Land Use Policy

Socio-economic, structural, and policy drivers of agroforestry in Great Britain

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Corresponding Author:	Francisco Areal Northumbria University Newcastle Upon Tyne, UNITED KINGDOM
First Author:	Francisco Jose Areal
Order of Authors:	Francisco Jose Areal
	Kyriaki Remoundou
	Beth Clark
	Shan Jin
	Rao Fu
	Felix Eigenbrod
	Martin Lukac
	Yit Teh
	Lynn J Frewer
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Response to Reviewers:	

23/02/2026

Dear Prof. Uchendu Eugene Chigbu,

Thank you for giving us the opportunity to revise our manuscript entitled “What drives agroforestry in Great Britain? Analysing economic, structural, social, and policy factors” co-authored by Kyriaki Remoundou, Beth Clark, Shan Jin, Rao Fu, Felix Eigenbrod, Martin Lukac, Yit Arn Teh and Lynn J Frewer.

We are grateful to both reviewers for their constructive comments. We believe we have addressed all points raised by reviewers.

Sincerely,

Francisco Areal

Response to Reviewer 1 comments:

Reviewer #1: The paper has improved considerably. The presentation of the results through new tables, figures and a new structure make it much easier to read and follow the arguments.

We thank the reviewer for these comments.

The highlights should be thought through again. I see that the other reviewer wants them to be more specific, but now they cannot be understood. These two are very difficult:
*** Five-year uptake: small woods, shelterbelts preferred over silvoarable systems**
*** Target by region & farm type: South East cereals/livestock for silvoarable**

We agree with the reviewer that these highlights are difficult to be understood. We have decided to change them for the following:

Farmers are more likely to adopt small woods and windbreaks

The likelihood of adoption depends on the region and farm type

After a final check on punctuation and addressing my few comments below, it should be good for publication.

L284 write out PCA on first mentioning in the text

Thank you. This is done now.

Figure 3: check the legend on each graph. Some are covering the first item

We thank the reviewer for pointing out this issue. The figures have been checked and revised to avoid any legend covering parts of the graphs. We have placed the legend outside the box.

Figure 4, 5 and 6: include more information into the caption that allows to understand that one shows the regional context and the other ones are "real" structural factors. Give them some kind of subcategories.

Thank you. We have now added more information on the caption to enable readers to understand the differences between the structural category. These are 1: regional/spatial; 2: Main income; 3:Farmed area, AF experience and tenure type.

Figure 9: play a bit with the size of the figure and its content. The labels on the

bottom are standing too close.

We thank the reviewer for pointing out this issue. We have amended the graph make the categories at the bottom of the graph more clear.

Response to Reviewer 3 comments:

Reviewer #3: I am satisfied with the revisions made by the authors based on the comments/suggestions made by the reviewers.

We thank the reviewer for the comments made.

However, I am of the view that interrogative titles can be avoided. Dear authors please suggest a non-interrogative title of the manuscript. The title may be like "The drivers of agroforestry in Great Britain" or "Socio-economic, structural, and policy drivers of agroforestry in Great Britain".

We thank the reviewer for making this suggestion.

We have decided to change the title to "Socio-economic, structural, and policy drivers of agroforestry in Great Britain" following the reviewer's suggestion.

Overall a novel work with rigour. Now the paper is technically sound with convincing, and logical arguments.
We thank the reviewer for these comments

Highlights

- Adoption barriers are practice-specific: silvoarable needs market infrastructure
- Farmers are more likely to adopt small woods and windbreaks
- The likelihood of adoption depends on the region and farm type
- Farmer identity dictates uptake: lifestyle identity reduces AF adoption likelihood
- Effective policy: practice-specific incentives + outreach by farmer traits

Socio-economic, structural, and policy drivers of agroforestry in Great Britain

Francisco J. Areal[1], Kyriaki Remoundou[2], Beth Clark[3], Shan Jin[4], Rao Fu[3], Felix Eigenbrod[5], Martin Lukac[6], Yit Arn Teh[3], Lynn J. Frewer[3]

[1] Newcastle Business School, Northumbria University, Newcastle upon Tyne, NE1 8ST, UK

[2] Aberystwyth Business School, Aberystwyth University, Hugh Owen Building Penglais Campus SY23 3DY, UK

[3] School of Natural and Environmental Sciences, Newcastle University, Newcastle upon Tyne, NE1 7RU, UK

[4] Faculty of Business and Law, University of Portsmouth, Portsmouth, PO1 3DE, UK

[5] University of Southampton, Southampton, SO17 1BJ, UK

[6] School of Agriculture, Policy and Development, University of Reading, RG6 6AR, UK

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Corresponding author address:

Francisco J. Areal, Newcastle Business School, Northumbria University, Newcastle upon Tyne, NE1 8ST, United Kingdom

Corresponding author email address:

francisco.areal@northumbria.ac.uk

Socio-economic, structural, and policy drivers of agroforestry in Great Britain

Abstract

Agroforestry (AF) is widely recognised as an effective approach for addressing the climate, biodiversity, and food security impacts of modern agriculture, yet its adoption remains limited. This paper examines the economic, structural, social and policy factors influencing farmer adoption of eight AF practices in Great Britain. Survey data from 315 farmers, including a Best-Worst Scaling (BWS) experiment, are analysed using a spatial multivariate ordered probit model. Farmers show a higher intention to adopt low-intensity practices (e.g., small woods, windbreaks) compared to more transformative integrated systems (silvoarable, silvopasture and agrosilvopasture). The BWS results suggest that the level of financial support is an important consideration when evaluating AF schemes, Farmers prefer schemes that include upfront payments and do not require public access to their land. We further find that the factors affecting the likelihood of adoption differ across the eight practices considered. We argue that strategies aiming to increase AF uptake must be practice-specific and designed to address the distinct technical and perceptual barriers associated with different AF systems (e.g. targeted financial support, and building market infrastructure for silvoarable, coupled with demographically-tailored outreach that aligns scheme communication with farmer identity, age, and location). Scaling up AF requires differentiated, evidence-based interventions that reflect farmer priorities and preferences for specific AF practices.

Keywords: agroforestry adoption, agri-environmental schemes, best-worst scaling, farmers decision-making, spatial analysis

1. Introduction

Agroforestry (AF), the integration of trees with crops or livestock systems, is a land-use approach that can enhance multifunctional ecosystem services (ES) delivery (Baker et al., 2025) in comparison to conventional agriculture (Burgess and Rosati, 2018; García de Jalón et al., 2018b; Kay et al., 2018). Its potential benefits include climate change mitigation through carbon sequestration or regulation of local microclimate effects (Kay et al., 2019), biodiversity promotion (e.g. increasing the presence of breeding farmland birds (Whittingham et al., 2009), the creation of habitats for pollinators and other species (Image et al., 2023), and protection against flooding (Carroll et al., 2004). Along with environmental and climate benefits (Mosquera-Losada et al., 2018), AF can also support productive ES through supporting yields and improving animal welfare (Broster et al., 2017), while supporting food production and having the potential to improve farm productivity and financial performance (García de Jalón et al., 2018b). Despite this compelling portfolio of benefits, the widespread adoption of AF by farmers remains limited in many regions internationally (Borremans et al., 2016; den Herder et al., 2017; Irwin et al., 2022; Sereke et al., 2016; Sharma et al., 2017).

Farm-level decisions regarding AF adoption are made by farmers, landowners or other key stakeholders with relevant influence (García de Jalón et al., 2018a; Valdivia and Poulos, 2009), and therefore understanding such decisions requires examining the farmers' decision-making calculus, which is influenced by economic, structural, social and attitudinal factors (Brown et al., 2021; Celio et al., 2014; Jin et al., 2024). Furthermore, the design of policy incentives, including payment schemes, contract flexibility, and administrative complexity, plays a critical role in shaping uptake (Brown et al., 2021; Celio et al., 2014; Jin et al., 2024). Research into farmer adoption needs to account for both intrinsic motivations and the extrinsic policy framework. Much of the existing literature analyses farmers' intention to adopt AF as a single, undifferentiated practice (Felton et al., 2023; Irwin et al., 2022; Sereke et al., 2016). However, AF adoption is likely to vary significantly across AF practices, as each practice has distinct technical requirements and economic implications. The effectiveness of different AF practices also depends on the biophysical and farm characteristics.

The UK presents a critical and informative context in which to investigate these adoption dynamics. With approximately 3.3% of agricultural land under agroforestry (den Herder et al., 2017), uptake lags behind national ambitions. The UK Climate Change Committee recommends a major expansion of AF to 10% of suitable land by 2050 to meet the government's net-zero emission targets (Climate Change Committee, 2025). Historically, UK farmers received support for AF under the European Union's Common Agricultural Policy (e.g. Natura 2000 payments, forest-environmental payments and support for non-productive investments) (European Commission, 2005). Post-Brexit, UK and devolved governments are developing new domestic policy mechanisms to incentivise AF uptake, such as the AF Plan Grant within the Environmental Management Scheme, Sustainable Farming Incentive (SFI) and/or a Countryside Stewardship (CS) agreement, which offer financial support to farmers/land managers to design, create and maintain an AF system (UK Government, 2025). Currently, initiatives such as the Tree Planting Taskforce and reforms to the Woodland Carbon Code aim to support tree cover expansion by making it easier for land managers to stack multiple revenue streams from multiple ES markets.

This combination of ambitious targets, low adoption rates, and evolving policies presents a valuable and timely research context for examining the barriers to, and facilitators of, farmers' adoption of AF. The results can offer useful lessons for other countries trying to increase AF as they show how structural, policy, social and economic factors influence farmers' willingness to integrate trees on farms. This study contributes to the AF adoption literature by providing a novel approach applied within a policy-relevant setting. First, we investigate farmers' intentions to adopt eight distinct agroforestry practices to identify which practices hold the most appeal to farmers, and why. Second, we explicitly incorporate farmers' preferences for key policy design characteristics (e.g., payment duration, scheme administrator) as factors influencing adoption likelihood. Finally, we examine spatial heterogeneity in adoption intentions across UK regions, acknowledging that local conditions and farming cultures may significantly influence adoption rates. By integrating these dimensions, our analysis aims to provide policymakers and advisors with tailored evidence to

design more effective, context-sensitive support strategies that accelerate agroforestry adoption.

The following sections discuss the factors that can influence farmers' intention to adopt AF (section 2); outline the methodology and data used in this study (section 3); present and discuss the results and offer policy recommendations (section 4); explain the research limitations and future research (section 5); and summarise the findings (section 6).

2. Analytical framework

2.1 Factors affecting AF practices adoption

Research on AF adoption has identified a diverse set of enabling and constraining factors, including economic, social, structural and, policy factors.

Farmers' adoption decisions are often driven primarily by direct economic factors. These include barriers such as high upfront investment and ongoing maintenance costs, uncertain or long-term financial returns, and fears that trees will interfere with core farm operations (Felton et al., 2023; Irwin et al., 2022; Tosh, 2021). Conversely, the potential opportunities for income diversification through timber, non-timber tree products (e.g. fruits, nuts), carbon credits, or ecosystem service payments can serve as a significant economic incentive (FitzGerald et al., 2021; Iversen et al., 2023)

Policy design and implementation can influence farmers' decisions to adopt AF practices (Norton et al., 2024). Evidence from agri-environmental schemes (AES) shows that farmers' enrolment is highly sensitive to scheme attributes. Farmers' willingness to participate is influenced by the level, timing and certainty of payments, contract length and flexibility, and the complexity of administrative requirements (Mamine et al., 2020; Ruto and Garrod, 2009; Schulze et al., 2024; Tyllianakis and Martin-Ortega, 2021). Complex bureaucracy has been found to be a barrier to AF adoption (Hasler et al., 2022; Micha et al., 2015). Upfront payments, simplified application processes, and schemes that minimise obligations for collaboration or public access are more likely to encourage uptake (Abdul-Salam et al., 2022; Schulze et al., 2024; Villamayor-Tomas et al., 2019). Furthermore, uncertainty over policy changes, the administrative burden of claiming payments and the lack of knowledge around woodland management are commonly cited barriers in the forest management literature (Lawrence and Dandy, 2014). Insufficient knowledge around the financial and legal impacts of AF can also be a barrier to uptake among interested farmers (Hood et al., 2025).

The adoption of new land use practices is not purely a rational economic calculation but is deeply embedded in the social context and personal identity. The concept of the "good farmer" is a powerful social norm; practices that align with this identity are more readily adopted. A productivist identity, centred on food production and maintaining tidy, working land, can be a significant barrier to AF adoption. Conversely, a conservationist or "land steward" identity that values environmental management can be a strong enabler (Burton, 2004; Dixon et al., 2022; Jin et al., 2024). Thus, farmers may oppose AF if they want to

manage the land for food production and maintain the land to a specific appearance, whereas farmers who prioritise conservation values (e.g. balancing profit with nature-positive outcomes) may favour AF as a means of realising these values (Lawrence and Dandy, 2014). In addition, farmer concerns about tree-specific diseases have also been reported in the literature as an AF adoption barrier (Houndjo Kpoviwanou et al., 2024). Social networks and regional traditions also play a role in increasing the likelihood of AF adoption, as learning from peers can reduce the associated perceived risks (Rois-Díaz et al., 2018). Rois-Díaz et al. (2018) found that older farmers were less likely to implement AF practices in general when studying AF adoption in eight European countries including Spain (high nature and cultural value, high value trees, and livestock AF), Italy (silvopasture), Greece (high nature and cultural value, silvoarable), Portugal (high nature and cultural value), France (silvoarable), Germany (high nature and cultural value, silvoarable), UK (high value trees, arable AF, and Hungary (silvopasture). Similarly McGinty et al. (2008) reported a negative association between age and AF adoption in Brazil. Neupane et al. (2002) found negative association between age and education level and adoption in Nepal (exotic fodder and grass species), whereas Nkamleu and Manyong (2005) did not find evidence of a similar relationship in Cameroon (agrosilvopastoral). In contrast, Beyene et al. (2019) reported a positive association between age and the adoption of AF practices (silvoarable).

Structural conditions may include broader systemic, biophysical and farm-level conditions and can be important in relation to the practical feasibility of AF adoption. Land tenancy, which is common in the UK, with 31% of farms being mixed tenure and 14% wholly tenanted (DEFRA, 2024), is a critical structural constraint; insecure tenancies or short-term leases directly conflict with the long-term investment in trees, often requiring landlord consent (Barnes et al., 2022; Borremans et al., 2018; FitzGerald et al., 2021; Perks et al., 2018). Farm characteristics and location are also important factors in AF adoption. Biophysical factors such as soil type, topography, and climate determine the suitability of land for different AF practices (Abdul-Salam et al., 2022; Pattanayak et al., 2003). Operational characteristics, including farm size, enterprise type (i.e. farm main income), and existing infrastructure, influence the capacity and economic rationale for adoption (Beyene et al., 2019). Finally, access to knowledge, technical advice, and supply chains for inputs or markets are essential structural enablers or barriers (Reeg, 2011; Sereke et al., 2016).

2.2 Conceptual Framework

Based on previous research, we develop a multidimensional conceptual framework to explain farmers' AF adoption decisions for specific AF practices. The framework, depicted in Figure 1, integrates four categories of decision determinants: economic, structural, policy and social factors (Figure 1).

