliflower Eggplant Banana Tomato	Citrus Tomato Potato	Citrus Tomato Eggplant	Citrus Eggplant Tomato Potato	Citrus Eggplant	Citrus Eggplant	Citrus Eggplant Potato B. Beans*	Citrus Eggplant Potato Cowpea	Citrus Eggplant Potato	Citrus Eggplant B. Beans Potato	Citrus Eggplant B. Beans	Citrus Eggplant B. Beans	Citrus Potato Eggplant	Citrus B. Beans Eggplant Marrow	Citrus Marrow B. Beans Eggplant

* B. Beans and Beans are recorded as one.

++ No data available.

BLOCK 15: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals	Cereals Citrus	Cereals Citrus Banana Tomato	Cereals Tomato Banana Citrus	Banana Citrus Tomato	Citrus Banana	Tomato Citrus	Tomato B. Beans Cereals Citrus	Tomato Cereals Banana B. Beans	Tomato Beans Cereals Banana Citrus Marrow	B. Beans Cereals Citrus Tomato	Tomato B. Beans Citrus Marrow	Citrus Tomato Marrow B. Beans	Marrow Citrus B. Beans* Tomato	Citrus B. Beans Marrow Tomato
APRIL	Cereals	Cereals Citrus Tomato Marrow	Cereals Citrus Banana Tomato	Citrus Tomato Banana Cereals	Banana Citrus Tomato Eggplant Marrow Cereals	Citrus Banana	Tomato Citrus Melon	Tomato Cereals Citrus	Tomato Cereals Marrow Banana	Tomato Marrow Eggplant Cereals Citrus	Tomato Cereals Citrus Marrow	Tomato Marrow Citrus	Tomato Citrus Marrow Cereals	++	Tomato Citrus
JULY	Citrus Banana	Banana Citrus	Banana Citrus	Citrus Banana	Banana Citrus	Citrus Banana	Citrus Banana	Banana Citrus	Banana Citrus Eggplant	Citrus Eggplant	Citrus	Tomato Citrus Eggplant	Citrus	Citrus	Citrus
OCTOBER	Citrus Eggplant Banana Corn	Cereals Banana	Banana Citrus Tomato B. Beans Eggplant Marrow	Banana Citrus	Citrus Banana	Citrus	B. Beans Eggplant Citrus	Banana B. Beans	B. Beans Banana Citrus Cucumber Marrow Eggplant	Beans Citrus	B. Beans Citrus	B. Beans Citrus	Citrus B. Beans	Citrus B. Beans	Citrus B. Beans Marrow

* B. Beans and Beans are recorded as one.

++ No data available.

BLOCK 16: CROP COMBINATIONS, 1965-1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals	Cereals Tomato	Tomato Cereals	Cereals Tomato Citrus	Tomato Cereals Citrus B. Beans	Tomato Citrus	Tomato B. Beans Cereals Citrus	Tomato B. Beans* Citrus	Tomato Cereals B. Beans Citrus Marrow	B. Beans* Cereals Citrus Marrow	Tomato Cereals B. Beans Citrus Marrow	B. Beans Marrow Citrus Cereals Tomato	Citrus Potato Banana	B. Beans Tomato Citrus Marrow	Tomato B. Beans Marrow Citrus
APRIL	Cereals	Tomato Cereals	Tomato Cereals	Tomato Cereals Citrus	Tomato Citrus Cereals	Tomato Citrus	Tomato Citrus Cereals	Tomato Cereals Citrus Marrow	Tomato Cereals Marrow	Tomato Cereals Citrus Marrow	Tomato Cereals Marrow Citrus	Tomato Marrow Citrus	Tomato Marrow Citrus	++	Tomato Citrus
JULY	Citrus Tomato Cucumber Corn Eggplant Melon Banana	Citrus Cucumber Banana Eggplant Corn	Citrus Banana	Citrus Banana	Citrus	Citrus Tomato	Citrus Cucumber	Citrus Tomato	Citrus Eggplant	Citrus Eggplant	Eggplant Citrus Banana	Citrus Eggplant Tomato	Citrus	Citrus Eggplant	Citrus Eggplant
OCTOBER	Eggplant Banana Citrus Corn	Cereals Tomato Citrus Banana	B. Beans Citrus Eggplant Banana Marrow	Marrow Citrus Banana	Citrus	B. Beans Citrus	B. Beans Citrus	B. Beans Citrus Corn	B. Beans Citrus	B. Beans Citrus Beans	B. Beans Citrus Eggplant	B. Beans Citrus	B. Beans Citrus	B. Beans Citrus	B. Beans Citrus Eggplant

* B. Beans and Beans are recorded as one.

++ No data available.

BLOCK 17: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals	Tomato Cereals	Tomato Cereals	Tomato Cereals B. Beans	Tomato Cereals B. Beans	Tomato	Tomato B. Beans	Tomato B. Beans	Tomato B. Beans Cereals Marrow	Tomato Beans	B. Beans Tomato Marrow	Tomato B. Beans Marrow	B. Beans Tomato	Tomato B. Beans*	Tomato B. Beans Marrow
APRIL	Cereals	Tomato Cereals	Tomato Cereals	Tomato Cereals	Tomato Cereals Marrow	Tomato	Tomato	Tomato Cereals	Tomato Cereals Marrow	Tomato Marrow	Tomato	Tomato	Tomato Marrow	++	Tomato
JULY	Cucumber Tomato Eggplant Melon Citrus Corn	Cucumber Eggplant Citrus	Cucumber Citrus	Citrus	Citrus	Citrus	Cucumber Citrus	Tomato	Citrus Eggplant Tomato	Citrus Eggplant	Citrus	Citrus Eggplant Corn	Eggplant Citrus	Citrus	Citrus Eggplant Pepper
OCTOBER	Eggplant Potato Tomato Marrow Citrus	Cereals	B. Beans Tomato	Cucumber Marrow Citrus	Citrus Tomato	B. Beans	B. Beans	B. Beans Cucumber Citrus	B. Beans	B. Beans	B. Beans	B. Beans	B. Beans	B. Beans Citrus Marrow	B. Beans Marrow Pepper Citrus Eggplant

* B. Beans and Beans are recorded as one.

++ No data available.

BLOCK 18: CROP COMBINATIONS, 1965-1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Tomato Citrus	Cereals Tomato Banana Citrus B. Beans Eggplant	Cereals Tomato Banana Citrus	Tomato Banana Cereals Citrus	Banana Citrus	Citrus	Citrus	Citrus Cereals	Tomato Cereals B. Beans Cauliflower Potato	Tomato Beans Eggplant Cauliflower	Tomato Cereals B. Beans Marrow	Tomato B. Beans Marrow	B. Beans Pepper Cereals Beans	Tomato B. Beans* Marrow Cauliflower	Tomato B. Beans Eggplant
APRIL	Cereals Tomato Banana	Tomato Cereals Banana	Tomato Cereals Banana Melon Citrus Marrow	Tomato Banana Cereals Citrus	Cereals Banana Citrus	Citrus	Cereals	Cereals Tomato Melon	Tomato Melon Cucumber	Tomato Eggplant Cereals	Tomato Cereals	Tomato Marrow	Tomato Marrow	++	Tomato
JULY	Banana Tomato Melon Citrus	Banana Citrus Cucumber Eggplant	Banana Citrus	Banana Citrus	Banana Citrus	Citrus	Banana Citrus	Tomato Melon	Tomato Eggplant	Eggplant	Cucumber Marrow	Eggplant Cucumber	Corn Banana Eggplant	Banana	Eggplant Banana Pepper
OCTOBER	Banana Tomato Citrus Eggplant	Banana Tomato Cereals Citrus	Banana B. Beans Citrus Tomato	Banana Citrus	Citrus	++	Tomato Citrus	B. Beans Tomato Eggplant Marrow Okra	B. Beans Marrow Eggplant Cauliflower Pepper Cucumber	B. Beans Pepper Eggplant Beans Cauliflower	B. Beans Beans Marrow Cucumber	B. Beans Pepper	B. Beans Beans Eggplant Marrow Cauliflower	B. Beans Lettuce Eggplant Marrow Banana Cabbage Pepper	B. Beans Eggplant Marrow Lettuce Pepper

* B. Beans and Beans are recorded as one.

++ No data available.

BLOCK 19: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Tomato	Cereals Tomato	Tomato Cereals	Tomato Cereals	++	Banana Citrus Tomato	Tomato Cereals Banana Citrus	Tomato Cereals Banana Citrus	Tomato Cereals Banana Citrus	Tomato Banana Citrus B. Beans Pepper	Tomato Citrus Cauliflower Banana Pepper B. Beans Cereals	Tomato Citrus B. Beans Banana Cereals Marrow	Tomato Citrus Banana B. Beans Pepper	Tomato Citrus Marrow Banana Pepper B. Beans	Tomato Citrus Pepper Banana B. Beans
APRIL	Cereals Tomato	Tomato Cereals	Tomato Cereals Citrus	Tomato Cereals Citrus Banana	Banana Tomato Cereals Citrus	Banana Citrus Tomato	Tomato Citrus Banana	Tomato Cereals Banana Citrus Cucumber	Tomato Cereals Banana Citrus Cucumber	TTomato Banana Citrus Cereals Cucumber	Tomato Cereals Citrus Banana Cucumber Melon	Tomato Citrus Cucumber Banana Cereals Beans	Tomato Citrus Banana	Tomato Citrus Banana Pepper	Tomato Citrus Pepper Cucumber Banana
JULY	Tomato Cucumber Citrus	Cucumber Banana Citrus Cauliflower	Citrus Banana	Citrus Banana	Banana Citrus	Banana Citrus	Citrus Banana Cucumber	Citrus Banana	Banana Citrus	Citrus Banana Cucumber	Citrus Banana	Citrus Banana Cucumber	Citrus Banana	Citrus Banana	Citrus Banana
OCTOBER	Tomato Cauliflower Citrus Potato Eggplant	Tomato Cucumber Citrus Banana Eggplant	Tomato	Tomato Citrus Banana	Banana Citrus	Banana Citrus	Tomato Banana Marrow Eggplant Pepper	Banana Citrus Marrow Tomato B. Beans Eggplant Cauliflower	Banana Citrus Cabbage Cauliflower B. Beans	Cauliflower Citrus Pepper B. Beans Banana Eggplant Potato	Citrus Pepper Banana Cucumber B. Beans Marrow	Citrus B. Beans Potato Banana Pepper Beans Marrow	Citrus Cauliflower Marrow Banana Potato Beans B. Beans Pepper	Citrus Pepper Banana Marrow Cabbage Beans Eggplant	Citrus Marrow Eggplant Banana

++ No data available.