Economic factors refer to perceived benefits, such as income diversification (FitzGerald et al., 2021; Iversen et al., 2023), perceived opportunities such as job creation, ecosystem service payments, and rural economy support (Sharma et al., 2017), and perceived barriers such as business investment and maintenance costs (Tosh, 2021), increased workload (Felton

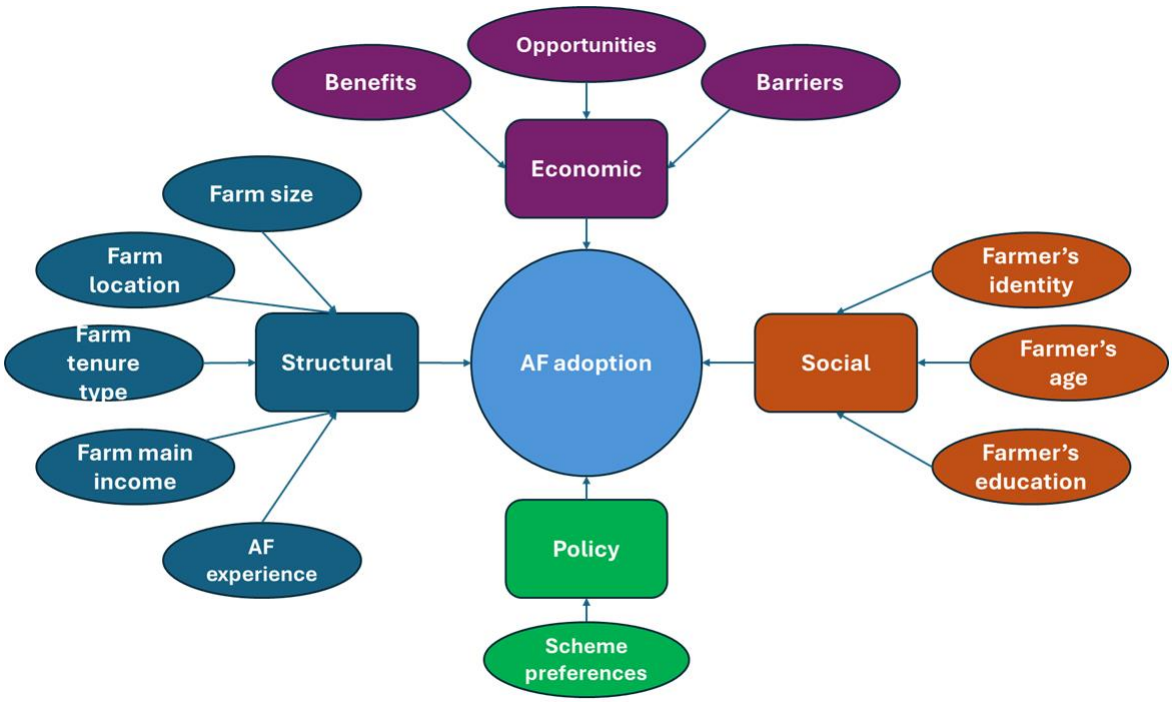
et al., 2023), low short-term financial returns, and fears of interference with core farm operations (Irwin et al., 2022).

Structural factors are the fixed features of the farm and the farmer that enable or constrain adoption. This dimension includes farm characteristics such as farm size and location, which influence biophysical suitability and opportunity costs (Abdul-Salam et al., 2022; Beyene et al., 2019); tenure type, where short rental agreements can preclude long-term investments such as tree planting (Barnes et al., 2022; Perks et al., 2018) and farmers' prior experience with AF.

Policy factors relate to farmers' AF preferences for AF scheme characteristics. The literature on AES highlights that adoption is sensitive to contract length, payment levels, administrative burden and flexibility (Ruto and Garrod, 2009; Schulze et al., 2024).

Social factors include the subjective perceptions, identities, and norms that shape farmers' behaviour. The key element here is farmer identity (e.g. productivist by conservationist) (Burton, 2004). This dimension also accounts for socio-demographic characteristics such as age and education level (Pattanayak et al., 2003; Rois-Díaz et al., 2018).

Figure 1. Conceptual Framework of Factors Influencing Farmer Adoption of Agroforestry Practices



3. Methods

This study examines AF adoption within the UK, which represents a relevant setting due to its national net zero-targets, low AF uptake, and post-Brexit transition in agricultural policy.

AF is widely recognised as a key land-based strategy for climate change mitigation and adaptation globally, yet many countries face similar gaps between policy ambition and AF adoption (Buttoud, 2013; Santiago-Freijanes et al., 2021). Our findings provides insights into how farmers respond to policy instruments and incentives in this context, offering transferable lessons for other nations designing or reforming agri-environmental schemes. For instance, this study is directly relevant to current EU policy debates where increasing AF uptake is embedded in the EU Farm to Fork Strategy (European Commission, 2020b) and the EU Biodiversity Strategy for 2030, which explicitly calls for greater use of AF support under rural development, stating that "the uptake of agroforestry support measures under rural development should be increased as it has great potential to provide multiple benefits for biodiversity, people and climate" (European Commission, 2020a)". Although AF is eligible under both first and second pillar of the CAP 2021-2027, uptake remains low, signalling the need for better-designed incentives.

3.1 Survey questionnaire

In collaboration with the UK Department for Environment, Food and Rural Affairs (DEFRA), we designed an online survey questionnaire to gain a comprehensive understanding of farmers' views and attitudes towards the adoption of AF in Great Britain (England, Scotland and Wales). The survey questionnaire was administered by a marketing company (Potentia-Insight) to a panel of farmers in England, Wales and Scotland during September and October 2023. Our sample includes a total of 315 responses. Table A1 in the Appendix presents the geographical distribution of our sample, which was designed to be representative of farmers in Great Britain. The distribution across countries closely aligns with the proportion of the agricultural workforce in each devolved nation (Appendix A) (DEFRA, 2024). While regional balance was the primary sampling focus, we note that the median farmer age in our sample is 46 years, which is lower than the national median of 62 years for England (DEFRA, 2025). The survey questionnaire took farmers, on average, 28 minutes to complete. Ethics approval was provided by Newcastle University ethics committee on 26th January 2023 (reference 28794/2022).

The survey questionnaire included an introductory section that explained the study's aim and outlined the terms and conditions for participation. This was followed by sections that asked questions about the farmers' existing AF adoption; potential barriers to adoption as perceived by farmers; farmers' intention to adopt AF in the future; farmers' perceptions and attitudes linked to agriculture; and farmers' self-reported identity. Farmers were asked to evaluate a total of 34 statements covering potential opportunities (5), benefits (10), and barriers (19) associated with the adoption of AF, as well as 19 more statements capturing views on farmers' identity using a 5-point Likert scale (Felton et al., 2023). A best-worst scaling (BWS) exercise, in which farmers were asked to choose among different AF scheme characteristics, was also included. The final section included questions on the farm characteristics and the socio-demographic background of the farmer. The survey

questionnaire, which includes the questions analysed in this paper, is provided in Supplementary Material 1.

To measure farmers' preferences for the features of AF schemes, we conducted a Best-Worst Scaling (BWS) experiment (case 1) (Finn and Louviere, 1992; Louviere et al., 2015). BWS is a method designed to study and quantify individual choices (i.e., measure preferences among multiple options). The BWS method is grounded in Random Utility Theory, which posits that individuals select the option they perceive as maximising their utility. We considered a total of 13 features (Table 1). In the BWS task, participants were presented with 13 sets of 4 items and asked to select the "most important feature to be included in the AF scheme" and the "least important feature to be included in the AF scheme" within each set. A balanced incomplete block design (BIBD) was used to ensure that all scheme features are equally represented and compared. enabling us to infer individual preferences for each item based on the responses. Since each attribute was shown to respondents four times and took either a value of -1 or 1, the average total score for each attribute ranges between -4 and 4, with higher values indicating a stronger preference. The R Package AlgDesign was used to generate the BIBD (Wheeler, 2004).

We use the average BWS scores for each of the scheme features as explanatory variables in the AF adoption model.

Table 1. AF scheme features

Feature #	Feature
1	The level of monetary support (payment)
2	Includes upfront payment
3	Includes non-monetary support (e.g. training, advisory, marketing assistance with tree-derived yield)
4	Allows you to select the scheme type (e.g. government, private sector, public-private partnership)
5	Requires collaboration with other farmers (joint/common agroforestry areas)
6	Allows public access to land
7	The length of the AF scheme contract
8	Establishes a minimum planting density
9	Requires planting native species
10	Excludes livestock from the AF scheme
11	Includes additional payment for additional AF management options
12	How the performance is evaluated (e.g. based on measurable outcomes, changes made to the farmland, or both)
13	Includes a withdrawal penalty*

*This variable was removed in the econometric analysis due to multicollinearity

Louviere et al. (2015) show that best and worst data can be summarised by subtracting the worst count for each attribute (i.e., the total number of times an attribute is selected as "least important") from the best count for that attribute (i.e., the total number of times an attribute is selected as "most important").

To assess farmers' intention to adopt AF, we asked farmers to indicate how likely or unlikely they were to adopt (or continue adopting) the following AF practices in their farm in the next 5 years: silvoarable; silvopasture; agrosilvopasture; riparian buffer strips; windbreak/shelterbelt systems; wood pasture and parkland; traditional orchards; and small woods. The answers were recorded on a 5-point Likert scale (from extremely unlikely to extremely likely). The selected AF practices, which were discussed with Defra, were presented to farmers with a description of each AF type (the descriptions are included in Supplementary material 2).

The survey questionnaire included a farm characteristics section, which collected information on farm size and farmed area, main income of the farm, type of farm tenure (owned and/or tenanted, owned land, full agricultural tenancy, farm business tenancy, seasonal agreements), and socio-demographic information such as age, gender and farmers' level of education. We also collected the outcode (i.e. first part of the UK postcode) to obtain the approximate geographic coordinates (latitude and longitude) of the farm location. For the latter step, we used Postcodes.io API, an open-source service that provides detailed information about postcodes, including their geographical coordinates and administrative regions.

Based on this information, we produced a spatial distribution map of farmers' likelihood of adoption by AF type. The Inverse Distance Weighted (IDW) spatial interpolation function was used in the QGIS software. This deterministic method calculates a weighted average of the unknown likelihood of adoption based on the values surrounding known likelihood of adoption, assuming that closer points to the unknown location have a greater influence on the estimated value than those farther away (Pereira et al., 2022). Each point in the map is calculated using the equation (1) below.

$$Z_p = \frac{\sum_{i=1}^{n}\left(\frac{z_i}{d_i^p}\right)}{\sum_{i=1}^{n}\left(\frac{1}{d_i^p}\right)} \qquad (1)$$

where Z_p is the value (likelihood of adoption) of the unknown point that needs to be interpolated; Z_i is the value (likelihood of adoption) of the known point, d_i is the distance to a known point; n is the number of observations, and p is the distance coefficient, which is selected by the user (we use a distance coefficient of 2, which is most commonly used) (Ahmad et al., 2021; Paramasivam and Venkatramanan, 2019).

3.2 Principal component analysis and Econometric model

3.2.1 Principal Component Analysis

We conducted Principal Component Analyses (PCAs) for statements related to the opportunities, benefits, and barriers associated with AF adoption, as well as farmers' identity (full results are available in Supplementary Material 3). To determine the number of components to retain, we employed the Kaiser criterion, which recommends retaining components with eigenvalues greater than or equal to 1. We used Cronbach's alpha and the Kaiser-Meyer-Olkin (KMO) measures to assess the reliability and suitability of data for the analysis (Kaiser, 1970). All scores for the components obtained were rescaled to a 1-5 scale to facilitate interpretation (Areal, Riesgo, et al., 2012) and had a Cronbach's alpha equal to or greater than the 0.70 minimum value standard, ensuring their internal validity and a KMO greater than 0.60, ensuring the dataset is suitable for conducting PCA. The components were subjected to varimax rotation to simplify the structure and enhance interpretability. Using this criterion, the % of total variance captured by PCA for opportunities, benefits, barriers, and good farmers was 46%, 57%, 57%, and 66%, respectively. All components obtained were retained for analysis, as the levels were considered acceptable given the high dimensionality and complexity of the dataset. The components obtained from the PCAs were used as explanatory variables in a multivariate ordered probit model to investigate the likelihood of farmers adopting AF practices.

3.2.2 Econometric model

We estimate the likelihood of adopting different agroforestry practices using a spatial multivariate ordered probit model. This approach simultaneously accounts for the correlation between the multiple adoption decisions and controls for spatial dependence. We model spatial spillovers through a spatial lag variable, which captures the influence of adoption in neighbouring farm locations. This is informed by a spatial weights matrix constructed using farm coordinates and the Haversine distance formula. We further control for underlying geographic variation by including both linear and squared terms of latitude and longitude.

The observed stated likelihood to adopt each of the AF practices i ($i = 1, \dots, 8$) can be represented as:

$$y_i = \{1 \; if \; z_i \leq \tau_1 \; 2 \; if \; \tau_1 < z_i \leq \tau_2 \dots \; k \; if \; z_i > \tau_{k-1} \qquad (2)$$

Where z_i is the latent variable (i.e. unobservable) willingness to uptake AF practice i, τ_s are unknown parameters to be estimated; and y_i is the stated likelihood of adopting a specific AF practice i. The errors (unobserved factors) influencing the latent variables are assumed to follow a multivariate normal distribution, allowing for correlations among the ordinal outcomes. We can represent our model as follows:

$$Y_i = \rho W Y_i + X\beta_i + \varepsilon_i \quad (3)$$

Where Y_i is a vector of the stated likelihood of adopting AF practice i; ρ is the spatial dependence parameter; W is a spatial weight matrix or connectivity matrix; X is a matrix of measurable explanatory variables common to all AF practices, which includes the principal components obtained to capture economic factors, farmers' preferences for AF scheme characteristics obtained through the BWS experiment, regional dummy variables, longitude and longitude coordinates, and farm and farmer characteristics; β_i is a vector of parameters

associated with the explanatory variables for each AF practice; and ε_i captures all the unobservable factors not taken into consideration. The spatial weight matrix is defined as

$$W = exp(-distance_{ij}) \quad (4)$$

where the matrix elements w_{ij} are based on the distance between locations i and j. The negative exponent ensures that as the distance increases, the weight approaches zero.

Our dependent variable Y_i is farmers' response to the following question on AF adoption: *"Please indicate how likely you are to adopt (or continue adopting) the following AF practices in your farm in the next 5 years?"*

The answers were recorded on a 5-point Likert scale ranging from extremely unlikely to extremely likely. The farmers were asked this question for the eight AF types considered in this study: silvoarable, silvopasture, agro-silvopasture, riparian buffer strips, windbreaks, wood pastures, parklands, traditional orchards, and small woods.

4. Results and Discussion

Farmers' intention to adopt AF varies considerably across different practices, though absolute scores on the 1-5 likelihood scale remain moderate overall (Table 2, Figure 2). Overall, intention to adopt is higher for smaller-scale interventions such as small woods (3.26) and shelterbelts (3.13), followed by wood pasture (2.73) and traditional orchards (2.71). In contrast, uptake potential is markedly lower for more integrated systems such as silvoarable, silvopasture, agrosilvopasture, and riparian buffers (2.48), silvopasture (2.22), agrosilvopasture (2.19), and silvoarable (1.91). These results align with the historically limited area under AF in the UK, as well as documented low intention to adopt complex silvoarable systems (den Herder et al., 2017; Newman et al., 2018).

Figure 2 reveals distinct spatial patterns in adoption likelihood, reflecting the variation in suitability by region. These geographical differences have ecological relevance. For instance, in regions showing higher farmer interest in practices such as hedgerows and woodland creation, preferences align with models identifying the same practices as the most effective for enhancing bumblebee abundance and landscape-level pollination services (Image et al., 2023).

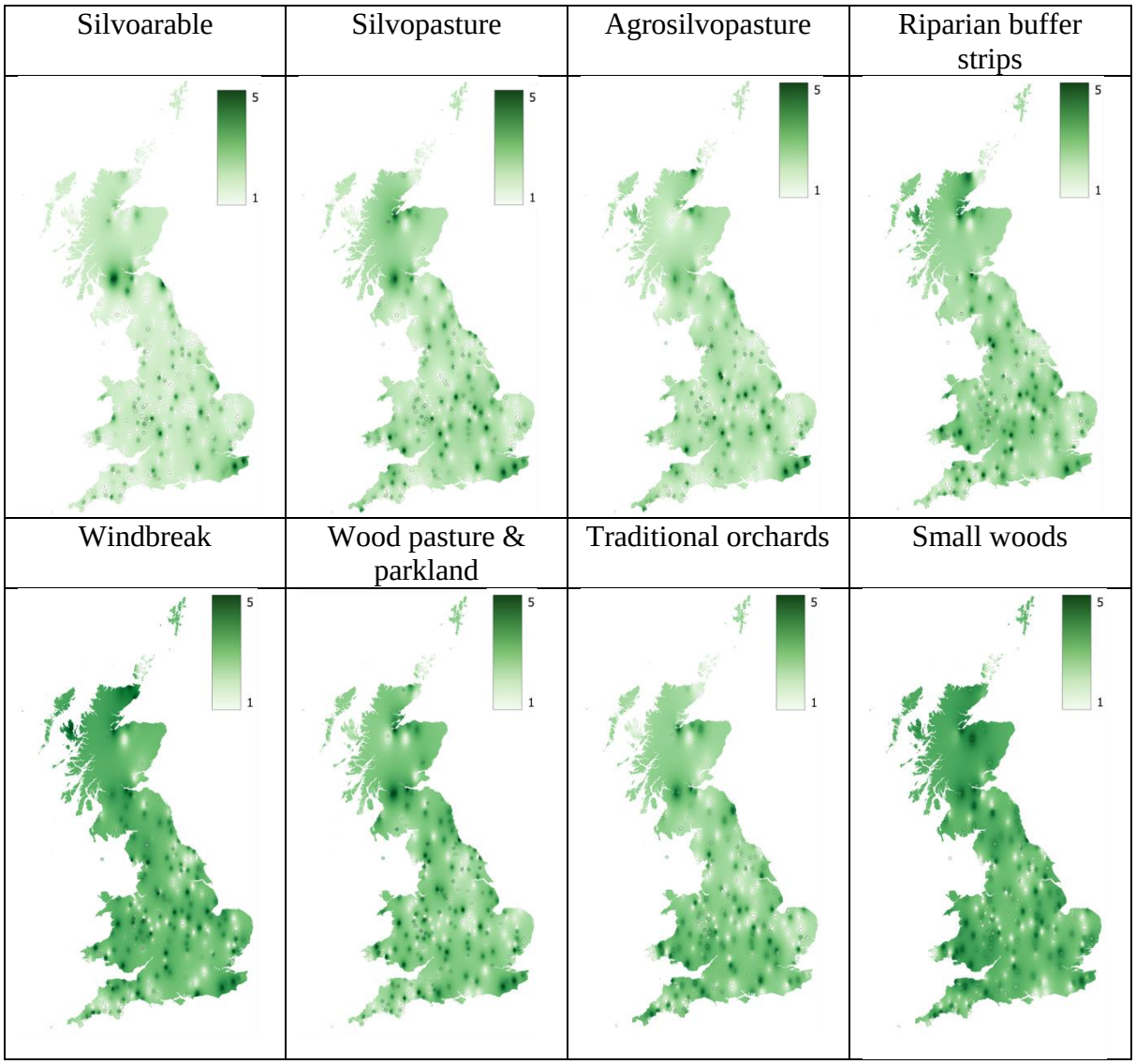
Descriptive statistics for all the variables included in the models are provided in Supplementary Material 3.