BLOCK 20: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Tomato Citrus	Tomato Citrus	Tomato Cereals Citrus	Tomato Citrus Cereals	++	Cereals Citrus Tomato	Tomato Citrus Cereals	Tomato Cereals Citrus	Tomato Citrus Cereals	Tomato Citrus Pepper Cereals	Tomato Cereals Citrus Pepper	Tomato Citrus Pepper B. Beans Potato Cereals	Tomato Citrus Pepper Cereals Potato B. Beans	Citrus Tomato Pepper Marrow	Tomato Citrus Cucumber
APRIL	Cereals Tomato Citrus	Tomato Cereals Citrus	Tomato Cereals Citrus	Cereals Tomato Citrus	Tomato Citrus Cereals	Tomato Citrus	Tomato Citrus Cereals Cucumber	Cereals Citrus Cucumber Tomato Melon	Tomato Citrus Cucumber Cereals Melon	Tomato Citrus Cucumber Cereals	Tomato Citrus Cereals Cucumber B. Beans*	Tomato Citrus Cucumber Beans	Tomato Citrus Beans	Tomato Citrus B. Beans* Pepper Cucumber	Tomato Citrus
JULY	Citrus	Citrus Cucumber	Citrus	Citrus	Citrus	Citrus	Citrus Cucumber	Citrus	Citrus	Citrus	Citrus	Citrus Cucumber	Citrus	Citrus	Citrus
OCTOBER	Tomato Citrus	Tomato Citrus Pepper	Tomato Citrus	Eggplant Tomato Citrus	Citrus	Citrus Tomato	Tomato Citrus Pepper Marrow	Tomato Citrus Marrow Pepper B. Beans	Citrus Tomato Cucumber Pepper B. Beans Marrow	Citrus Pepper Tomato Beans Potato	Citrus Pepper B. Beans Beans Tomato	Citrus Potato Pepper Tomato Marrow Banana	Citrus Cucumber Marrow	Citrus Pepper Marrow Beans	Citrus Marrow

* B. Beans and Beans are recorded as one.

++ No data available.

BLOCK 21: CROP COMBINATIONS, 1965-1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Tomato	Tomato Cereals	Tomato Cereals	Tomato Cereals	++	Tomato Cereals	Tomato Cereals	Tomato Cereals	Tomato Cereals	Tomato Cereals	Cereals Tomato	Tomato Cereals Citrus Pepper B. Beans	Tomato Cereals B. Beans Citrus Potato	Tomato Pepper Marrow Cereals Citrus B. Beans	Tomato Pepper Citrus
APRIL	Cereals Tomato	Tomato Cereals	Cereals Tomato Melon	Cereals	Cereals Tomato	Tomato Cereals	Tomato Cereals	Cereals Melon Tomato	Tomato Cereals Cucumber Melon	Tomato Cereals Cucumber Melon	Cereals Melon Tomato Cucumber	Cereals Tomato Cucumber Citrus	Cereals Tomato Citrus Potato	Tomato Citrus	Tomato Citrus Cucumber
JULY	Sesame Citrus Eggplant Pepper Tomato	Citrus Cucumber Eggplant	Cucumber Citrus	Citrus Banana	Citrus	Citrus Banana	Citrus Cucumber	Citrus Banana	Citrus Eggplant Banana Melon	Citrus Banana Melon	Melon Citrus	Citrus Cucumber Melon Banana	Cucumber Citrus Melon	Citrus	Citrus
OCTOBER	Tomato Eggplant	Tomato	Tomato	Tomato	Tomato Marrow Citrus	Tomato Marrow	Tomato Marrow	Tomato Marrow	Tomato Cucumber	Tomato Cauliflower Citrus Beans	Tomato Beans Pepper Citrus B. Beans Onion	Tomato Pepper Beans B. Beans Marrow Citrus	Pepper Citrus Beans Marrow B. Beans Eggplant	Pepper Citrus Marrow Eggplant Beans Tomato	Citrus Beans Marrow Eggplant

++ No data available.

BLOCK 22: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Cereals Tomato	Tomato Cereals	Tomato Cereals	Tomato Cereals	++	Cereals Tomato	Tomato Cereals	Tomato Cereals	Cereals Tomato	Tomato Cereals	Cereals Tomato	Cereals Tomato Potato	Cereals Tomato Onion Potato Cauliflower Citrus Eggplant Pepper	Tomato Cereals Citrus Eggplant Potato Cauliflower Onion Pepper	Tomato Citrus Eggplant Cabbage Pepper Potato Cereals Onion
APRIL	Cereals Melon	Cereals Tomato	Melon Cereals	Cereals Melon	Cereals Melon	Cereals Tomato Melon Marrow Banana	Cereals Tomato Melon	Cereals Melon	++	Cereals Melon Cucumber Tomato	Cereals Tomato Melon	Cereals Melon Tomato	Cereals Tomato Melon Onion Citrus Eggplant Potato Cucumber	Cereals Melon Tomato Citrus Eggplant Cucumber Pepper Corn	Citrus Eggplant Tomato Cereals Pepper Melon
JULY	J. Mallow Citrus Sesame Pepper Cowpea Forest	Pepper Eggplant J. Mallow	J. Mallow Pepper Eggplant Citrus	Banana J. Mallow	Banana J. Mallow	J. Mallow Banana	J. Mallow Melon	J. Mallow Melon Pepper Citrus Sesame	J. Mallow Banana	Melon	J. Mallow Citrus Banana Melon	Melon Citrus J. Mallow	Melon Citrus J. Mallow	Citrus	Citrus J. Mallow
OCTOBER	Tomato	Tomato	Tomato	Tomato	Tomato Eggplant Banana Marrow	Tomato Marrow Eggplant Banana	+++	+++	+++	Tomato Eggplant Pepper Marrow	Tomato Eggplant Pepper	Tomato Citrus Eggplant Marrow J. Mallow Beans Pepper	++	Citrus Eggplant Tomato Pepper Cabbage Marrow	Citrus Marrow Tomato Eggplant Pepper

++ No data available

+++ Data is overlapped with Block 23.

BLOCK 23: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	Tomato Cereals	Tomato Cereals	Cereals Tomato	Tomato Cereals	++	Tomato Cereals	Tomato Cereals	Cereals Tomato	++	Cereals Tomato	Cereals Tomato	Cereals Tomato	Cereals Tomato	Cereals Tomato	Cereals Tomato Eggplant Pepper Marrow
APRIL	Cereals Tomato	Cereals Tomato	Cereals Tomato	Cereals Tomato	Cereals Melon	Cereals Tomato Melon	Cereals Tomato	Cereals Melon	++	Cereals Tomato	Cereals Tomato	Cereals Tomato Cucumber	Cereals Tomato Cucumber	Cereals Cucumber Tomato B. Beans*	Cereals Cucumber B. Beans* Pepper Tomato Eggplant
JULY	Melon Sesame	Citrus Pepper	Pepper Citrus Eggplant	J. Mallow Citrus Forest Pepper	J. Mallow Citrus Forest	Citrus Forest	J. Mallow Pepper	J. Mallow Pepper Banana Citrus	J. Mallow	J. Mallow	J. Mallow	J. Mallow Forest Cucumber Pepper Eggplant	J. Mallow Forest Citrus	J. Mallow Forest Citrus	J. Mallow Citrus
OCTOBER	Tomato	Tomato	Tomato	Tomato	Tomato	Tomato	+++	+++	+++	Tomato Eggplant	Tomato Pepper	Tomato Marrow	++	Tomato Marrow Pepper Eggplant Forest	Tomato Marrow Pepper Forest Eggplant Citrus

* B. Beans and Beans are recorded as one.

++ No data available.

+++ Data is overlapped with Block 22.

BLOCK 24: CROP COMBINATIONS, 1965–1979

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
JANUARY	++	++	Cereals Tomato	Tomato	++	Tomato Cereals Eggplant	Tomato Cereals Eggplant	Tomato Cereals Eggplant	Tomato Cereals Eggplant	Tomato Cereals Eggplant	Tomato Cereals Eggplant Citrus	Cereals Tomato Citrus Eggplant	Tomato Cereals Citrus	Tomato Citrus Cereals Eggplant Pepper	Cucumber Tomato Cereals Citrus Eggplant Marrow
APRIL	++	++	Cereals Tomato	Cereals Tomato	Cereals Tomato Melon	Tomato Cereals Eggplant Citrus Melon Cucumber Pepper	Cereals Tomato Citrus	Cereals Tomato Eggplant Citrus Melon Pepper	Tomato Cereals Melon Citrus Pepper Eggplant Cucumber	Tomato Cereals Eggplant	Cereals Tomato Citrus Eggplant	Cereals Tomato Citrus Eggplant	Cereals Tomato Citrus	Cucumber Cereals Tomato Citrus Eggplant B. Beans	++
JULY	++	++	Citrus	Citrus	Citrus	Citrus	Citrus J. Mallow Forest Melon Eggplant Pepper	Citrus Forest	Citrus Forest	Citrus	Citrus Pepper J. Mallow	Citrus J. Mallow	++	Citrus J. Mallow	Citrus J. Mallow
OCTOBER	++	Tomato Citrus Eggplant Pepper	Tomato	Tomato	Tomato	Tomato Eggplant Citrus Pepper	Tomato Eggplant Citrus	Tomato Eggplant Pepper Citrus B. Beans	++	Tomato Eggplant Citrus	Tomato Citrus Eggplant	Citrus Tomato	Citrus Tomato Eggplant	Citrus Tomato Eggplant Marrow	++

++ No data available.