Table 2. Likelihood of adoption per AF type (scale 1-5)

AF practice	Mean	Std dev
Silvoarable	1.91	1.11
Silvopasture	2.22	1.24
Agrosilvopasture	2.19	1.18

Riparian buffer strips	2.48	1.30
Windbreak	3.13	1.32
Wood pasture and parkland	2.73	1.36
Traditional orchards	2.71	1.47
Small woods	3.26	1.33

Figure 2. Spatial distribution of the likelihood of farmers adopting AF practices in the next 5 years (1=Extremely unlikely; 5= Extremely likely)



To understand how policy design may influence farmers' intention to adopt AF practices, we conducted a BWS experiment evaluating farmer preferences for 13 AF scheme characteristics (Table 3). The results indicate that the level of financial support is important to farmers. Furthermore, farmers prefer AF schemes that offer financial support (including upfront payments and additional payments for additional AF management options). Schemes that

require farmers to plant native species, and provide non-monetary assistance such as training, advice, and marketing assistance are also more appealing. Farmers also prefer having the flexibility to choose between schemes offered by the government, private and blended finance (public-private partnerships). Conversely, schemes that permit public access to their land, exclude livestock, impose withdrawal penalties, or mandate collaboration with other farmers are less preferred.

Table 3. Farmers' preferences for AF scheme characteristics

Rank	Feature	Score*
1	The level of monetary support (payment)	2.65
2	Includes upfront payment	1.85
3	Includes additional payment for additional AF management options	1.15
4	Requires planting native species	1.12
5	Includes non-monetary support (e.g. training, advisory, marketing assistance with the produce of trees)	0.50
6	Allows you to select the scheme type (e.g. government, private sector, public-private partnership)	0.30
7	How the performance is evaluated (e.g. based on measurable outcomes, changes made to the farmland, or both)	0.26
8	The length of the AF scheme contract	-0.08
9	Establishes a minimum planting density	-0.50
10	Requires collaboration with other farmers (joint/common agroforestry areas)	-1.16
11	Includes a withdrawal penalty	-1.50
12	Excludes livestock from the AF scheme	-1.80
13	Allows public access to land	-2.80

*Average score per attribute ranges between -4 and 4.

We incorporated these preference scores into our econometric model to assess their relationship with the likelihood of adoption.

The results of the spatial multivariate ordered probit models are presented visually in Figures 3–8 (full results in Supplementary Material 3). Findings indicate that economic, structural, social, and policy factors influence the adoption probability for each of the eight AF practices, although the relevance of these factors varies by practice. A significant correlation exists between the error terms of the eight adoption equations, supporting the multivariate approach and indicating that common unobserved factors influence adoption across practices (Appendix B).

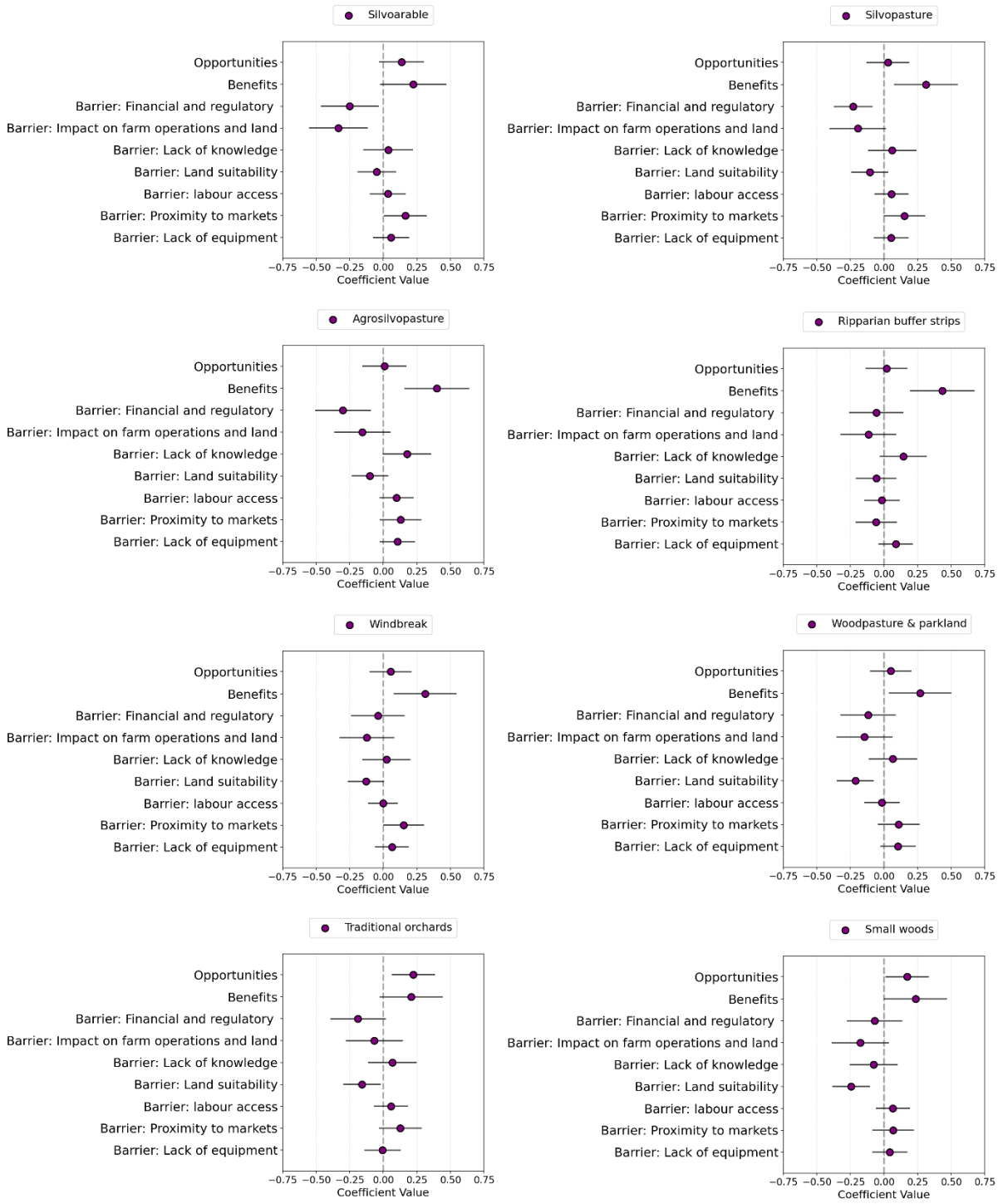
Consistent with our conceptual framework, the following subsections present the econometric results, organised by the four key determinants of adoption: economic, structural, social and policy factors. Policy recommendations are provided under section 4.5.

4.1 Economic factors

Different economic considerations were associated with the likelihood of adopting various AF practices (Figure 3). Specifically, our results suggest that farmers who associate environmental and economic benefits with AF are more likely to adopt silvopasture, agrosilvopasture, riparian buffer strips, windbreaks, and wood pasture and parkland practices. This relationship was not significant for silvoarable, traditional orchards or small woods. We further find that farmers' positive views regarding the potential opportunities of adopting AF practices are generally not associated with a higher likelihood of adopting these practices, if other factors are held constant, with the exception of traditional orchards and small woods. This finding reveals a degree of scepticism about adoption AF practices unless it is "easy", even from farmers who have favourable opinions on AF benefits and opportunities. These generally do not translate into adoption, except for low-risk practices. This demonstrates that awareness and perceived opportunity may be insufficient to increase the likelihood that farmers implement these changes. Consequently, promoting certain AF practices (e.g. silvoarable) requires moving beyond highlighting long-term benefits and opportunities. To enhance the adoption of AF practices that are influenced by farmers' perceived opportunities and/or benefits of AF, a broader communication of AF benefits and opportunities could be considered or enhanced if already in place. For instance, the use of TV edutainment to influence farmers' decisions to implement changes of agricultural practices has been shown to be an effective way to influence farmers' practices (Areal et al., 2020; Clarkson et al., 2018).

Perceived barriers can explain reluctance to introduce and maintain trees in farmland. Key barriers to adopting silvoarable, silvopasture, and agrosilvopasture AF practices included financial constraints such as high upfront costs, low or delayed returns, and burdensome regulatory requirements. Financial barriers, such as poor financial returns and a reduction in the value of the land, along with regulatory barriers have been previously identified as important obstacles for AF adoption (Lawrence and Dandy, 2014; Valatin et al., 2016). For example, high levels of paperwork have been identified as a factor explaining low grant uptake for woodland expansion services (Lawrence and Dandy, 2014). To overcome financial and regulatory barriers to silvoarable, silvopasture and agrosilvopasture adoption, the introduction of upfront cost support, along with annual payments, could be considered. Perceived risks included fears that AF may impact on other farm operations, the landscape, and the value of the land, and were linked to a lower likelihood of adopting silvoarable practices. Another important perceived barrier was the potential unsuitability of the land for adopting AF practices, particularly in relation to planting trees for wood pasture and parkland, traditional orchards, and small woods. Poor land location has been identified previously as a reason for not planting woodland (Watkins et al., 1996). Perceived importance of market proximity was not a significant factor for most AF practices, except for silvoarable adoption. Finally, barriers such as a lack of knowledge about markets, tree planting and management, a lack of equipment, or poor access to labour were not found to be significantly relevant to the adoption of the AF practices considered in our study.

Figure 3. Influence of economic factors on farmers' intention to adopt AF practices (Coefficient Estimates with 90% Confidence Intervals)



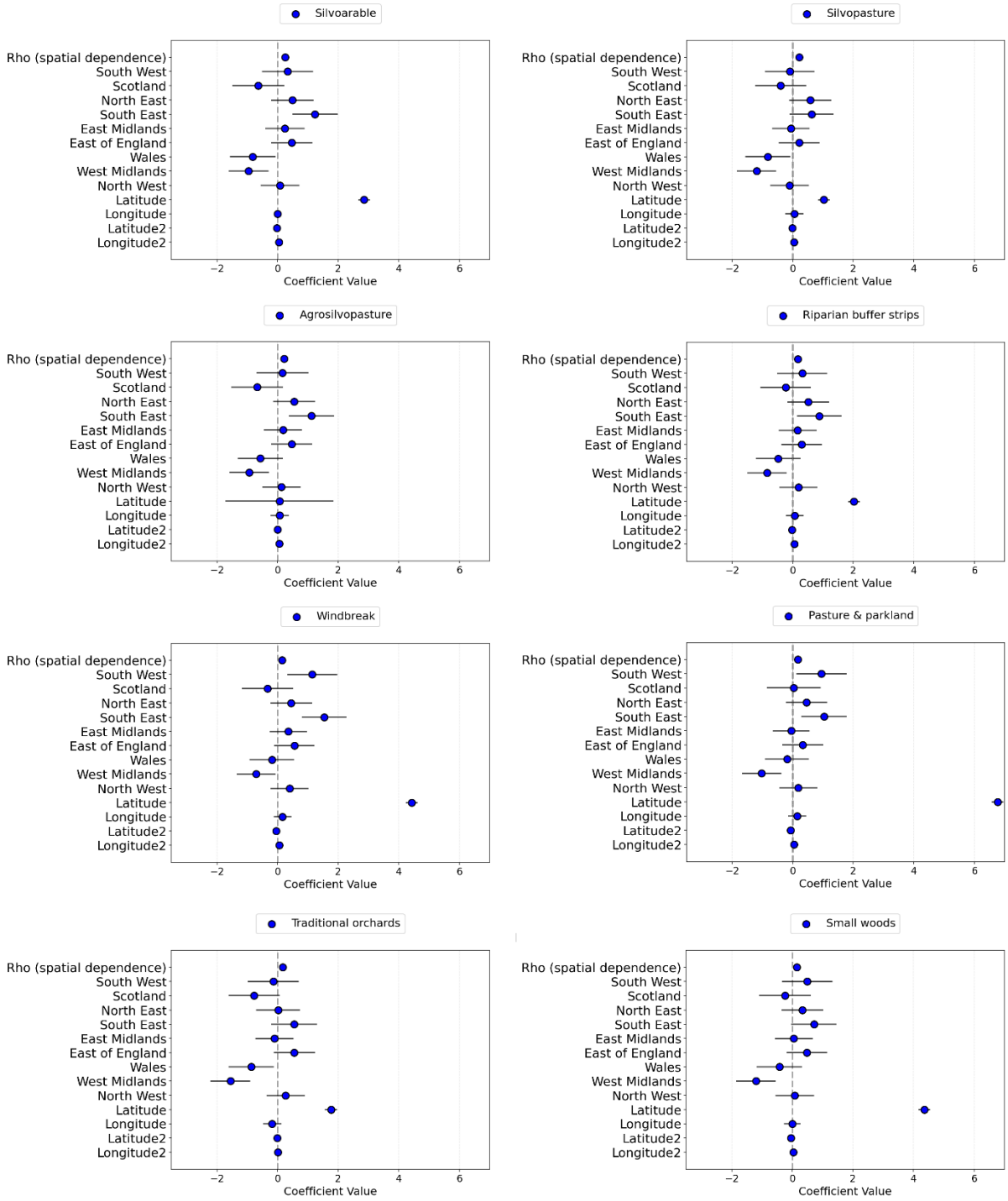
4.2 Structural factors

Adoption of AF by farmers is also influenced by structural factors, including geographical conditions (climate, topography, soil type), the farm's main activity/income, the type of tenancy agreement and prior AF experience (Figures 4-6).

Geographical region dummies and GIS coordinates (longitude and latitude) were used to capture geographically-specific factors, which have been found to be relevant in farms' AF adoption decisions (Abdul-Salam et al., 2022). At the regional level, relative to farmers in Yorkshire and the Humber, which is the reference region, farmers in the South East of England are more likely to adopt silvoarable, agrosilvopasture, riparian buffer strips, windbreaks, and wood pasture and parkland, whereas farmers in the Southwest of England are more likely to adopt windbreaks, wood pasture, and parkland. Adoption likelihood was significantly lower in the West Midlands compared to Yorkshire and the Humber. Farmers in Wales also showed a lower propensity to adopt silvoarable, silvopasture, and traditional orchards relative to the same baseline region. The positive and significant coefficient associated with latitude and the negative coefficient of latitude squared moderate these results, indicating that the likelihood of adopting AF practices increases moving northwards, but at a decreasing rate. The positive and significant coefficient for longitude squared suggests a non-linear relationship, where the likelihood of adopting AF practices initially increases as one moves eastwards, but then decreases after reaching a certain point.

We further find that unobserved spatial heterogeneity plays a role in farmers' willingness to adopt AF practices. The spatial dependence parameter ρ, which captures the spatial dependence of AF adoption (i.e. the association between a farmer's likelihood of adopting AF practices and the neighbouring farmers' likelihood of adopting AF practices), is statistically significant for all AF practices. These findings suggest that the presence of underlying spatial processes shapes AF adoption beyond observable political or administrative boundaries, such as local topography, shared informal knowledge, or local networks (Areal, Balcombe, et al., 2012). Hence, local conditions need to be considered in any scheme that aims to increase AF adoption rates.

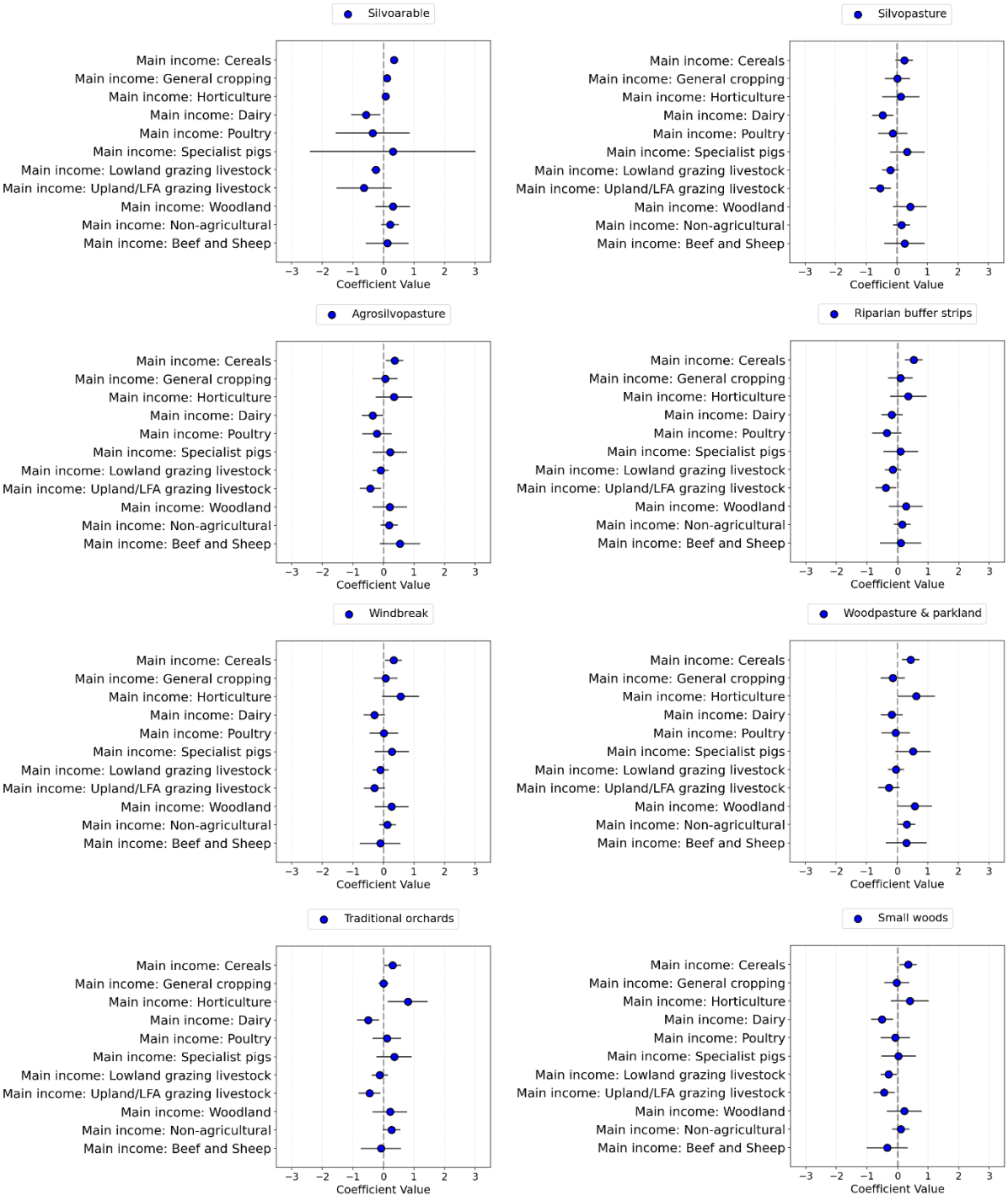
Figure 4. Influence of structural factors on farmers' intention to adopt AF practices (1: regional/spatial) (Coefficient Estimates with 90% Confidence Intervals)



The farm's main source of income is found to be associated with the likelihood of adopting AF practices. Farms where the main income comes from cereal production are more likely to adopt all forms of AF, with the exception of silvopasture and traditional orchards. Our results further suggest that the adoption of traditional orchards, wood pasture and parkland is more likely to happen in horticultural farms. Farms where the main income does not come from agricultural production (e.g. diversification enterprises, agri-environmental schemes) are more likely to adopt wood pasture and parkland. Dairy and upland/Least Favourable Area (LFA) livestock farms are less likely to adopt silvoarable, silvopasture, traditional orchards and small woods. In addition, upland/LFA livestock farms are less likely to adopt

agrosilvopasture and riparian buffer strips. Lowland grazing livestock farms are less likely to adopt small woods. Pearson and McConnachie (2023) note that dairy farmers' values regarding animal health and welfare may favour the planting of hedgerows and tree cover. This finding differs from that of Irwin et al. (2022), who found that dairy farmers in Ireland are generally positive about adopting AF practices on marginal areas of their farms. However, given that dairy farming is time-demanding, current incentives may make AF practices unappealing.

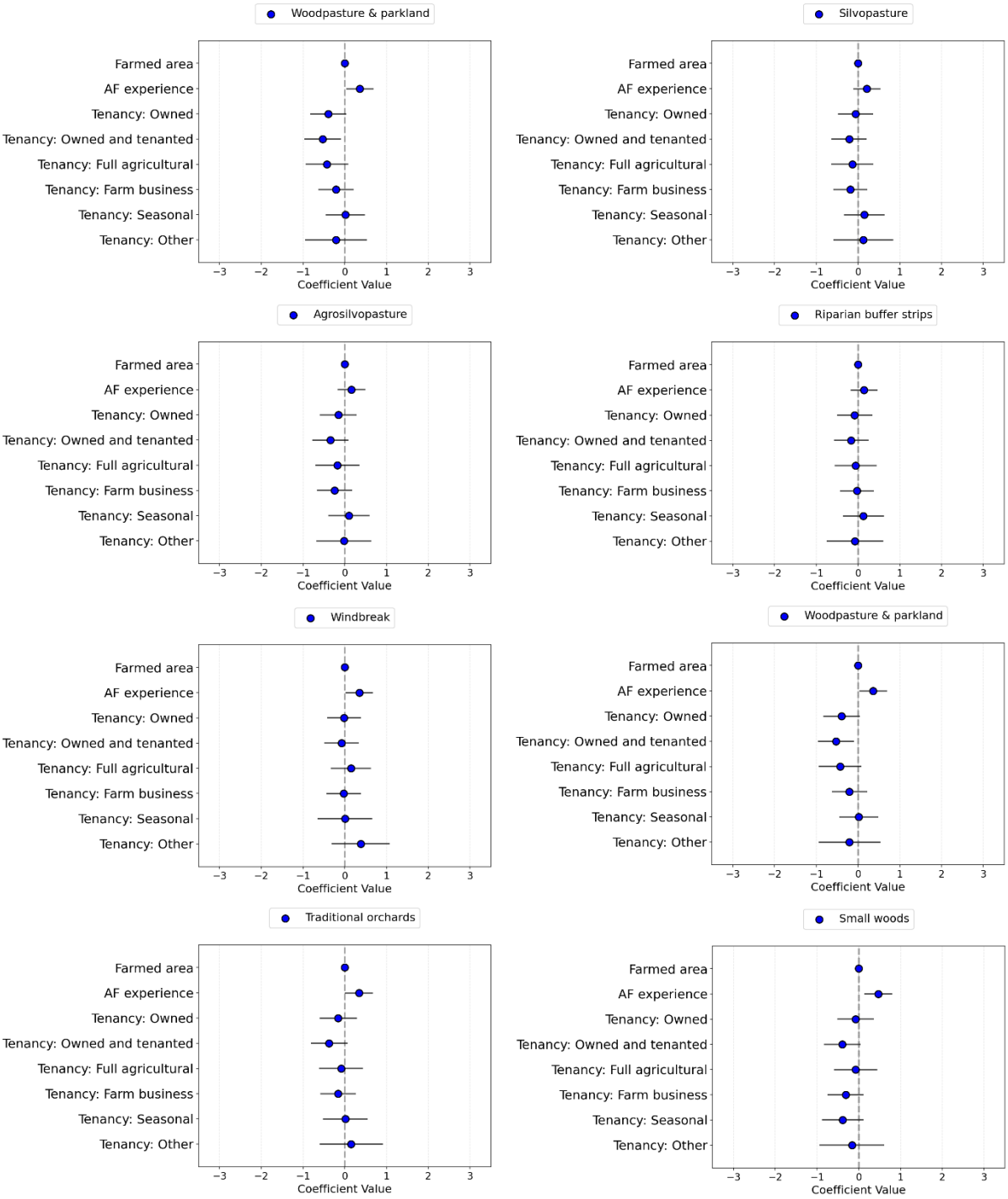
Figure 5. Influence of structural factors on farmers' intention to adopt AF practices (2: Main income) (Coefficient Estimates with 90% Confidence Intervals)



In relation to tenancy type and the adoption of AF practices, Watkins et al. (1996) identified the tenant farmer's need to consult with landowners as a reason for not planting woodland. However, we find that tenancy type is not associated with the likelihood of adopting AF practices when controlling for economic, social, policy and other structural factors.

A factor discouraging adoption of AF practices is that farmers lack experience with AF (Barnes et al., 2022; Rois-Díaz et al., 2018). Here, farmers' experience with AF practices is positively associated with the adoption of windbreaks, wood pastures, and parklands, as well as traditional orchards and small woods (i.e., farmers with experience in these AF practices are more likely to adopt them in 5-year practices than farmers with no experience). This indicates that the likelihood of adopting silvoarable, silvopasture, agrosilvopasture, riparian buffer strips, wood pasture and parkland is not dependent on farmers' experience with AF. Barnes et al. (2022) advocate for a dual approach to policy intervention that distinguishes between past adopters (experienced farmers) and those reluctant to adopt as an initial step in AF implementation. These findings suggest that the successful implementation of this dual approach would need tailoring to specific AF practices. Farm area was found not to be associated with the likelihood of adoption, which is in line with Felton et al. (2023).

Figure 6. Influence of structural factors on farmers' intention to adopt AF practices (3: Farmed area, AF experience and tenure type) (Coefficient Estimates with 90% Confidence Intervals)



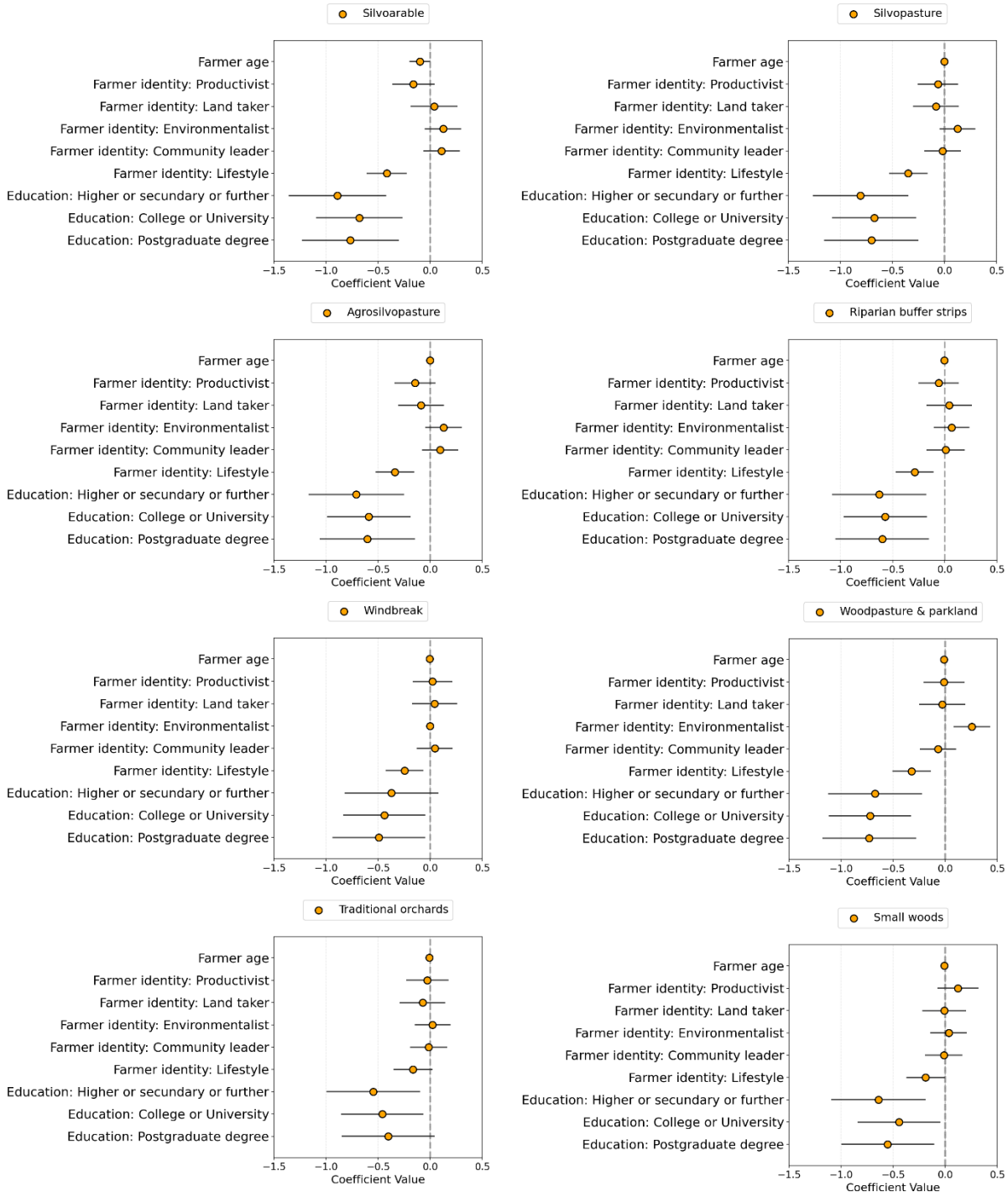
4.3 Social factors

Social factors, such as farmers' age, education, and identity, influenced the adoption of different AF practices in various ways (Figure 7). The farmer's age was found to be negatively correlated with the adoption of silvoarable and wood pasture and parkland. Older farmers were less likely to adopt these practices, potentially due to the perceived amount of time required for the delivery of economic payments; however, no difference in adoption by age was found for other AF practices. However, this finding should be interpreted with the

awareness that our sample is overrepresented by relatively younger farmers compared to the national population. The findings are partially in line with Rois-Díaz et al. (2018), who found that older farmers were less likely to implement AF practices in general. Farmers whose highest level of education is primary/secondary school up to 16 years are more likely to adopt AF practices than farmers with higher education levels.

Farmers' identity can also play a role in AF adoption. Farmers who consider a "good farmer" to be someone who sees farming as a lifestyle, helps friends and neighbours with farming, and values landscape aesthetics are less likely to adopt AF practices, with the exception of traditional orchards. This may be because these farmers perceive AF adoption as a potential threat to the social and cultural benefits they derive from their farms, making them reluctant to change their current land use practices (Howley et al., 2015). Such a stewardship-oriented ethos, which emphasises tradition, mutual support, and aesthetic appreciation of the rural environment, needs to be carefully considered when promoting AF practices among British farmers. Farmers who consider a "good farmer" to be someone who minimises negative impacts of farming on wildlife, minimises the use of pesticides/fungicides that harm wildlife health, maintains habitat for wildlife, manages for both profit and environment, and considers long-term conservation of farm resources before short-term profits are more likely to adopt wood pasture and parkland. This is consistent with US research, where farmers with an environmentalist identity were more likely to plant trees and shrubs on their farmland (Dixon et al., 2022). Kam and Potter (2024) point out an increase in demand for land from new non-farming/lifestyle landowners (e.g. people interested in carbon markets), increasing the heterogeneity of land ownership. These new non-farming/lifestyle landowners may have different attitudes towards agri-environmental schemes compared to farmers, with social and environmental implications.

Figure 7. Influence of social factors on farmers' intention to adopt AF practices (Coefficient Estimates with 90% Confidence Intervals)



4.4 Policy factors

Understanding how farmers' preferences for AF scheme features may influence the adoption of AF practices is key to tailoring schemes to better meet farmers' needs, thereby increasing farmers' uptake of AF practices.