Appendix 5

The complete results of Land Use Intensity by Block and Season in the East Ghor Canal Project Area, 1965-1979.

EAST GHOR CANAL PROJECT: LAND USE INTENSITY BY BLOCKS (%), JANUARY, 1965-1979

Block No.	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	70.0	74.0	83.4	83.3	74.4	76.0	72.0	73.0	82.0	86.3	82.3	88.4	82.6	86.6	82.0
2	68.2	51.7	60.6	44.2	34.6	29.7	15.7	49.4	50.0	43.5	46.5	76.2	57.2	47.6	56.1
4	88.8	90.1	87.6	70.83	76.2	57.1	70.7	99.2	47.7	88.0	76.4	50.1	40.8	58.5	79.3
5	67.3	55.8	60.6	52.6	57.7	44.7	55.4	54.7	56.7	68.1	47.0	43.4	57.0	65.2	62.4
6	86.3	74.9	85.4	92.4	58.8	61.6	68.1	75.4	64.9	88.6	88.5	62.1	77.9	87.8	75.9
7	79.0	64.8	62.3	45.1	54.4	56.0	56.9	68.9	75.5	83.7	72.4	42.1	83.6	78.3	87.1
8	76.5	67.5	67.4	79.0	56.7	47.4	48.5	50.9	79.5	80.8	56.6	69.1	75.9	61.1	64.0
9	67.0	51.4	62.6	63.0	40.5	82.6	46.7	52.3	54.8	58.2	46.2	55.8	60.6	57.0	56.6
10	64.2	65.6	55.9	70.2	50.0	38.0	46.7	67.7	69.8	78.4	68.5	75.6	62.3	76.5	59.4
11	73.7	73.6	27.1	73.9	33.3	17.7	46.9	69.3	75.9	69.2	65.4	62.2	59.1	51.2	52.0
12	60.4	72.7	65.6	67.5	38.0	28.8	52.1	68.6	59.8	57.0	61.0	56.0	68.2	58.1	61.8
13	82.3	75.5	66.8	68.0	29.4	38.7	40.0	70.0	58.0	70.2	77.6	57.3	62.3	53.3	66.2
14	51.0	37.7	49.7	50.3	37.0	23.6	41.2	46.1	43.7	54.7	49.0	36.8	44.0	53.6	64.2
15	143.2	63.3	40.1	70.1	32.4	17.9	21.8	25.7	39.8	47.6	47.4	63.2	54.7	56.2	58.0
16	48.3	58.5	54.9	52.0	44.7	19.7	43.2	48.8	48.4	36.7	56.1	41.8	44.0	50.0	52.5
17	39.4	45.6	40.8	45.9	24.0	20.5	38.9	44.9	31.2	41.5	55.5	47.5	32.6	40.7	52.8
18	08.3	24.9	15.9	22.9	07.8	02.9	04.9	09.5	09.1	20.7	20.4	19.9	12.6	15.4	21.3
19	42.1	43.1	44.1	45.8	*	23.2	32.7	43.5	39.6	43.1	40.4	48.6	47.0	46.7	45.3
20	52.8	55.6	54.2	50.4	*	35.7	33.8	53.8	49.3	55.9	52.6	58.2	51.6	41.1	49.1
21	83.2	62.8	71.0	72.9	*	28.7	41.9	55.4	47.0	71.9	78.2	54.9	61.7	73.6	65.0
22	62.4	64.4	42.3	60.6	*	55.5	51.0	27.3	29.7	61.5	58.6	58.1	66.1	52.7	54.8
23	53.2	52.8	39.1	43.1	*	33.3	40.4	50.0	*	47.1	45.2	40.1	42.7	43.3	46.0
24	*	*	49.8	95.4	*	53.3	57.9	56.4	60.0	56.3	40.6	53.6	57.4	52.8	62.5

* No data available

EAST GHOR CANAL PROJECT: LAND USE INTENSITY BY BLOCKS (%), APRIL, 1965-1979

Block No.	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	70.4	75.4	78.2	72.2	76.0	78.5	68.6	77.0	77.9	77.1	73.1	86.9	90.0	90.1	84.7
2	59.2	52.3	60.6	44.2	24.3	23.3	19.1	52.0	51.1	48.1	84.2	58.1	82.7	67.2	77.9
4	80.9	77.2	83.4	37.0	56.6	48.5	43.1	74.7	92.9	83.8	82.0	89.4	60.3	66.5	50.9
5	65.1	58.7	57.1	54.1	55.1	36.5	47.9	63.9	64.4	64.3	68.5	69.5	49.3	58.2	96.3
6	78.1	68.2	82.6	109.9	63.3	66.8	83.4	50.7	113.0	83.8	101.8	80.7	87.0	83.7	90.6
7	71.8	69.1	70.9	74.3	58.5	58.1	65.6	77.4	87.4	95.4	73.9	70.0	80.8	80.8	68.9
8	77.4	63.4	39.0	71.4	53.7	56.7	62.1	48.3	81.0	71.6	78.1	72.3	72.5	69.9	58.7
9	66.8	63.5	60.5	60.8	54.6	82.8	57.1	43.0	57.6	61.9	66.3	60.2	64.4	62.0	54.3
10	69.6	61.1	68.1	67.8	38.6	24.7	55.7	74.4	77.1	78.0	75.3	73.4	67.1	71.6	52.8
11	72.4	74.5	69.7	62.3	25.5	16.0	49.7	74.0	81.5	81.0	88.4	67.7	78.5	*	80.0
12	59.1	65.2	57.7	48.1	32.4	25.9	55.2	65.2	68.3	69.1	74.2	54.3	79.1	*	74.3
13	69.8	65.7	61.7	61.0	29.1	18.3	53.1	73.4	33.7	71.0	66.8	60.2	75.5	*	70.8
14	39.0	54.8	50.1	51.0	32.2	19.1	39.6	50.0	52.9	42.4	50.5	35.0	64.3	*	50.1
15	48.2	53.2	36.8	53.2	35.6	18.7	32.0	52.7	57.8	65.6	55.5	56.2	66.4	*	42.7
16	47.3	52.5	49.7	37.0	44.4	17.0	38.8	55.2	52.0	48.6	50.8	44.6	46.8	*	32.0
17	34.2	39.9	41.5	27.9	30.6	13.5	38.4	40.8	44.2	42.2	39.7	34.9	36.5	*	31.6
18	19.8	22.6	30.3	19.2	13.3	02.9	18.4	22.5	23.5	22.8	19.1	15.4	19.5	*	19.3
19	51.1	44.8	48.1	42.1	38.7	22.2	29.0	46.6	50.6	37.4	39.1	50.5	40.2	54.1	44.2
20	51.7	49.6	54.2	50.6	41.7	35.3	38.3	51.2	56.6	57.8	68.2	61.0	49.7	64.1	55.8
21	69.8	58.1	53.9	36.6	42.8	36.8	44.7	61.5	67.1	75.6	67.7	57.9	65.5	65.4	45.1
22	65.3	52.0	59.7	54.6	49.2	54.8	57.2	30.0	*	56.0	48.2	47.2	59.7	60.0	38.5
23	36.4	35.1	36.1	37.4	36.2	29.6	36.9	42.7	*	42.1	41.2	41.6	36.7	48.7	43.4
24	*	*	43.5	45.3	75.7	51.7	54.2	49.8	43.1	55.9	59.4	56.4	48.0	52.4	*

* No data available

EAST GHOR CANAL PROJECT: LAND USE INTENSITY BY BLOCKS (%), JULY, 1965-1979

Block No.	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	56.5	64.8	85.0	62.0	78.7	69.4	62.1	67.3	64.4	58.2	63.1	67.1	69.7	76.6	73.9
2	40.7	45.0	38.7	29.2	23.3	23.3	29.6	26.8	27.2	24.8	51.5	29.5	47.3	48.8	52.8
4	40.9	43.0	26.4	34.0	36.6	54.6	59.9	31.8	47.6	37.2	37.6	48.3	52.2	60.0	51.1
5	42.3	40.8	42.8	39.1	36.4	44.6	45.6	40.9	43.0	32.1	34.0	39.3	49.3	46.8	49.4
6	38.2	61.4	60.0	68.0	46.5	62.1	52.3	55.3	60.6	52.3	49.7	66.4	51.9	70.0	76.4
7	39.1	57.0	49.7	46.9	56.0	51.5	54.9	49.3	64.9	50.7	53.0	55.7	60.9	66.6	70.8
8	44.4	54.0	36.9	32.8	38.7	29.9	43.2	34.4	50.6	30.0	41.6	43.9	46.4	45.3	43.4
9	*	36.4	35.4	15.8	28.8	13.8	21.2	23.4	32.3	23.9	25.8	40.8	42.4	55.3	43.3
10	35.0	42.4	35.6	24.4	33.1	22.9	35.4	34.5	48.5	40.0	41.0	45.1	49.4	48.6	49.4
11	22.0	50.0	28.4	16.7	14.7	15.0	22.1	32.1	39.7	29.5	41.4	42.6	38.6	33.5	38.9
12	38.9	45.5	33.9	29.4	22.6	24.5	36.9	38.0	47.0	44.5	40.7	49.5	44.6	45.8	45.9
13	40.4	54.0	40.0	15.8	07.3	12.0	37.0	35.6	28.4	34.2	31.9	46.6	42.9	36.4	37.5
14	22.4	30.3	19.6	14.8	15.8	18.7	30.0	24.1	29.5	22.3	30.9	27.7	30.0	24.0	30.5
15	15.8	23.2	24.2	21.8	20.1	16.4	39.0	11.4	18.1	14.1	11.6	21.2	17.8	21.0	21.3
16	22.1	15.4	12.0	08.9	09.9	07.1	16.9	25.0	10.2	13.2	07.6	18.8	12.6	14.4	16.6
17	12.1	11.6	05.9	02.1	02.5	16.6	07.3	25.5	05.1	03.9	02.3	04.5	06.0	04.5	10.3
18	10.1	10.2	06.9	08.0	07.8	01.9	05.1	09.3	02.4	03.1	11.0	00.6	01.6	01.8	05.1
19	11.4	12.6	08.1	10.2	18.1	13.0	15.7	15.6	13.9	14.6	13.0	16.6	13.9	16.6	13.1
20	09.5	12.0	12.8	11.1	10.9	10.5	14.7	11.3	11.0	15.9	14.2	22.9	16.4	15.2	16.8
21	07.7	06.6	10.1	04.4	03.7	04.0	04.8	04.2	07.5	07.7	18.5	16.1	18.4	07.8	10.3
22	01.3	03.6	03.7	09.7	07.3	08.7	10.7	02.0	07.2	18.0	05.2	09.1	19.1	09.9	16.1
23	07.3	01.0	02.7	01.6	01.2	00.5	08.2	06.7	06.9	05.1	05.6	12.8	14.2	07.9	04.9
24	*	*	04.3	02.7	04.6	05.0	10.4	06.4	07.1	06.5	13.4	12.6	*	13.7	16.3

* No data available

EAST GHOR CANAL PROJECT: LAND USE INTENSITY BY BLOCKS (%), OCTOBER, 1965-1979

Block No.	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	75.0	59.3	82.8	79.0	75.7	75.0	77.0	78.2	84.3	76.5	77.8	80.7	86.3	80.0	86.7
2	63.0	51.6	53.6	24.3	23.3	15.5	46.0	44.7	37.2	30.3	66.3	41.5	47.1	54.9	71.6
4	53.6	62.8	68.7	69.7	47.0	74.9	58.2	58.7	53.0	63.9	52.8	45.5	85.1	70.2	71.9
5	47.3	53.1	64.8	53.6	43.0	47.4	51.8	49.2	56.2	48.2	46.2	38.2	51.7	59.9	66.7
6	36.6	54.6	64.3	62.2	49.7	64.5	61.6	56.0	59.6	64.0	61.9	58.6	67.8	75.4	74.4
7	36.0	43.3	49.0	48.6	49.5	51.1	47.2	47.8	53.6	51.9	52.4	59.2	67.3	62.8	68.0
8	34.0	30.4	43.2	36.8	37.2	37.9	32.8	30.0	36.7	33.6	32.0	47.9	45.5	48.0	49.3
9	13.6	14.2	28.8	27.7	13.6	15.1	20.6	18.0	26.1	30.0	24.7	40.2	43.4	49.8	44.7
10	33.7	32.7	36.5	32.5	22.6	21.4	32.2	28.2	35.7	40.5	39.1	50.1	44.6	52.0	57.3
11	53.2	22.8	37.8	24.4	19.3	14.1	27.6	24.4	38.1	44.2	37.6	43.3	40.0	45.7	61.9
12	33.7	56.4	50.5	33.8	28.8	28.6	39.1	38.8	52.9	47.0	46.6	49.5	58.1	56.9	63.4
13	21.6	68.1	57.1	23.5	23.6	20.5	39.1	30.9	45.1	42.8	42.5	47.5	49.9	51.3	51.7
14	15.8	32.7	36.3	32.2	19.3	27.2	33.2	27.5	29.0	36.2	29.2	35.2	40.6	43.6	50.0
15	11.4	45.2	38.3	23.6	16.3	13.6	17.3	18.7	30.8	23.9	24.9	33.8	29.0	38.4	46.4
16	13.2	20.7	22.9	19.7	06.2	14.8	22.7	22.3	25.6	27.0	18.2	19.5	27.6	28.8	34.8
17	08.7	05.6	24.2	10.2	02.6	08.1	19.0	17.9	18.8	28.4	16.0	19.2	23.7	24.3	30.3
18	08.9	13.7	14.4	07.8	02.1	*	06.9	08.1	09.7	09.9	20.1	10.2	11.0	14.7	18.2
19	17.7	37.9	37.0	22.5	18.0	13.3	36.5	29.3	30.5	32.0	31.2	37.1	44.6	35.5	32.2
20	36.8	38.9	40.2	49.2	12.6	19.6	50.5	38.0	42.1	35.8	42.5	50.8	37.4	36.3	37.5
21	46.1	60.6	62.1	33.9	15.9	31.9	34.7	49.4	53.5	42.2	45.3	42.0	43.1	43.1	29.7
22	33.3	46.5	39.5	52.6	41.9	31.3	*	*	*	37.4	28.2	30.0	*	30.8	36.1
23	39.5	26.7	25.6	23.9	21.3	13.7	*	*	*	20.4	15.6	14.6	*	27.6	23.9
24	*	10.9	22.0	28.8	40.7	30.9	41.1	34.7	*	29.7	32.3	21.1	27.0	10.9	*