Farmers who prefer monetary payment and non-monetary support (e.g. training, advisory, marketing assistance with the produce of trees) as a feature of an AF scheme express a higher likelihood of adopting some of the eight AF practices studied (specifically, silvopasture, agrosilvoapsture, windbreaks and traditional orchards). Farmers who consider the payment

level as an important feature in an AF scheme indicate a higher likelihood of adopting each of the AF practices analysed, with the exception of small woods. The use of upfront payments has been previously found to increase the likelihood of adoption, but these need to be (perceived to be) significant (Abdul-Salam et al., 2022). A preference for upfront payments was not found to influence the probability of adoption. However, the upfront cost involved represented the main financial and regulatory barrier to adoption of silvoarable, silvopasture and agrosilvopasture practices.

Likewise, our results suggest that farmers who prefer schemes that allow public access to land and require planting native species are more likely to adopt silvopasture, agrosilvopasture, riparian buffer strips, windbreak and traditional orchards. In addition, farmers who perceive schemes allowing public access to their land or requiring native tree species to be planted, unappealing, are more likely to plant woodpark and parkland. As shown in Table 3, allowing public access to land is the least preferred option of an AF scheme, with 91% of farmers disliking public access. Hence, introducing this feature as part of an AF scheme would possibly need to be linked to strong incentives such as a monetary "compensation" for allowing public access. Farmers who prefer schemes with an established minimum planting density are more likely to adopt agrosilvopasture, riparian buffer strips, windbreaks, and traditional orchards.

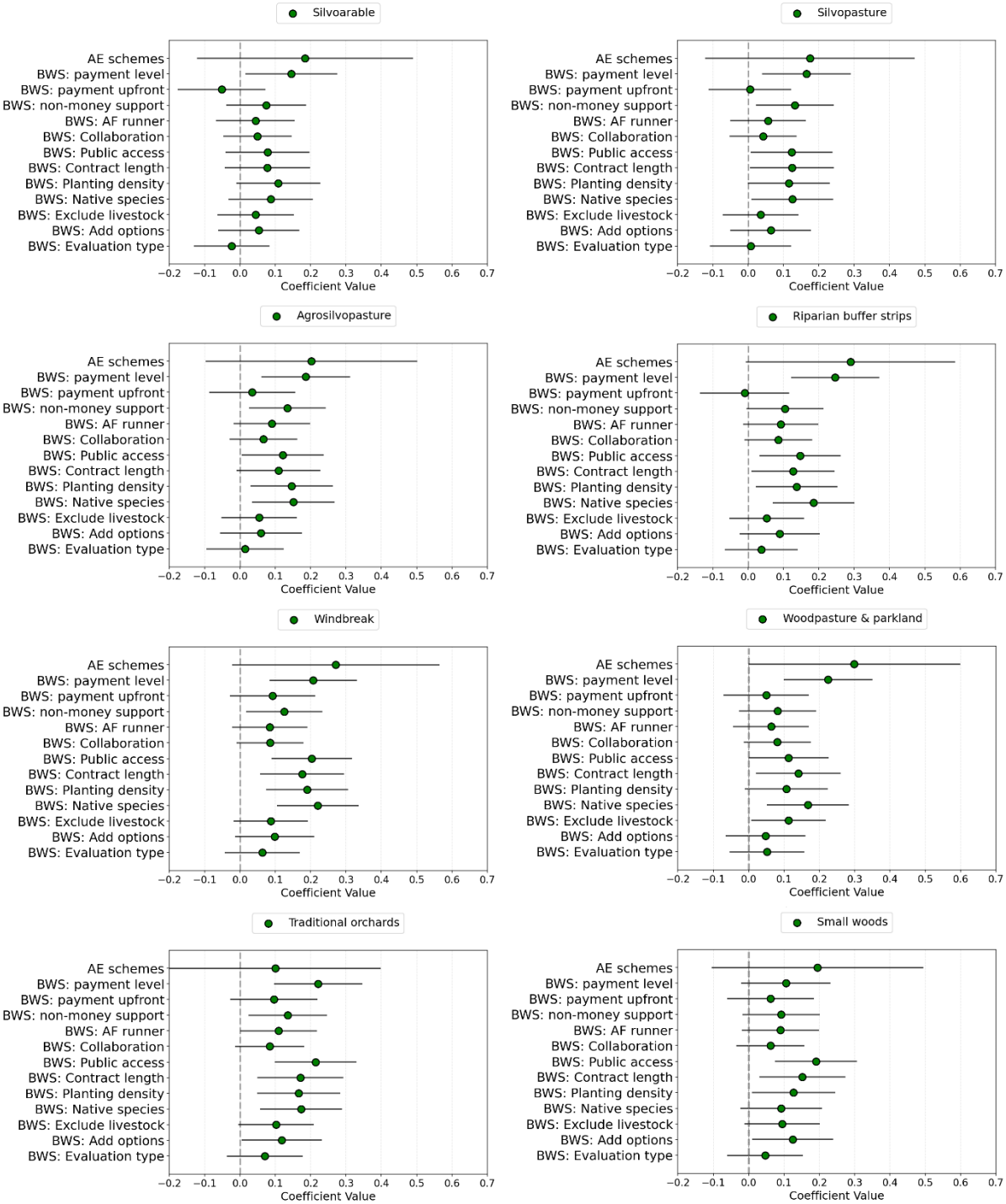
Farmers who showed a preference for schemes allowing them to select the type of scheme (e.g., government, private sector, public-private partnership) or requiring collaboration with other farmers were neither more nor less likely to adopt AF. To incentivise farmers to collaborate within an AF scheme, the introduction of communication strategies and specific monetary compensation may be necessary. Previous research on the relationship between collaboration with other farmers and the adoption of AF practices has yielded mixed results. Villamayor-Tomas et al. (2019) found that the need to coordinate tree planting with other farmers was negatively associated with farmers' participation in an AF scheme. In addition, Emery and Franks (2012) report that such collaboration with other farmers would be more likely if a lesser amount of land is taken out of production, or if the change were minimal.

Excluding livestock from the AF scheme was a characteristic disliked by the majority of farmers in the sample (78%). Farmers' preferences regarding the livestock were not found to influence the probability of adopting AF practices, except for planting wood pasture and parkland. In this case, the more acceptable it was for farmers to exclude livestock as part of the AF scheme, the more likely they were to adopt wood pasture and parkland.

Farmers who considered the scheme contract length as important were more likely to adopt all AF practices, except for silvoarable and agrosilvopasture. Farmers who considered the planting density an important characteristic of an AF scheme were more likely to adopt AF practices with the exception of silvoarable, silvopasture and wood pasture and parkland.

Finally, the likelihood of AF uptake did not differ significantly across farmers with different preferences regarding how the performance is evaluated (e.g. based on measurable outcomes, changes made to the farmland, or both).

Figure 8. Influence of preference over scheme characteristics on farmers' intention to adopt AF practices (Coefficient Estimates with 90% Confidence Intervals)

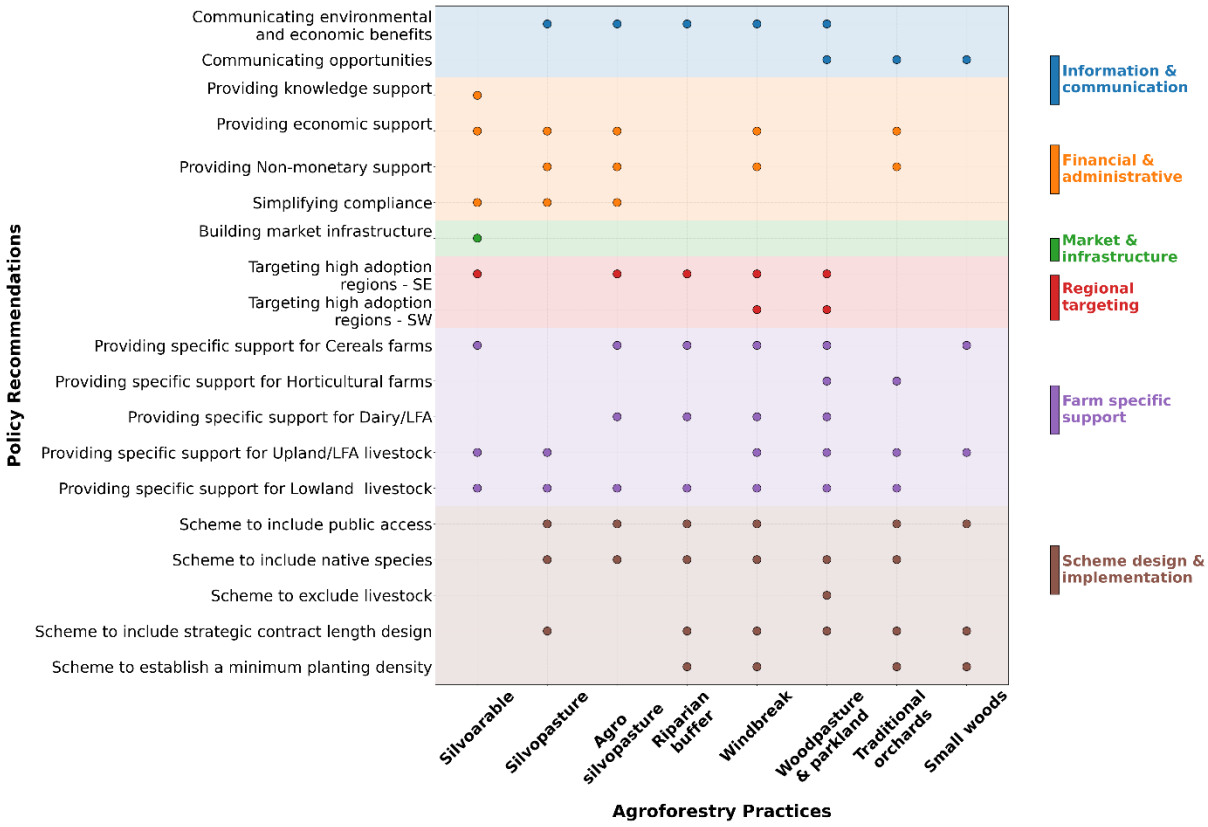


4.5 Policy recommendations

Figure 9 presents a policy-practice alignment matrix showing recommended policy interventions to encourage adoption of agroforestry practices. Each dot indicates a specific

policy recommendation applicable to a given AF practice, with dots coloured by policy category. Empty spaces indicate that no specific recommendation was identified.

Figure 9. Policy-AF practice Matrix: Recommended policy interventions to encourage AF adoption



While Figure 9 summarises which policy interventions are relevant for different AF practices, effective implementation of these policies also requires considering farmer characteristics. An efficient AF policy should focus on targeting farmers and AF systems that are more likely to provide environmental benefits at relatively low cost (of implementing a policy). In this regard, the analysis can be used to design strategies specific to each of the eight AF practices studied. For instance, strategies aiming to increase silvoarable adoption could primarily target young farmers who do not view farming as a lifestyle choice, with a full agricultural tenancy and farms located in cereal-growing areas, such as the Southeast, Northeast, East of England, and Yorkshire. Also to increase uptake, policymakers should develop strategic contract designs that balance duration with flexibility and financial security. This means offering secure, long-term agreements with clear exit options and risk mitigation to align with farmer priorities.

5. Research limitations and future research

This study does not include Northern Ireland farms, which does not allow us to derive conclusions and generalise the results to the UK level. We find that AF adoption varied across the UK which may be attributed to differences in traditional practices, biogeographic

conditions and types of farming practiced. However, further research is needed to explore this issue in more detail. Qualitative methods may enable a more in-depth examination of the underlying reasons for these differences.

The composition of our sample, which disproportionately includes younger farmers relative to the national farming population is a limitation. Given that prior research (Rois-Díaz, 2018) suggests older farmers may be less inclined to adopt agroforestry, this age bias could have led to an overestimation of overall enthusiasm for AF practices in the wider farming community. Consequently, the actual level of interest and potential adoption rates among the regional population may be lower than those indicated by our study.

Research on AF adoption could be expanded to not only examine not only the practices that farmers are willing to adopt, but also consider the specific tree species and the area they are willing to enrol in an AF scheme. This would assist the design and implementation of more targeted and effective policies aiming to increase the presence of trees on farmland and the tree cover in the UK.

6. Conclusions

The UK and devolved governments have introduced policies to increase the tree cover and meet net-zero and environmental goals. AF can play an important role in achieving these goals, yet farmer uptake remains low. Using a survey of farmers across England, Scotland and Wales, we analysed how economic (perceptions of barriers, benefits and opportunities), structural (farm characteristics), social (farmer identity and demographic characteristics) and policy (preferences for the characteristics of an AF incentive scheme) factors influence the likelihood of adoption of eight distinct AF practices.

Economic, structural, social, and policy factors can influence AF adoption, but their influence varies significantly by practice. The results suggest that, over the next five years, adoption is forecast to be greater for low-intensity practices, such as small woods, windbreaks, and traditional orchards, compared to integrated systems, including silvoarable, silvopasture, and agrosilvopasture.

Our analysis offers valuable insights for designing more effective policies to promote AF adoption in the UK. Even when farmers see benefits in agroforestry, that positive view rarely leads to adoption—unless the practice is low-risk and simple. Promoting awareness and long-term opportunities is not enough to overcome farmers' hesitation toward more complex practices like silvoarable systems. Policy must therefore address practical barriers and reduce perceived risk to turn favourable opinions into actual adoption. We find that a combination of tailored interventions is required. Three main findings should guide future strategy: a) adoption is practice-specific so policy cannot be uniform across the UK and in relation to agricultural practices; b) effective agroforestry policy requires a dual strategy of practice-specific support (e.g., market infrastructure for silvoarable) and demographically-tailored

outreach (e.g., identity-aligned messaging for different farmers); and c) by targeting specific regions and farm types—for instance, focusing silvoarable support on cereal and livestock farms in South East England—policy can be optimised to align with local suitability and farmer profiles, thereby increasing uptake efficiency.

Successfully scaling up AF depends on moving beyond a one-size-fits-all approach. Future policy must implement differentiated, evidence-based interventions that address both the technical barriers of each AF practice and the perceptual barriers of different farmer groups.

References

Abdul-Salam, Y., Ovando, P., Roberts, D., 2022. Understanding the economic barriers to the adoption of agroforestry: A Real Options analysis. Journal of Environmental Management 302, 113955.

Ahmad, A.Y., Saleh, I.A., Balakrishnan, P., Al-Ghouti, M.A., 2021. Comparison GIS-Based interpolation methods for mapping groundwater quality in the state of Qatar. Groundwater for Sustainable Development 13, 100573.

Areal, F.J., Clarkson, G., Garforth, C., Barahona, C., Dove, M., Dorward, P., 2020. Does TV edutainment lead to farmers changing their agricultural practices aiming at increasing productivity? Journal of Rural Studies 76, 213-229.

Baker, T.P., England, J.R., Brooks, S.T., Stewart, S.B., Mendham, D., 2025. Effect of silvopasture, paddock trees and linear agroforestry systems on agricultural productivity: A global quantitative analysis. Agricultural Systems 224, 104240.

Barnes, A.P., McMillan, J., Sutherland, L.A., Hopkins, J., Thomson, S.G., 2022. Farmer intentional pathways for net zero carbon: Exploring the lock-in effects of forestry and renewables. Land Use Policy 112, 105861.

Beyene, A.D., Alemu, M., Bluffstone, R., and Deribe, R., 2019. Household Level Determinants of Agroforestry Practices Adoption in Rural Ethiopia. Forests, Trees and Livelihoods 28, 194-213.

Borremans, L., Bert, R., Bert, V.G., Dorien, B., Céline, V., and Wauters, E., 2016. A sociopsychological analysis of agroforestry adoption in Flanders: understanding the discrepancy between conceptual opportunities and actual implementation. Agroecology and Sustainable Food Systems 40, 1008-1036.

Borremans, L., Marchand, F., Visser, M., Wauters, E., 2018. Nurturing agroforestry systems in Flanders: Analysis from an agricultural innovation systems perspective. Agricultural Systems 162, 205-219.

Broster, J.C., Dehaan, R.L., Swain, D.L., Robertson, S.M., King, B.J., Friend, M.A., 2017. Shelter type and birth number influence the birth and death sites of lambs and ewe movement around lambing time1. Journal of Animal Science 95, 81-90.

Brown, C., Kovács, E., Herzon, I., Villamayor-Tomas, S., Albizua, A., Galanaki, A., Grammatikopoulou, I., McCracken, D., Olsson, J.A., Zinngrebe, Y., 2021. Simplistic understandings of farmer motivations could undermine the environmental potential of the common agricultural policy. Land Use Policy 101, 105136.