* No data available

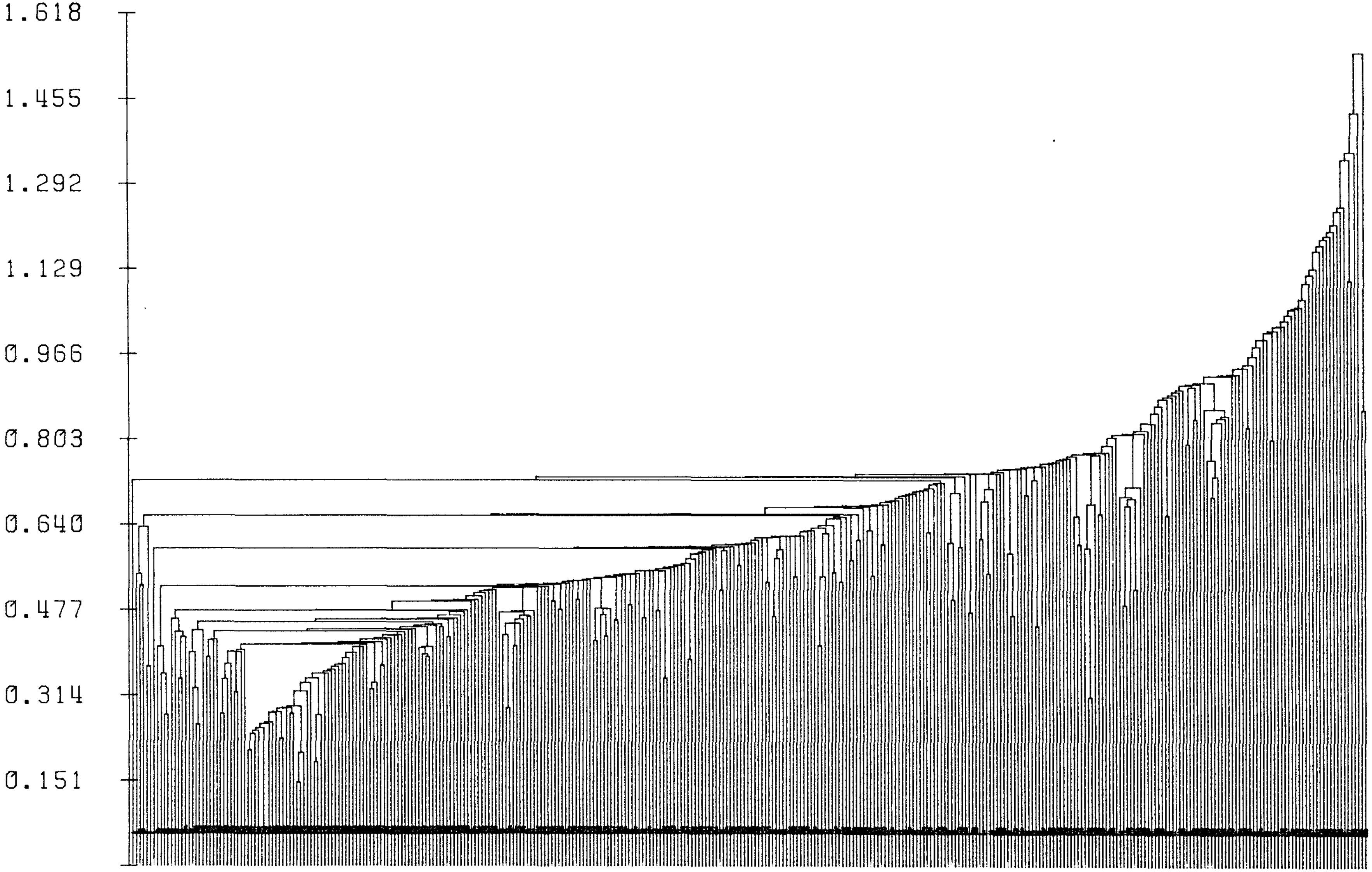
Appendix 6

Dendrograms of the General Classification of Farms

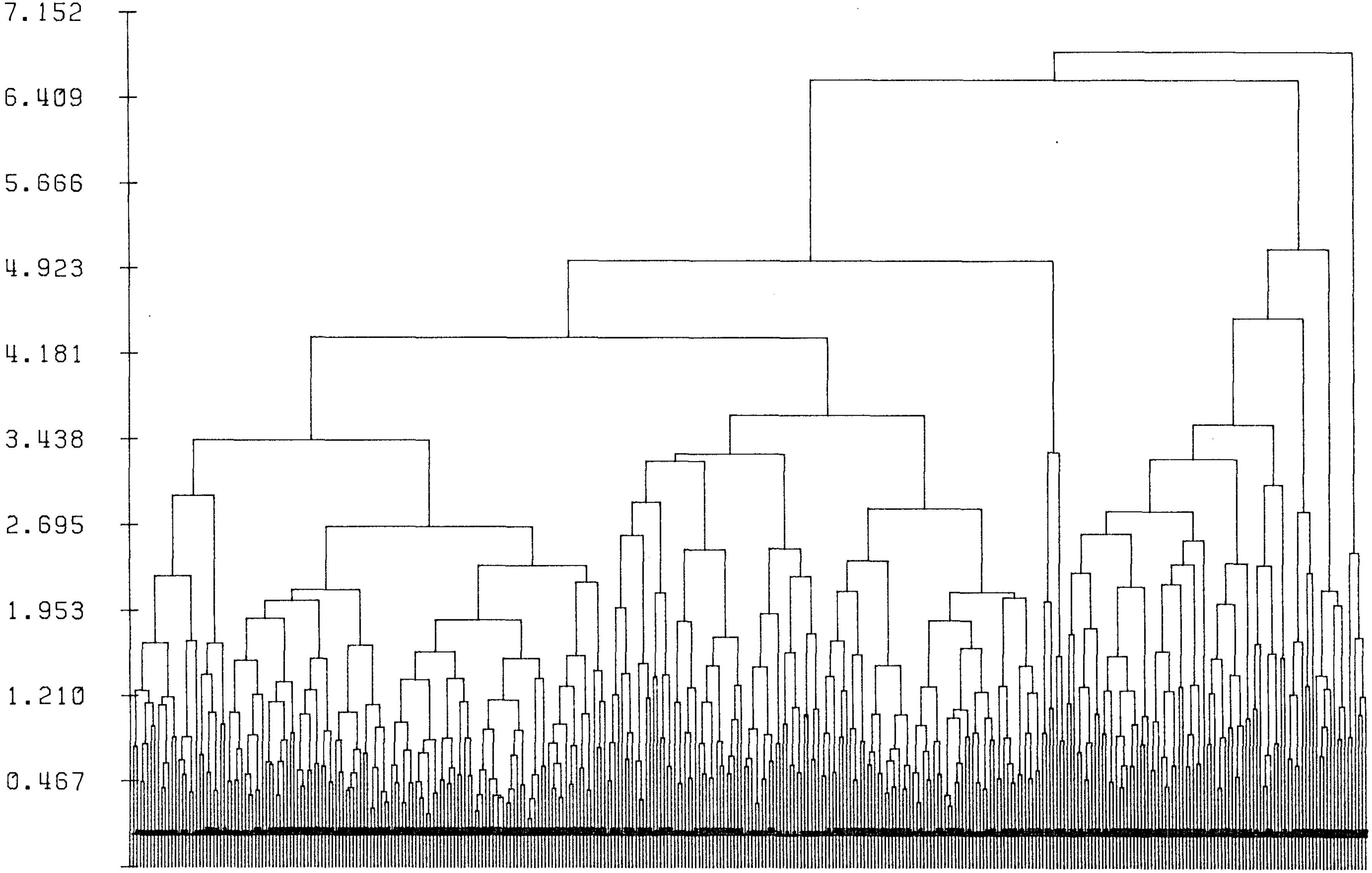
The complete set of dendrograms produced by the cluster analysis according to the different methods available for the calculation of the similarity coefficient.

1. Nearest Neighbour
2. Furthest Neighbour
3. Group Average
4. Centroid
5. Median
6. Ward's Method*
7. Lance-Williams' Flexible BETA
8. McQuitty's Similarity Analysis

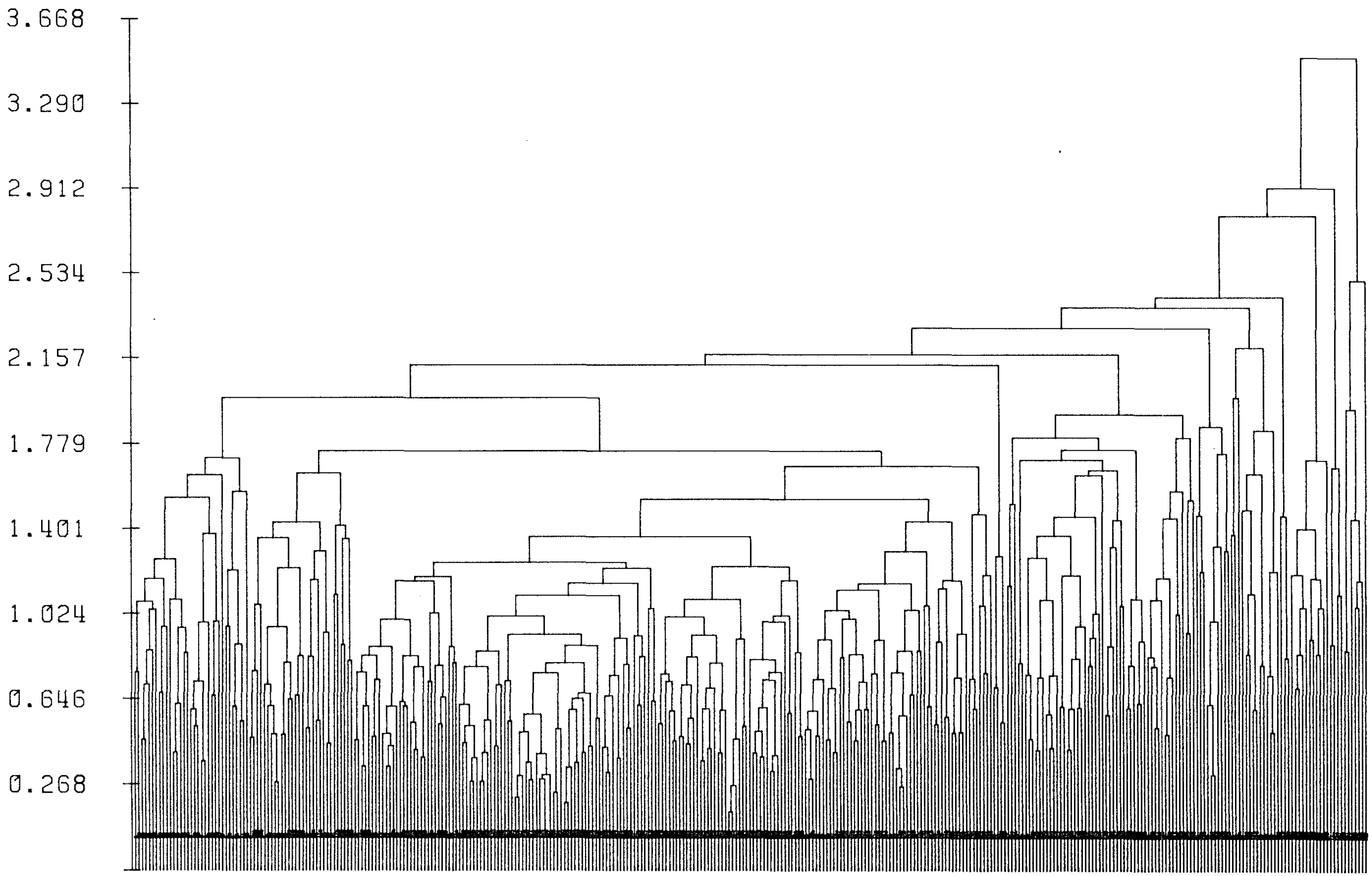
* Ward's Method dendrogram is shown in Chapter 11 as Fig. 11.1



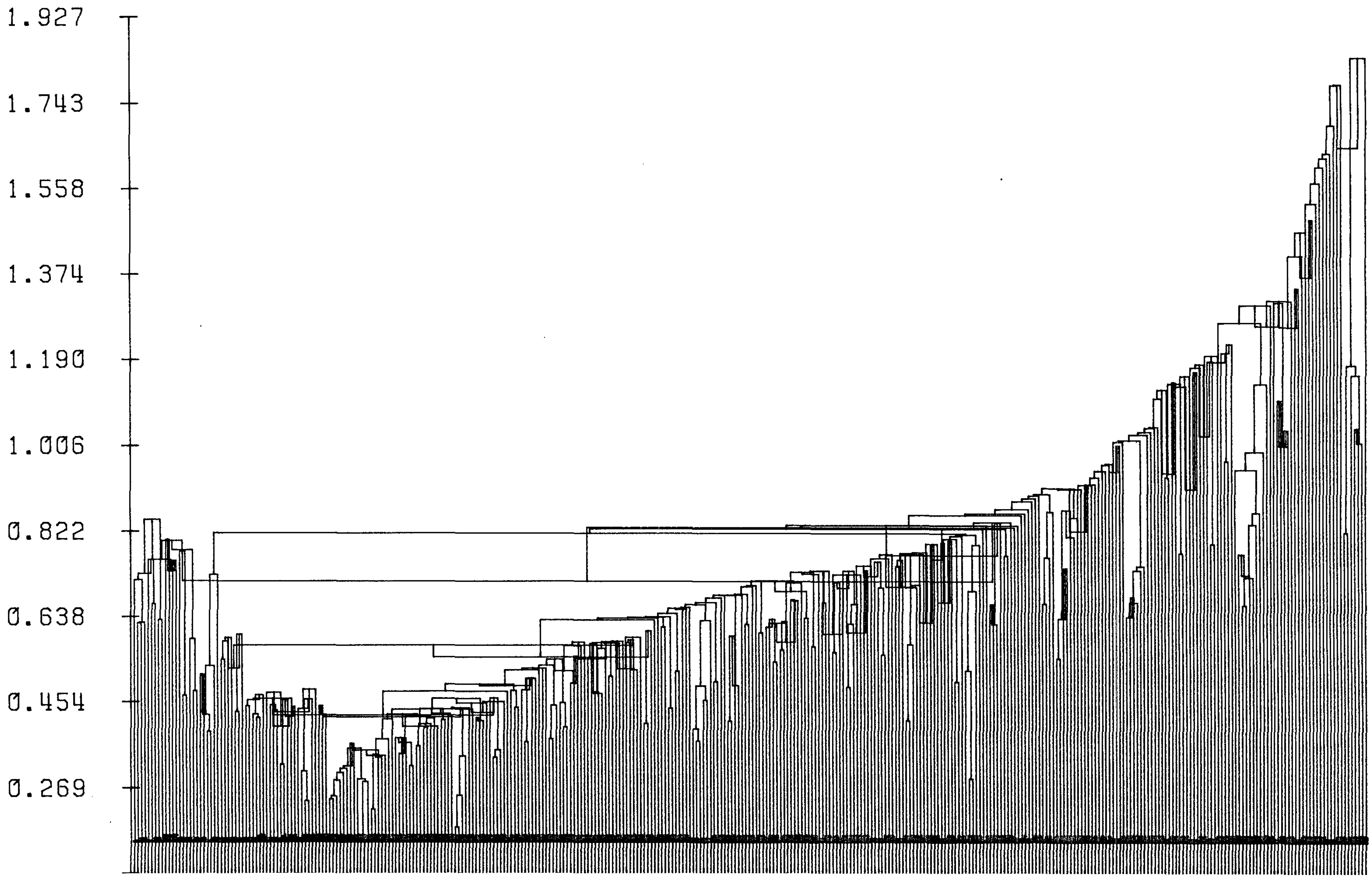
1. Nearest Neighbour



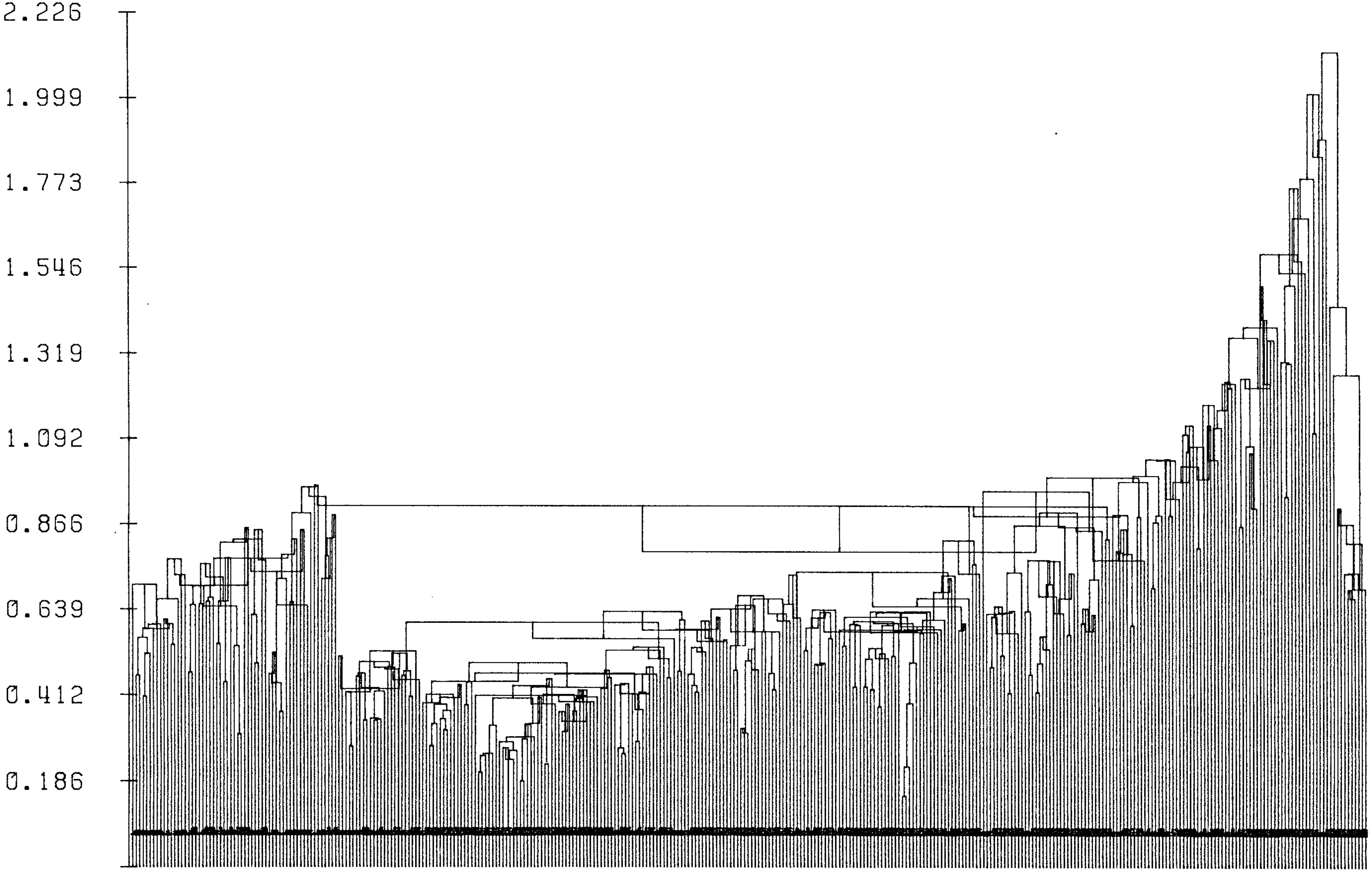
2. Furthest Neighbour



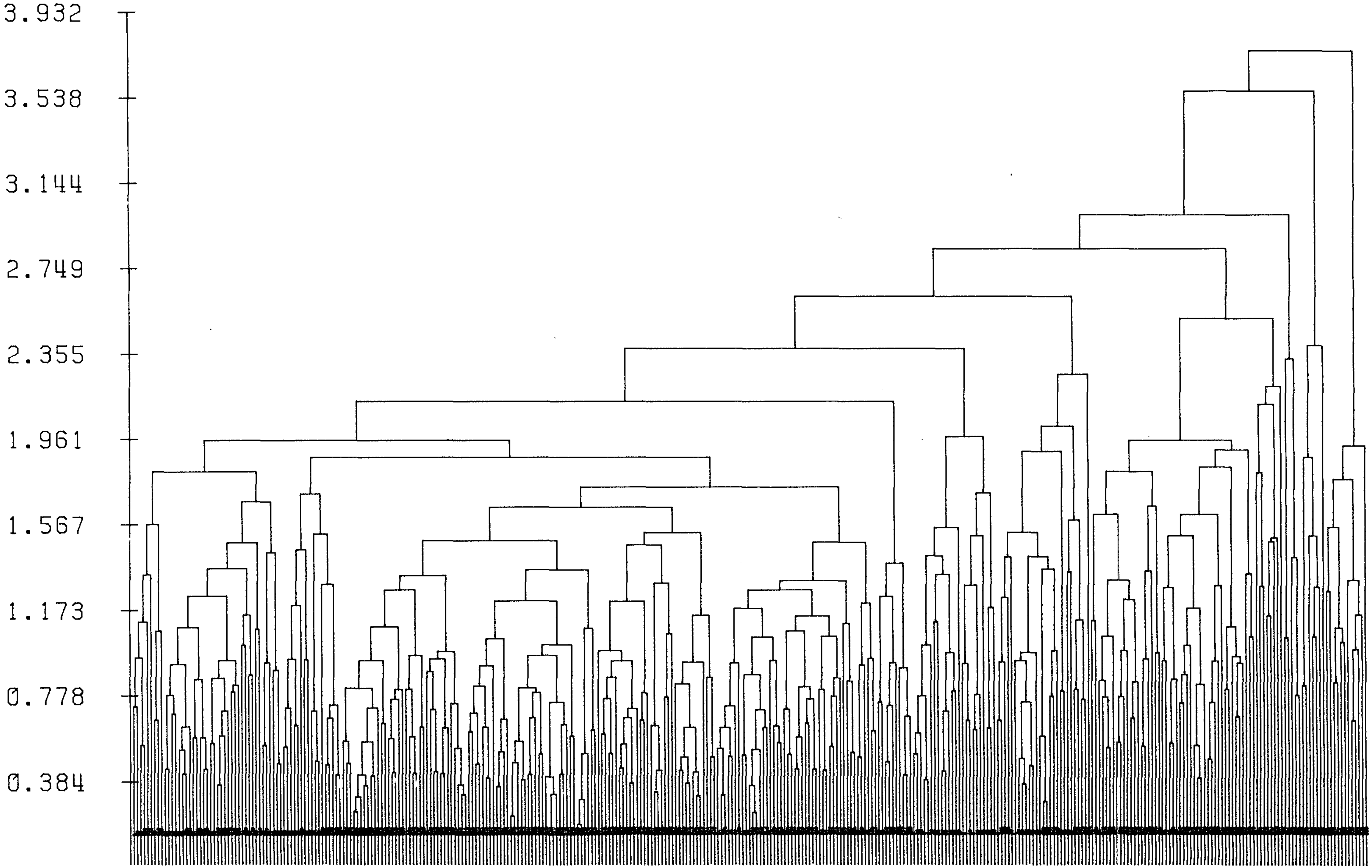
3. Group Average



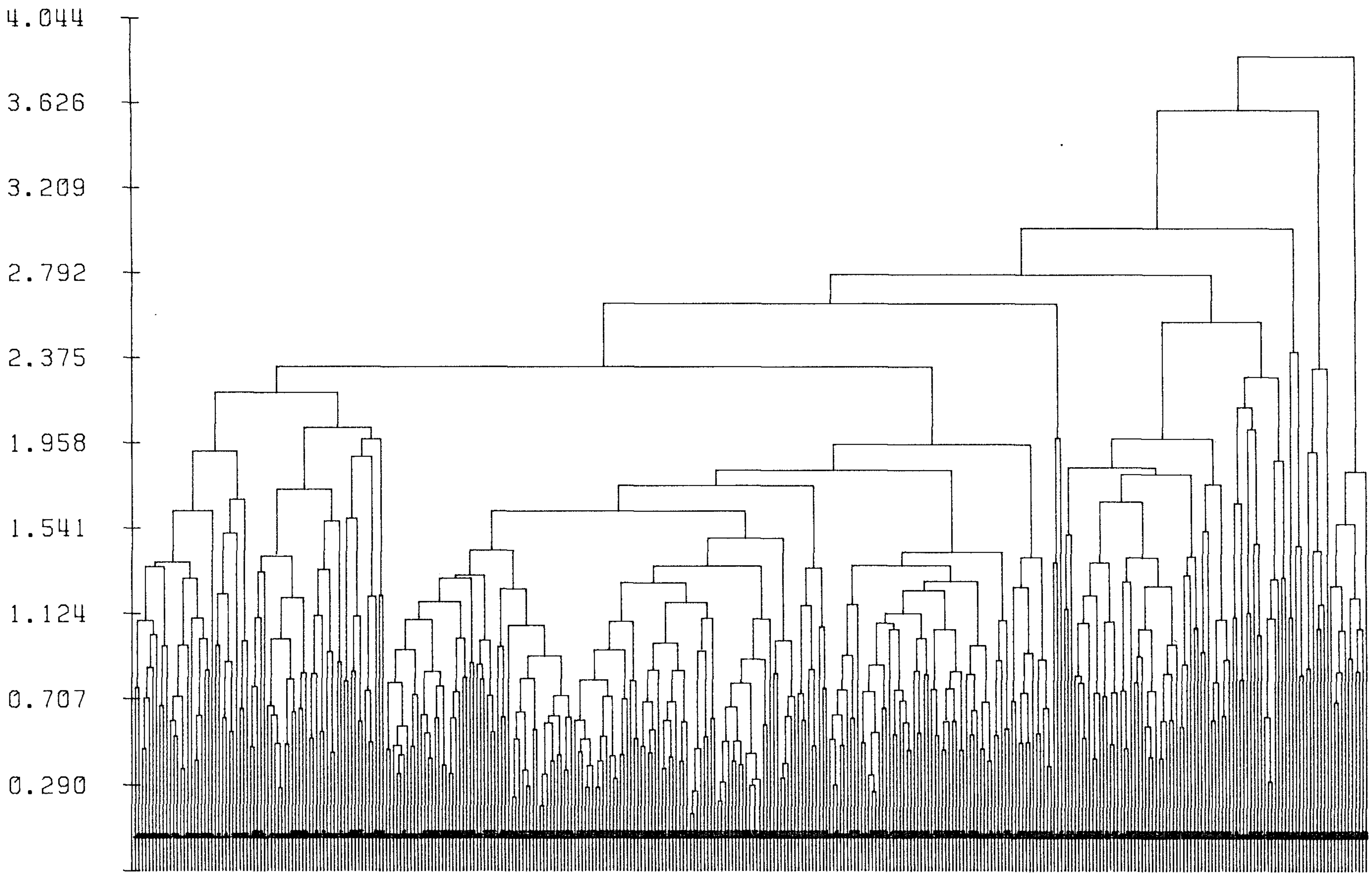
4. Centroid



5. Median or Gower's Method



7. Lance-Williams' Flexible BETA



8. McQuitty's Similarity Analysis

Appendix 7

Detailed Features of the General Classification Groups

The general features in detailed form of the individual groups created by the general classification of the East Ghor Canal Project farms according to the classificatory variables involved.

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Farmer's Age (in years)																		
Under 30	–	–	1	1.3	2	5.7	–	–	6	20.7	–	–	4	4.4	1	11.1	1	1.7
30–40	10	31.2	20	26.7	10	28.6	8	44.4	10	34.5	1	16.7	33	36.7	1	11.1	12	20.3
41–50	12	37.5	25	33.3	16	45.7	4	22.2	7	24.1	1	16.7	24	26.7	6	66.7	17	28.8
51–60	7	21.9	20	26.7	6	17.1	4	22.2	3	10.3	4	66.7	16	17.8	1	11.1	20	33.9
Over 60	3	9.4	9	12.0	1	2.9	2	11.1	3	10.3	–	–	13	14.4	–	–	9	15.3
Farmer Education																		
Illiterate	11	34.4	34	45.3	17	48.6	7	38.9	4	13.8	1	16.7	43	47.8	3	33.3	35	59.3
Elementary	10	31.2	31	41.3	13	37.1	5	27.8	4	13.8	2	3.3	35	38.9	4	44.4	20	33.9
Preparatory	3	9.4	5	6.7	5	14.3	5	27.8	5	17.2	1	16.7	9	10.0	2	22.2	3	5.1
Secondary	4	12.5	3	4.0	–	–	1	5.6	9	31.0	1	16.7	2	2.2	–	–	–	–
Graduate	4	12.5	2	2.7	–	–	–	–	7	24.1	1	16.7	1	1.1	–	–	1	1.7
Total Farms in the Group	32		75		35		18		29		6		90		9		59	

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
<u>Farmer's Experience (in years)</u>																		
10 and Less	6	18.7	4	5.3	11	31.4	3	16.7	10	34.5	–	–	13	14.4	1	11.1	6	10.2