Burgess, P.J., Rosati, A., 2018. Advances in European agroforestry: results from the AGFORWARD project. Agroforestry Systems 92, 801-810.
Burton, R.J.F., 2004. Seeing Through the 'Good Farmer's' Eyes: Towards Developing an Understanding of the Social Symbolic Value of 'Productivist' Behaviour. Sociologia Ruralis 44, 195-215.
Carroll, Z.L., Bird, S.B., Emmett, B.A., Reynolds, B., Sinclair, F.L., 2004. Can tree shelterbelts on agricultural land reduce flood risk? Soil Use and Management 20, 357-359.
Celio, E., Flint, C.G., Schoch, P., Grêt-Regamey, A., 2014. Farmers' perception of their decision-making in relation to policy schemes: A comparison of case studies from Switzerland and the United States. Land Use Policy 41, 163-171.
Clarkson, G., Garforth, C., Dorward, P., Mose, G., Barahona, C., Areal, F., Dove, M., 2018. Can the TV makeover format of edutainment lead to widespread changes in farmer behaviour and influence innovation systems? Shamba Shape Up in Kenya. Land Use Policy 76, 338-351.
Climate Change Committee, 2025. The seventh carbon budget.
DEFRA, 2024. Farming evidence - key statistics.
DEFRA, 2025. Agricultural workforce in England at 1 June 2025.
den Herder, M., Moreno, G., Mosquera-Losada, R.M., Palma, J.H.N., Sidiropoulou, A., Santiago Freijanes, J.J., Crous-Duran, J., Paulo, J.A., Tomé, M., Pantera, A., Papanastasis, V.P., Mantzanas, K., Pachana, P., Papadopoulos, A., Plieninger, T., Burgess, P.J., 2017. Current extent and stratification of agroforestry in the European Union. Agriculture, Ecosystems & Environment 241, 121-132.
Dixon, A.P., Arbuckle, J.G., Ellis, E.C., 2022. Farmer identities influence wildlife habitat management in the US Corn Belt. People and Nature 4, 103-114.
Emery, S.B., Franks, J.R., 2012. The potential for collaborative agri-environment schemes in England: Can a well-designed collaborative approach address farmers' concerns with current schemes? Journal of Rural Studies 28, 218-231.
European Commission, 2005. Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development

by the European Agricultural Fund for Rural Development (EAFRD)
Felton, M., Jones, P., Tranter, R., Clark, J., Quaife, T., Lukac, M., 2023. Farmers' attitudes towards, and intentions to adopt, agroforestry on farms in lowland South-East and East England. Land Use Policy 131, 106668.
Finn, A., Louviere, J.J., 1992. Determining the Appropriate Response to Evidence of Public Concern: The Case of Food Safety. Journal of Public Policy & Marketing 11, 12-25.
FitzGerald, O., Collins, C.M., Potter, C., 2021. Woodland Expansion in Upland National Parks: An Analysis of Stakeholder Views and Understanding in the Dartmoor National Park, UK, Land.
García de Jalón, S., Burgess, P.J., Graves, A., Moreno, G., McAdam, J., Pottier, E., Novak, S., Bondesan, V., Mosquera-Losada, R., Crous-Durán, J., Palma, J.H.N., Paulo, J.A., Oliveira, T.S., Cirou, E., Hannachi, Y., Pantera, A., Wartelle, R., Kay, S., Malignier, N., Van Lerberghe, P., Tsonkova, P., Mirck, J., Rois, M., Kongsted, A.G., Thenail, C., Luske, B., Berg, S., Gosme, M., Vityi, A., 2018a. How is agroforestry perceived in Europe? An assessment of positive and negative aspects by stakeholders. Agroforestry Systems 92, 829-848.

García de Jalón, S., Graves, A., Palma, J.H.N., Williams, A., Upson, M., Burgess, P.J., 2018b. Modelling and valuing the environmental impacts of arable, forestry and agroforestry systems: a case study. Agroforestry Systems 92, 1059-1073.
Hasler, B., Termansen, M., Nielsen, H.Ø., Daugbjerg, C., Wunder, S., Latacz-Lohmann, U., 2022. European agri-environmental policy: Evolution, effectiveness, and challenges. Review of Environmental Economics and Policy 16, 105-125.
Hood, A.S.C., Scherfranz, V., Scholes, R.E., Degani, E., Staton, T., Varah, A., Schaller, L., Mauchline, A.L., 2025. Identifying knowledge barriers to agroforestry adoption and co-designing solutions to them. People and Nature n/a.
Houndjo Kpoviwanou, M.R.J., Sourou, B.N.K., Ouinsavi, C.A.I.N., 2024. Challenges in adoption and wide use of agroforestry technologies in Africa and pathways for improvement: A systematic review. Trees, Forests and People 17, 100642.
Howley, P., Buckley, C., O Donoghue, C., Ryan, M., 2015. Explaining the economic 'irrationality' of farmers' land use behaviour: The role of productivist attitudes and non-pecuniary benefits. Ecological Economics 109, 186-193.
Image, M., Gardner, E., Breeze, T.D., 2023. Co-benefits from tree planting in a typical English agricultural landscape: Comparing the relative effectiveness of hedgerows, agroforestry and woodland creation for improving crop pollination services. Land Use Policy 125, 106497.
Irwin, R., Dhubháin, Á.N., Short, I., 2022. Irish dairy and drystock farmers' attitudes and perceptions to planting trees and adopting agroforestry practices on their land. Environmental Challenges 9, 100636.
Iversen, S.V., van der Velden, N., Convery, I., Mansfield, L., Kjeldsen, C., Thorsøe, M.H., Holt, C.D.S., 2023. Impacts of woodland planting on nature-based recreational tourism in upland England – A case study. Landscape and Urban Planning 230, 104587.
Jin, S., Cao, Y., Burd, M., Tindale, S., Feng, Z., Green, O., Newell-Price, P., Vicario-Modroño, V., Mack, G., Sánchez-Zamora, P., Gallardo-Cobos, R., Spörri, M., El Benni, N., Alonso, N., Miškolci, S., Outhwaite, S., Hunter, E., Frewer, L.J., 2024. Farmer identities and permanent grassland management: Evidence from five European biogeographic zones. People and Nature 6, 2228-2245.
Kam, H., Potter, C., 2024. Who should deliver agri-environmental public goods in the UK? New land managers and their future role as public good providers. Land Use Policy 139, 107072.
Kay, S., Crous-Duran, J., Ferreiro-Domínguez, N., García de Jalón, S., Graves, A., Moreno, G., Mosquera-Losada, M.R., Palma, J.H.N., Roces-Díaz, J.V., Santiago-Freijanes, J.J., Szerencsits, E., Weibel, R., Herzog, F., 2018. Spatial similarities between European agroforestry systems and ecosystem services at the landscape scale. Agroforestry Systems 92, 1075-1089.
Kay, S., Rega, C., Moreno, G., den Herder, M., Palma, J.H.N., Borek, R., Crous-Duran, J., Freese, D., Giannitsopoulos, M., Graves, A., Jäger, M., Lamersdorf, N., Memedemin, D., Mosquera-Losada, R., Pantera, A., Paracchini, M.L., Paris, P., Roces-Díaz, J.V., Rolo, V., Rosati, A., Sandor, M., Smith, J., Szerencsits, E., Varga, A., Viaud, V., Wawer, R., Burgess, P.J., Herzog, F., 2019. Agroforestry creates carbon sinks whilst enhancing the environment in agricultural landscapes in Europe. Land Use Policy 83, 581-593.
Lawrence, A., Dandy, N., 2014. Private landowners' approaches to planting and managing forests in the UK: What's the evidence? Land Use Policy 36, 351-360.

Louviere, J.J., Flynn, T.N., Marley, A.A.J., 2015. Best-Worst Scaling: Theory, Methods and Applications. Cambridge University Press.
Mamine, F., Fares, M.h., Minviel, J.J., 2020. Contract Design for Adoption of Agrienvironmental Practices: A Meta-analysis of Discrete Choice Experiments. Ecological Economics 176, 106721.
McGinty, M.M., Swisher, M.E., Alavalapati, J., 2008. Agroforestry adoption and maintenance: self-efficacy, attitudes and socio-economic factors. Agroforestry Systems 73, 99-108.
Micha, E., Areal, F.J., Tranter, R.B., Bailey, A.P., 2015. Uptake of agri-environmental schemes in the Less-Favoured Areas of Greece: The role of corruption and farmers' responses to the financial crisis. Land Use Policy 48, 144-157.
Mosquera-Losada, M.R., Santiago-Freijanes, J.J., Rois-Díaz, M., Moreno, G., den Herder, M., Aldrey-Vázquez, J.A., Ferreiro-Domínguez, N., Pantera, A., Pisanelli, A., Rigueiro-Rodríguez, A., 2018. Agroforestry in Europe: A land management policy tool to combat climate change. Land Use Policy 78, 603-613.
Neupane, R.P., Sharma, K.R., Thapa, G.B., 2002. Adoption of agroforestry in the hills of Nepal: a logistic regression analysis. Agricultural Systems 72, 177-196.
Newman, S., Pilbeam, D., Briggs, S., 2018. Agroforestry in the UK. CABI, 72–97.
Nkamleu, G.B., Manyong, V.M., 2005. Factors affecting the adoption of agroforestry practices by farmers in Cameroon. Small-scale Forest Economics, Management and Policy 4, 135-148.
Norton, L.R., Bruce, A., Chapman, P.J., Lamprinopoulou, C., Rothwell, S.A., Smith, L.G., 2024. Identifying levers for change in UK grazing livestock systems. Frontiers in Sustainable Food Systems Volume 8 - 2024.
Paramasivam, C.R., Venkatramanan, S., 2019. Chapter 3 - An Introduction to Various Spatial Analysis Techniques, in: Venkatramanan, S., Prasanna, M.V., Chung, S.Y. (Eds.), GIS and Geostatistical Techniques for Groundwater Science. Elsevier, pp. 23-30.
Pattanayak, S.K., Evan Mercer, D., Sills, E., Yang, J.-C., 2003. Taking stock of agroforestry adoption studies. Agroforestry Systems 57, 173-186.
Pearson, M., McConnachie, S., 2023. Increasing tree cover on dairy farms in England: The role of farmers' values. Forest Research, Farnham.
Pereira, G.W., Valente, D.S.M., de Queiroz, D.M., Santos, N.T., Fernandes-Filho, E.I., 2022. Soil mapping for precision agriculture using support vector machines combined with inverse distance weighting. Precision Agriculture 23, 1189-1204.
Perks, M., Khomik, M., Bathgate, S., Chapman, S., Slee, B., Yeluripati, J., Roberts, D., Morison, J., 2018. Agroforestry in Scotland–potential benefits in a changing climate. CXC Report, July.
Reeg, T., 2011. Agroforestry Systems as Land Use Alternatives in Germany?: A Comparison with Approaches Taken in other Countries. Outlook on Agriculture 40, 45-50.
Rois-Díaz, M., Lovric, N., Lovric, M., Ferreiro-Domínguez, N., Mosquera-Losada, M.R., den Herder, M., Graves, A., Palma, J.H.N., Paulo, J.A., Pisanelli, A., Smith, J., Moreno, G., García, S., Varga, A., Pantera, A., Mirck, J., Burgess, P., 2018. Farmers' reasoning behind the uptake of agroforestry practices: evidence from multiple case-studies across Europe. Agroforestry Systems 92, 811-828.
Roodman, D., 2011. Fitting Fully Observed Recursive Mixed-process Models with cmp. The Stata Journal 11, 159-206.

Ruto, E., Garrod, G., 2009. Investigating farmers' preferences for the design of agri-environment schemes: a choice experiment approach. Journal of Environmental Planning and Management 52, 631-647.
Schulze, C., Zagórska, K., Häfner, K., Markiewicz, O., Czajkowski, M., Matzdorf, B., 2024. Using farmers' ex ante preferences to design agri-environmental contracts: A systematic review. Journal of Agricultural Economics 75, 44-83.
Sereke, F., Dobricki, M., Wilkes, J., Kaeser, A., Graves, A.R., Szerencsits, E., Herzog, F., 2016. Swiss farmers don't adopt agroforestry because they fear for their reputation. Agroforestry Systems 90, 385-394.
Sharma, P., Singh, M., Tiwari, P., Verma, K., 2017. Agroforestry systems: Opportunities and challenges in India. Journal of Pharmacognosy and Phytochemistry 6, 953-957.
Tosh, C., 2021. Increasing adoption of agroforestry in the UK, Policy Brief. Organic Research Centre.
Tyllianakis, E., Martin-Ortega, J., 2021. Agri-environmental schemes for biodiversity and environmental protection: How we are not yet "hitting the right keys". Land Use Policy 109, 105620.
UK Government, 2025. Funding and grants for agroforestry.
Valatin, G., Moseley, D., Dandy, N., 2016. Insights from behavioural economics for forest economics and environmental policy: Potential nudges to encourage woodland creation for climate change mitigation and adaptation? Forest Policy and Economics 72, 27-36.
Valdivia, C., Poulos, C., 2009. Factors affecting farm operators' interest in incorporating riparian buffers and forest farming practices in northeast and southeast Missouri. Agroforestry Systems 75, 61-71.
Villamayor-Tomas, S., Sagebiel, J., Olschewski, R., 2019. Bringing the neighbors in: A choice experiment on the influence of coordination and social norms on farmers' willingness to accept agro-environmental schemes across Europe. Land Use Policy 84, 200-215.
Watkins, C., Williams, D., Lloyd, T., 1996. Constraints on farm woodland planting in England: a study of Nottinghamshire farmers. Forestry: An International Journal of Forest Research 69, 167-176.
Wheeler, R.E., 2004. optBlock. AlgDesign. The R project for statistical computing http://www.r-project.org/.
Whittingham, M.J., Krebs, J.R., Swetnam, R.D., Thewlis, R.M., Wilson, J.D., Freckleton, R.P., 2009. Habitat associations of British breeding farmland birds. Bird Study 56, 43-52.

Appendix A. Farmers sample distribution per English Government Office Region and country

Table A1. Farmers sample distribution per country

Region	# Farmers	% total sample	% people employed in agriculture

England	256	76.4%	72.0%
Scotland	37	11.0%	16.0%
Wales	42	12.5%	12.0%
Total	335	100.0%	100%

Appendix B. Error term correlations

The rho coefficients are direct correlation coefficients between latent errors of the equations. They range between -1 and 1 measuring the degree of association between the unobserved factors influencing the AF practices adoption. All coefficients are greater than 0 indicating a positive correlation (i.e. a high likelihood of adopting a specific AF practice is linked to other AF practices) (Roodman, 2011).

Table 12. Error term correlations

	mean	std.err.
rho_12	0.96	0.01
rho_13	0.96	0.01
rho_14	0.92	0.02
rho_15	0.88	0.02
rho_16	0.85	0.02
rho_17	0.79	0.04
rho_18	0.80	0.04
rho_23	0.98	0.01
rho_24	0.92	0.02
rho_25	0.90	0.02
rho_26	0.86	0.03
rho_27	0.82	0.04
rho_28	0.79	0.04
rho_34	0.91	0.02
rho_35	0.88	0.02
rho_36	0.84	0.03
rho_37	0.79	0.04
rho_38	0.76	0.05
rho_45	0.90	0.02
rho_46	0.86	0.03
rho_47	0.83	0.04
rho_48	0.82	0.04
rho_56	0.88	0.02
rho_57	0.83	0.03
rho_58	0.86	0.03
rho_67	0.87	0.02
rho_68	0.88	0.03
rho_78	0.90	0.02

Figure 1

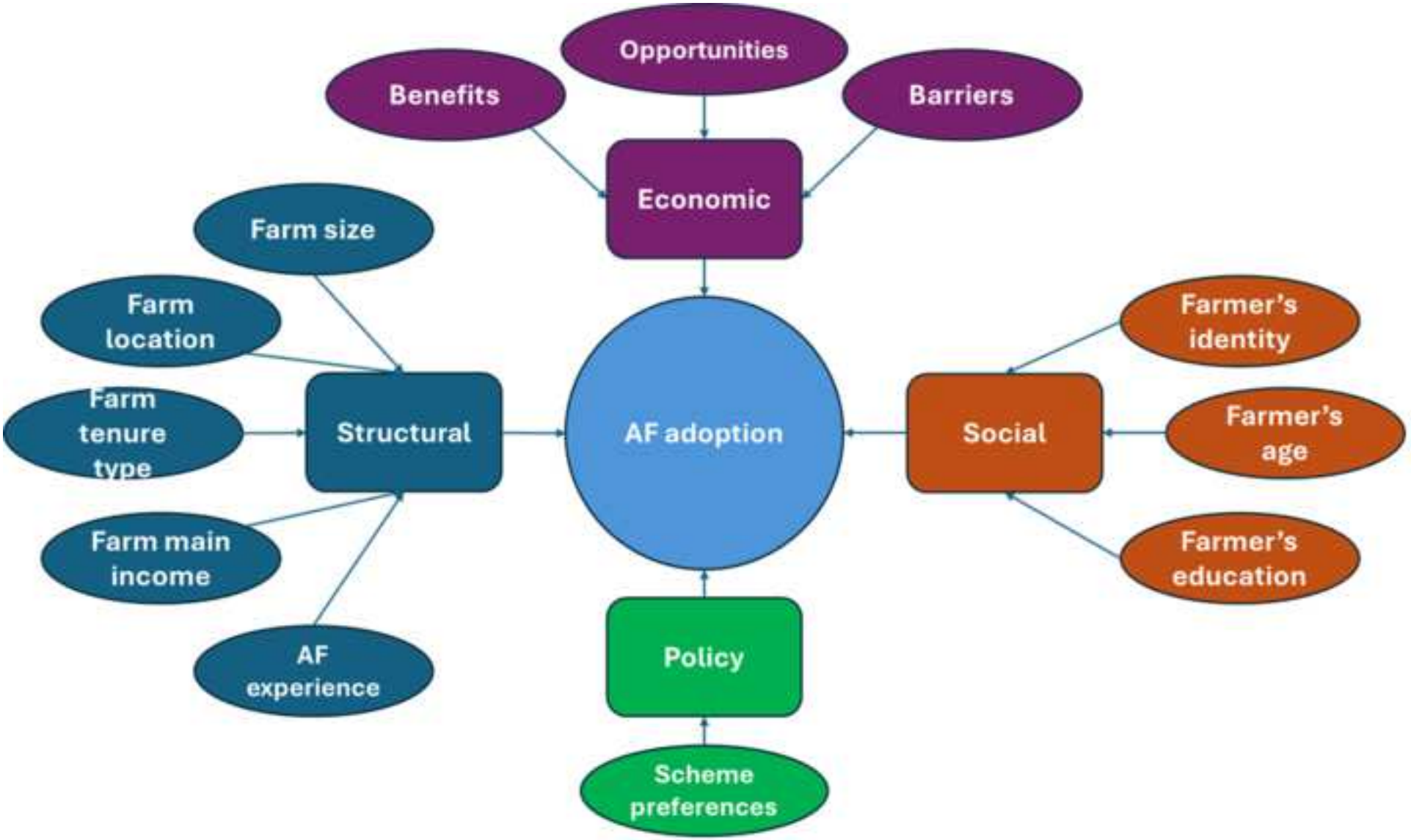


Figure 2

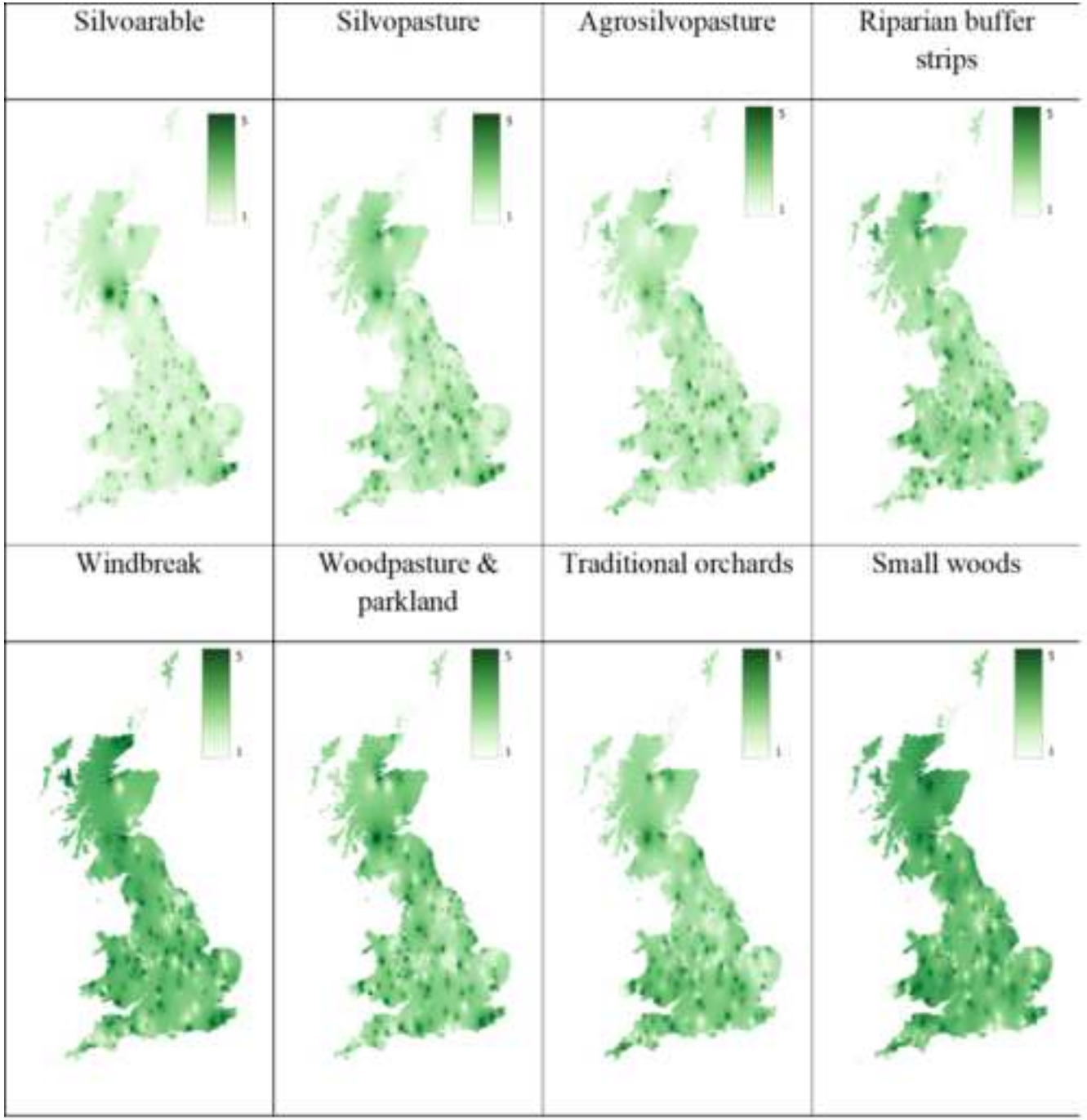


Figure 3

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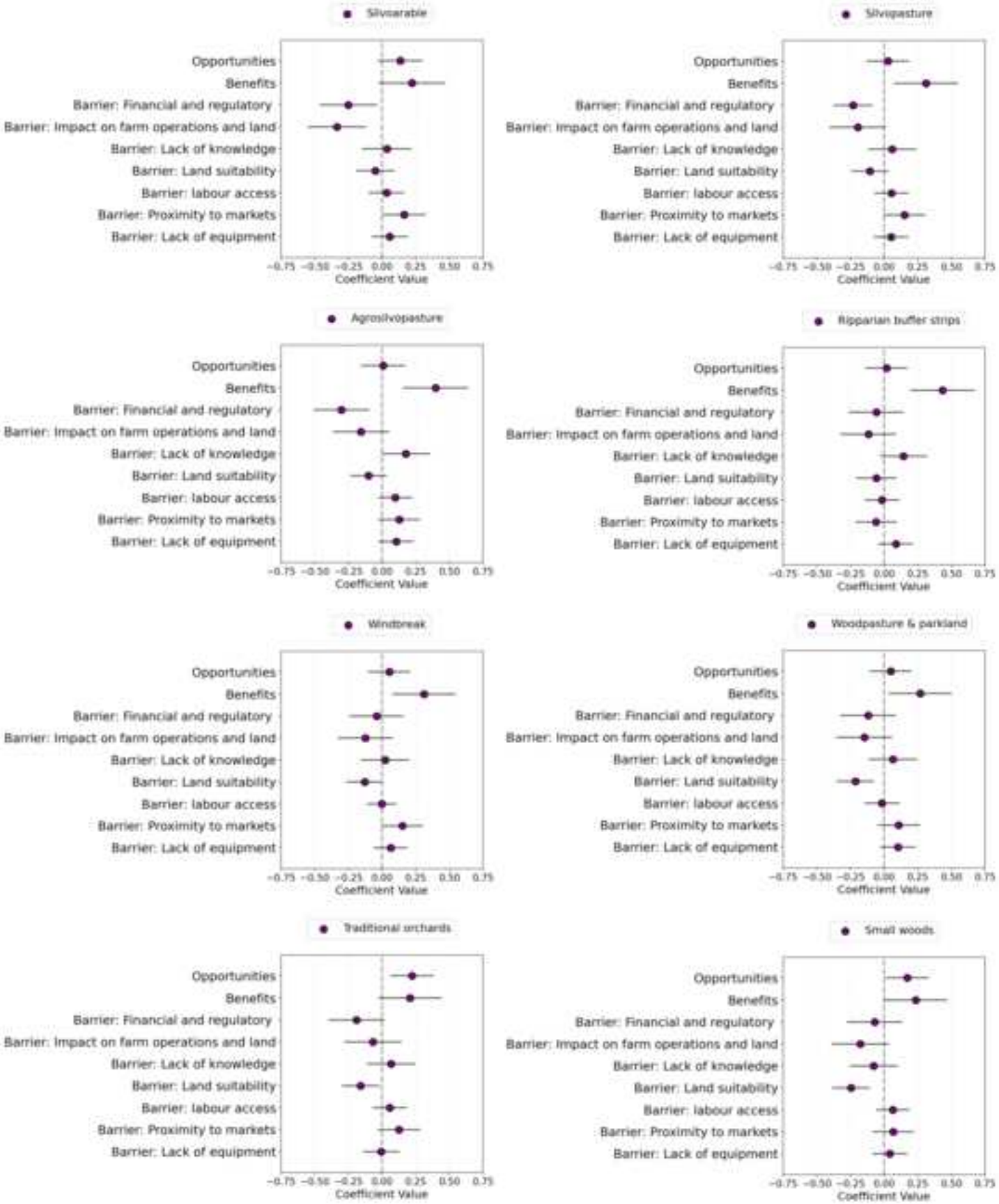

Structural 1

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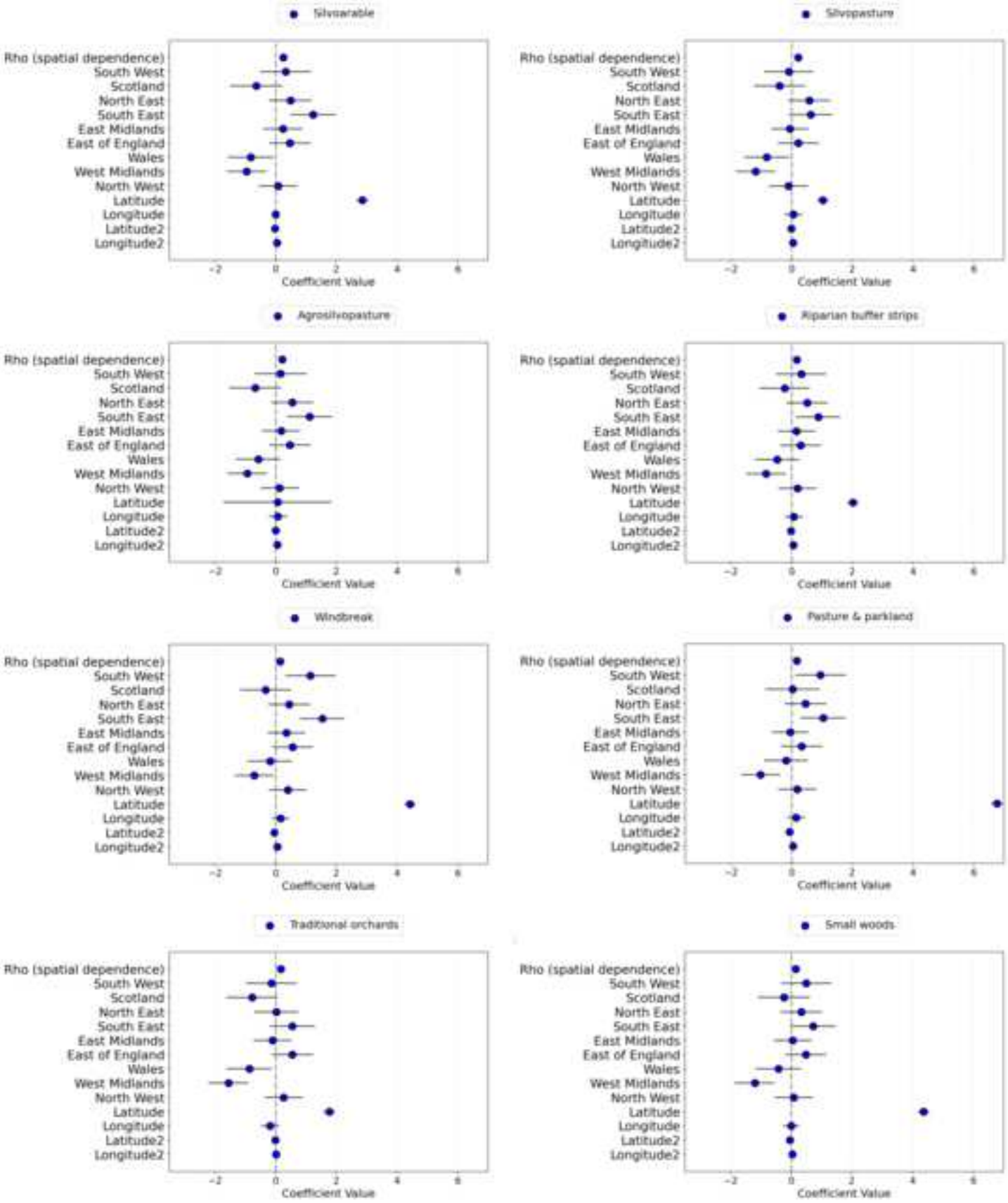