11–20	10	31.2	29	38.7	17	48.6	8	44.4	7	24.1	2	33.3	46	51.1	4	44.4	21	35.6
21–30	10	31.2	29	38.7	6	17.1	6	33.3	6	20.7	1	16.7	16	17.8	3	33.3	24	40.7
Over 40	6	18.7	13	17.3	1	2.9	1	5.6	6	20.7	3	50.0	15	16.7	1	11.1	8	13.6
<u>No. of years farmer spent in the valley</u>																		
20 and Less	4	12.5	10	13.3	5	14.3	1	5.6	11	37.9	2	33.3	14	15.6	–	–	9	15.3
21–30	12	37.5	11	14.7	16	45.7	2	11.1	10	34.5	2	33.3	14	15.6	2	22.2	9	15.3
31–40	9	28.1	26	34.7	10	28.6	9	50.0	5	17.2	–	–	27	30.0	1	11.1	14	23.7
Over 40	7	21.9	28	37.3	4	11.4	6	33.3	3	10.3	2	33.3	35	38.9	6	66.7	27	45.8
<u>Farmer's Origin</u>																		
Palestinian	10	31.2	20	26.7	24	68.6	10	55.6	22	75.9	4	66.7	21	23.3	–	–	17	28.8
Jordanian	20	62.5	53	70.7	11	31.4	8	44.4	6	20.7	2	33.3	69	76.7	9	100.0	42	71.2
Others	2	6.2	2	2.7	–	–	–	–	1	3.4	–	–	–	–	–	–	–	–
Total Farmers in the Group	32		75		35		18		29		6		90		9		59	

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Form of Land Tenure																		
Owner operator	20	62.5	54	72.0	4	11.4	7	38.9	15	51.7	4	66.7	53	58.9	6	66.7	30	50.8
Share cropper	9	28.1	14	18.7	17	48.6	9	50.0	9	31.0	1	16.7	29	32.2	2	42.2	19	32.2
Cash tenant	3	9.4	3	4.0	14	40.0	2	11.1	2	6.9	1	16.7	7	7.8	1	11.1	9	15.3
Others	–	–	4	5.3	–	–	–	–	3	10.3	–	–	1	1.1	–	–	1	1.7
Farm Size (in Dunums)																		
30 and Less	11	34.4	16	61.3	14	40.0	7	38.9	5	17.2	–	–	25	27.8	2	22.2	–	–
31–35	13	40.6	34	45.3	15	42.9	10	55.6	11	37.9	2	33.3	55	61.1	4	44.4	2	3.4
36–40	4	12.5	11	14.7	5	14.3	–	–	5	17.2	3	50.0	8	8.9	1	11.1	8	13.6
41–50	2	6.2	10	13.3	1	2.9	1	5.6	4	13.8	1	16.7	2	2.2	2	22.2	9	15.3
Over 50	2	6.2	4	5.3	–	–	–	–	4	13.8	–	–	–	–	–	–	40	67.8
Total Farms in the Group	32		75		35		18		29		6		90		9		59	