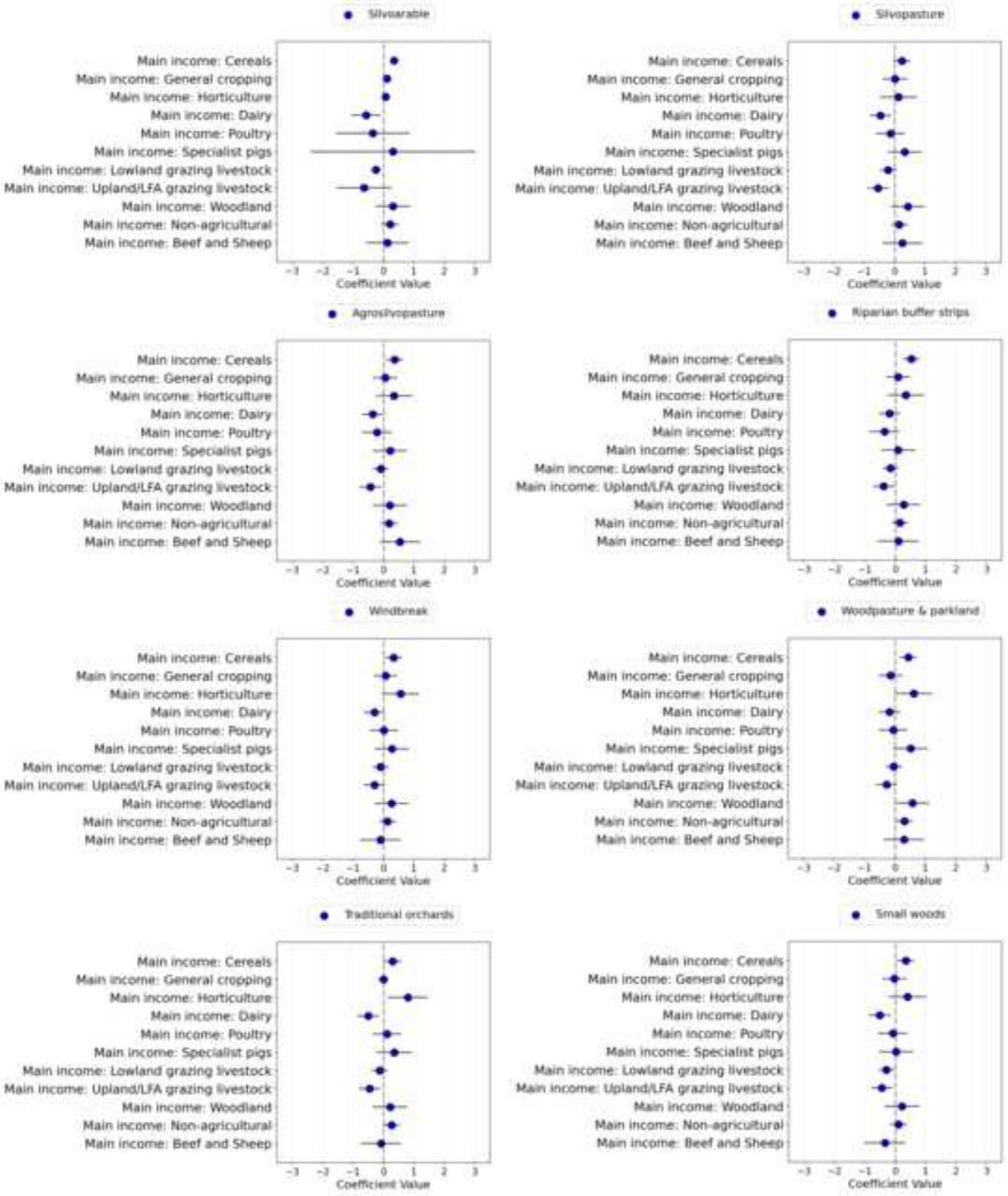

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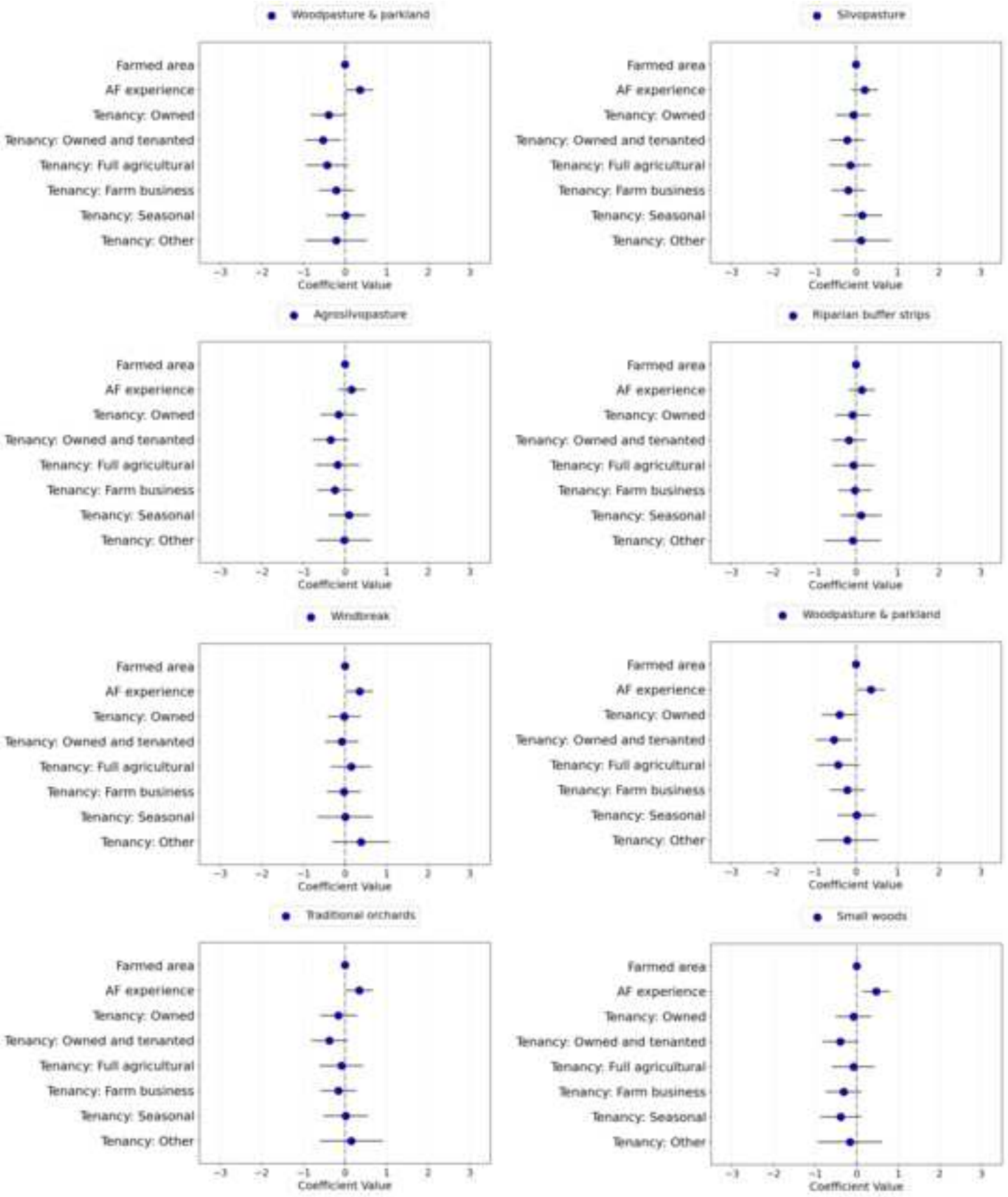

Social

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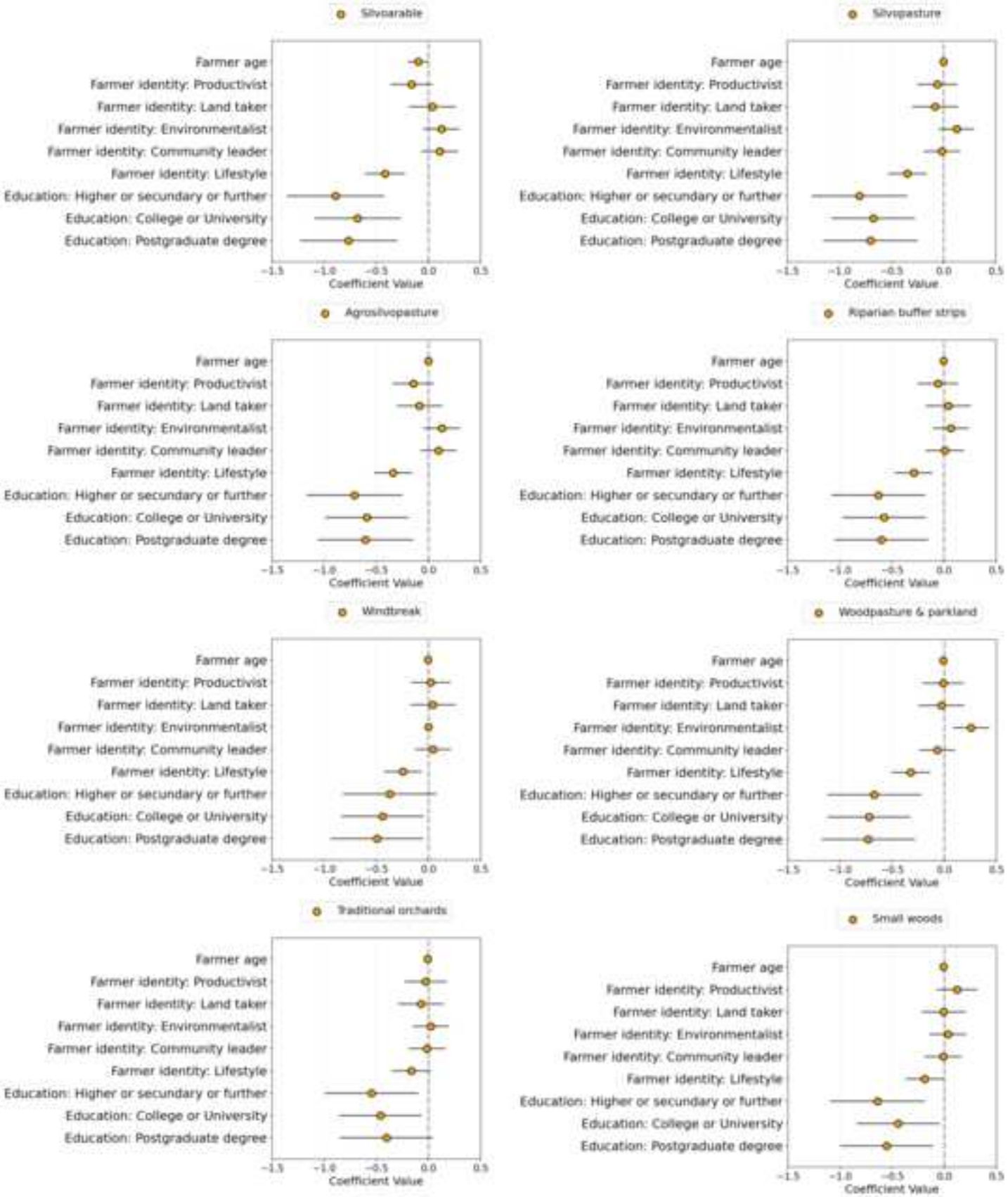

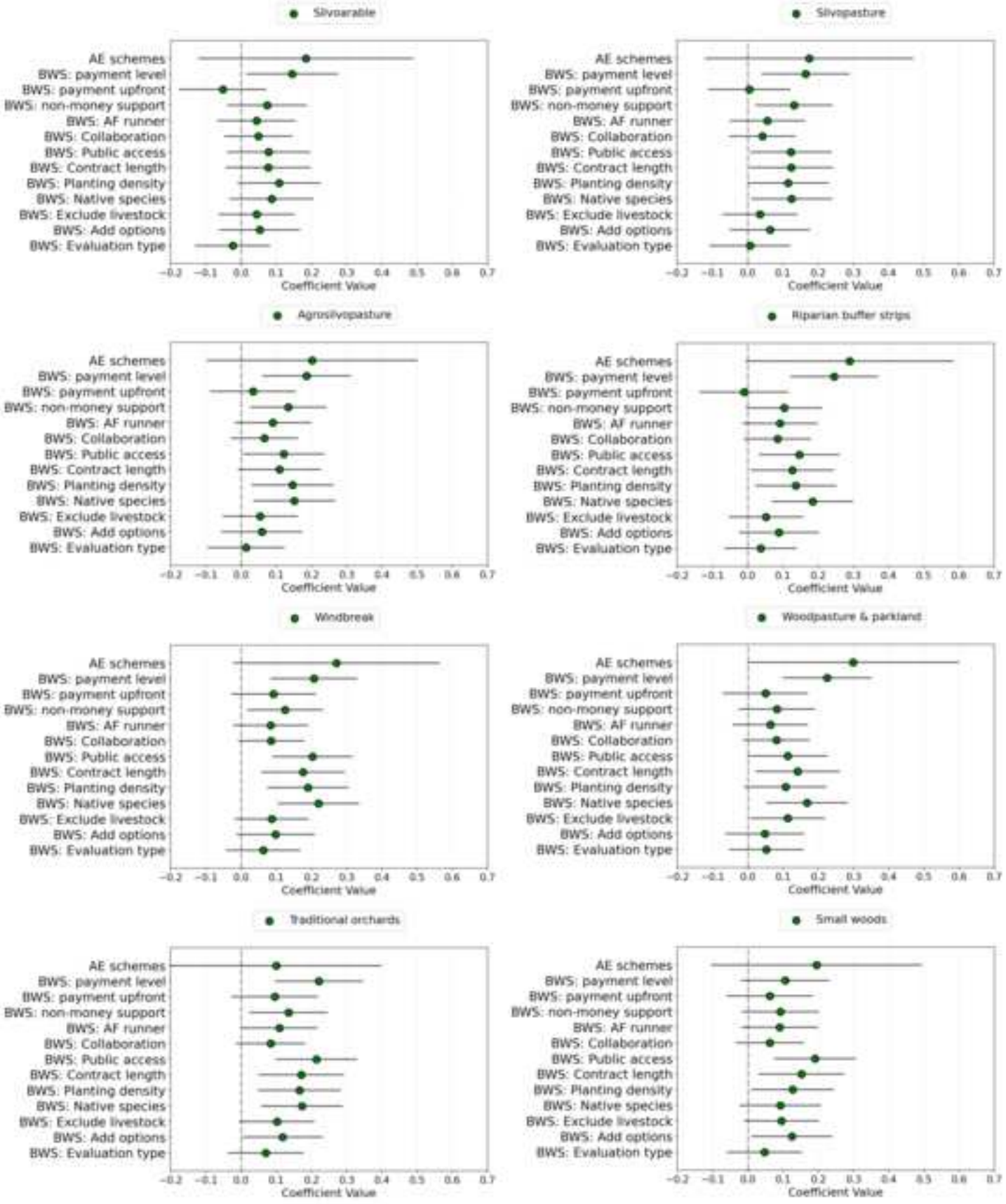

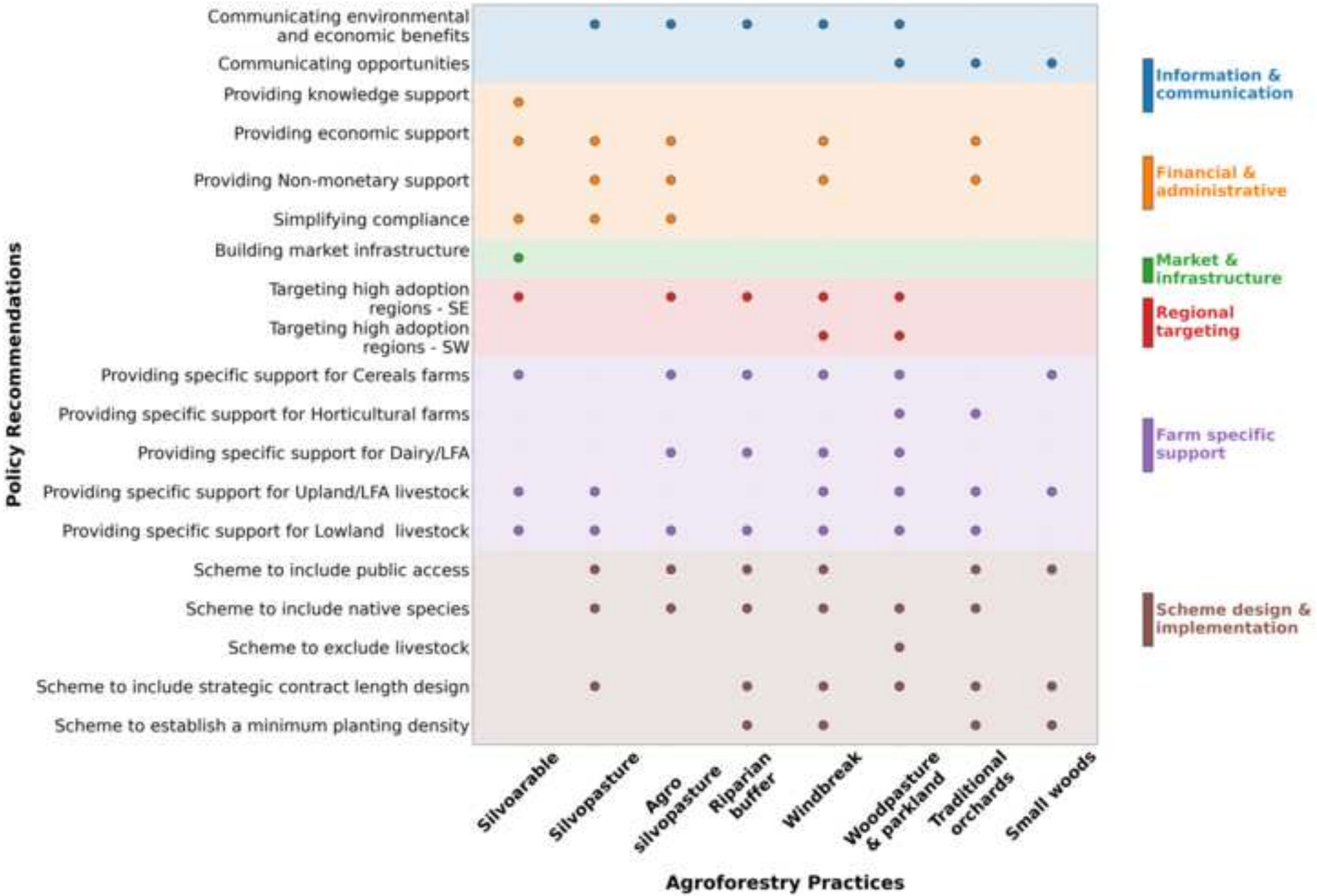

Supplementary material 1

Declaration of interests

☐The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☒The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Francisco J. Areal reports financial support was provided by United Kingdom Department for Environment Food and Rural Affairs. Lynn J. Frewer reports financial support was provided by UK Research and Innovation. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.