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
<u>Source of Supplies</u>																		
Commission Agent	–	–	2	2.7	–	–	1	5.6	1	3.4	1	16.7	15	16.7	–	–	7	11.9
Village Merchant	7	21.9	9	12.0	6	17.1	4	22.2	1	3.4	–	–	10	11.1	–	–	5	8.5
Co-operative	6	18.7	5	6.7	8	22.9	4	22.2	8	27.6	1	16.7	17	18.9	–	–	12	20.3
J.V.F.A.	–	–	7	9.3	–	–	1	5.6	1	3.4	–	–	10	11.1	1	1.1	4	6.8
Agricultural Co.	6	18.7	10	13.3	5	14.3	4	22.2	5	17.2	2	33.3	3	3.3	–	–	–	–
Landlord	–	–	–	–	–	–	–	–	–	–	–	–	2	2.2	–	–	–	–
Mixed	13	40.6	42	56.0	16	45.7	4	22.2	13	44.8	2	33.3	33	36.7	8	88.9	31	52.5
<u>Methods of Payment</u>																		
Cash	11	34.4	30	40.0	9	25.7	7	38.9	13	44.8	1	16.7	4	4.4	–	–	10	16.9
End of Season	6	18.7	12	16.0	8	22.9	5	27.8	2	6.9	–	–	9	10.0	–	–	6	10.2
Mixed	15	46.9	33	44.0	18	51.4	6	33.3	14	48.3	5	83.3	77	85.6	9	100.0	43	72.9
Total Farms in the Group	32		75		35		18		29		6		90		9		59	

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Annual Farm Income (J. Dinar)																		
2000 and less	10	31.2	21	28.0	14	40.0	11	61.1	3	10.3	–	–	32	35.6	5	55.6	16	27.1
2001–3000	10	31.2	23	30.7	11	31.4	6	33.3	5	17.2	–	–	29	32.2	3	33.3	21	35.6
3001–5000	6	18.7	17	22.7	7	20.0	1	5.6	6	20.7	–	–	22	24.4	1	11.1	19	32.2
Over 5000	6	18.7	14	18.7	3	8.6	–	–	15	51.7	6	100.0	7	7.8	–	–	3	5.1
Annual Farm Expenditure (J. Dinar)																		
1000 and less	12	37.5	27	36.0	11	31.4	10	55.6	4	13.8	–	–	39	43.3	3	33.3	21	35.6
1001–2000	14	43.7	33	44.0	24	68.6	6	33.3	9	31.0	–	–	29	32.2	6	66.7	30	50.8
2001–3000	4	12.5	10	13.3	–	–	2	11.1	7	24.1	–	–	15	16.7	–	–	6	10.2
Over 3000	2	6.2	5	6.7	–	–	–	–	9	31.0	6	100.0	7	7.8	–	–	2	3.4
Total Farms in the Group	32		75		35		18		29		6		90		9		59	

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Having additional income	20	62.5	19	25.3	5	14.3	2	11.1	11	37.9	–	–	6	6.7	3	33.3	6	10.2
Getting family help	21	65.6	25	33.3	17	48.6	8	44.4	9	31.0	2	33.3	41	45.6	4	44.4	19	32.2
Loan takers	12	37.5	32	42.7	13	37.1	8	44.4	11	37.9	6	100.0	62	68.9	7	77.8	41	69.5
Required advice	8	25.0	35	46.7	13	37.1	11	61.1	6	20.7	2	33.3	6	6.7	–	–	14	23.7
Co-op members	14	43.7	33	44.0	10	28.6	6	33.3	21	72.4	5	83.3	44	48.9	5	55.6	30	50.8
JVFA member	14	56.2	37	49.3	4	11.4	7	38.9	17	58.6	5	83.3	47	52.2	6	66.7	27	45.8
Amman Market user	20	62.5	53	70.7	14	40.0	10	55.6	25	86.2	6	100.0	30	33.3	3	33.3	21	52.5
Irbid Market user	25	78.1	61	81.3	23	65.7	14	77.8	24	82.8	3	50.0	25	27.8	8	88.9	18	30.5
N. Shuneh Market user	32	100.0	1	1.3	–	–	–	–	1	3.4	–	–	–	–	–	–	–	–
W. Yabis Market user	1	3.1	34	45.3	26	74.3	12	66.7	7	24.1	–	–	6	6.7	–	–	14	23.7
Sawalha Market user	1	3.1	28	37.3	16	45.7	7	38.9	12	41.4	6	100.0	86	95.6	9	100.0	48	81.4
Total Farms in the Group	32		75		35		18		29		6		90		9		59	

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
<u>No. of machinery owned by the Farmer</u>																		
Non	19	59.4	41	54.7	24	68.6	13	72.2	3	10.3	2	33.3	35	38.9	4	44.4	31	52.5
One	5	15.6	16	21.3	6	17.1	1	5.6	5	17.2	-	-	26	28.9	2	22.2	12	20.3
Two	1	3.1	5	6.7	5	14.3	2	11.1	7	24.1	1	16.7	15	16.7	3	33.3	11	18.6
Three	5	15.6	7	9.3	-	-	-	-	5	17.2	1	16.7	6	6.7	-	-	1	1.7
Four	1	3.1	4	5.3	-	-	2	11.1	2	6.9	-	-	4	4.4	-	-	3	5.1
Five and More	1	3.1	2	2.7	-	-	-	-	7	24.1	2	33.3	4	4.4	-	-	1	1.7
<u>Applying Advanced Techniques</u>																		
Non	31	96.9	73	97.3	35	100.0	18	100.0	23	79.3	-	-	69	76.7	6	66.7	53	89.8
Drip Irrigation/ Plastic Houses	1	3.1	2	2.7	-	-	-	-	4	13.8	-	-	18	20.0	2	22.2	5	8.5
Drip Irrigation and Plastic Houses	-	-	-	-	-	-	-	-	2	6.9	6	100.0	3	3.3	1	11.1	1	1.7
Total Farms in the Group	32		75		35		18		29		6		90		9		59	

	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Class 1 & 2 (%)																		
50 and Less	–	–	1	1.3	–	–	–	–	5	17.2	–	–	–	–	4	44.4	29	49.2
51–70	1	3.1	4	5.3	1	2.9	1	5.6	3	10.3	2	33.3	3	3.3	5	55.6	20	33.9
71–90	3	9.4	19	25.3	5	14.3	1	5.6	4	13.8	2	33.3	7	7.8	–	–	9	15.3
91–99	4	12.5	11	14.7	6	17.1	1	5.6	6	20.7	1	16.7	16	17.8	–	–	1	1.7
100	24	75.0	40	53.3	23	65.7	15	83.3	11	37.9	1	16.7	64	71.1	–	–	–	–
Class 3 (%)																		
None	28	87.5	56	74.7	27	77.1	16	88.9	17	58.6	4	66.7	82	91.1	9	100.0	22	37.3
1–10	1	3.1	9	12.0	7	20.0	2	11.1	4	13.8	1	16.7	5	5.6	–	–	9	15.3
11–20	3	9.4	3	4.0	1	2.9	–	–	4	13.8	–	–	1	1.1	–	–	6	10.2
21–50	–	–	7	9.3	–	–	–	–	3	10.3	1	16.7	2	2.2	–	–	9	15.3
Over 50	–	–	–	–	–	–	–	–	1	3.4	–	–	–	–	–	–	13	22.0
Class 4 (%)																		
None	32	100.0	75	100.0	35	100.0	18	100.0	29	100.0	5	83.3	87	96.7	–	–	55	93.2
1–40	–	–	–	–	–	–	–	–	–	–	1	16.7	3	3.3	1	11.1	4	6.8
Over 40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	88.9	–	–
Class 6 (%)																		
None	25	78.1	50	66.7	28	80.0	16	88.9	13	44.8	2	33.3	71	78.9	7	77.8	3	5.1
1–20	7	21.9	21	28.0	6	17.1	–	–	11	37.9	3	50.0	17	18.9	–	–	16	27.1
21–40	–	–	4	5.3	1	2.9	2	11.1	3	10.3	1	16.7	2	2.2	2	22.2	24	40.7
41–60	–	–	–	–	–	–	–	–	2	6.9	–	–	–	–	–	–	11	18.6
Over 60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	8.5
Total Farms in the Group	32		75		35		18		29		6		90		9		59	

Percentage of Cropped Land under	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 8		Group 9	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
A) <u>Fruit Trees</u>																		
None	9	28.1	6	8.0	28	80.0	17	94.4	9	31.0	4	66.7	78	86.7	9	100.0	46	78.0
1-30	-	-	2	2.7	2	5.7	1	5.6	-	-	1	16.7	11	12.2	-	-	7	11.9
31-60	5	15.6	23	30.7	5	14.3	-	-	2	6.9	1	16.7	1	1.1	-	-	5	8.5
61-99	9	28.1	16	21.3	-	-	-	-	5	17.2	-	-	-	-	-	-	-	-
100	9	28.1	28	37.3	-	-	-	-	13	44.8	-	-	-	-	-	-	1	1.7
B) <u>Vegetables</u>																		
None	9	28.1	29	38.7	-	-	7	38.9	14	48.3	-	-	-	-	1	11.1	1	1.7
1-30	6	18.7	14	18.7	-	-	3	16.7	3	10.3	-	-	-	-	1	11.1	3	5.1
31-60	8	25.0	16	21.3	5	14.3	7	38.9	4	13.8	-	-	7	7.8	-	-	6	10.2
61-99	4	12.5	11	14.7	3	8.6	1	5.6	1	3.4	2	33.3	22	24.4	4	44.4	15	24.4
100	5	15.6	5	6.7	27	77.1	-	-	7	24.1	4	66.7	61	67.8	3	33.3	34	57.6
C) <u>Cereals</u>																		
None	28	87.5	69	92.0	34	97.1	-	-	26	89.7	5	83.3	69	76.7	3	33.3	44	74.6
1-30	2	6.2	4	5.3	1	2.9	7	38.9	1	3.4	1	16.7	9	10.0	-	-	3	5.1
31-60	2	6.2	2	2.7	-	-	-	-	1	3.4	-	-	12	13.3	4	44.4	9	15.3
61-99	-	-	-	-	-	-	4	22.2	1	3.4	-	-	-	-	1	11.1	3	5.1
100	-	-	-	-	-	-	7	38.9	-	-	-	-	-	-	1	11.1	-	-
Total Farms in the group	32		75		35		18		29		6		90		9		59	