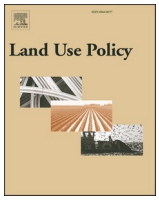
Farmers' attitudes towards, and intentions to adopt, agroforestry on farms in lowland South-East and East England

Land Use Policy 131 (2023) 106668

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol



Farmers' attitudes towards, and intentions to adopt, agroforestry on farms in lowland South-East and East England☆

Michelle Felton [a], Philip Jones [a], Richard Tranter [a,*], Joanna Clark [b], Tristan Quaife [c], Martin Lukac [a]

[a] School of Agriculture, Policy and Development, University of Reading, United Kingdom
[b] School of Archaeology, Geography and Environmental Science, University of Reading, United Kingdom
[c] National Centre for Earth Observation, School of Mathematical, Physical and Computational Sciences, University of Reading, United Kingdom

ARTICLE INFO

Keywords:
Agroforestry
Farmers' attitudes
Barriers to planting
Theory of planned behaviour

ABSTRACT

Agroforestry (AF) is a land use that incorporates growing trees into agricultural crops and/or livestock production on the same piece of land. Due to tree cover and growth, AF has the potential to generate additional products, enhance biogenic carbon capture and storage, reduce soil erosion and surface water run-off and improve soil structure and fertility. These effects are likely to improve farmers' financial return with minimal land loss to agricultural production. To date, there has been very little uptake of AF in the UK despite awareness of these benefits and increasing policy support. This suggests that there are barriers to adopting AF that policy, or market developments, have yet to address. This study set out to identify these barriers, along with potential drivers to further uptake of AF in South-East and East lowland England by means of a survey of 224 farmers and landowners in 2019 covering a range of farm sizes and types. Of those farmers who said they might consider planting small areas of AF, small woods and plantations were the preferred option. Silvo-arable AF was preferred to silvo-pastoral AF. If raised to the regional level, this could take up to some 5 % of the total farmed area. Financial reasons were behind some of the reluctance to plant, as was the view that trees might interfere with other farm operations. Farmers might need both planting grants and maintenance payments to help the UK Government reach their woodland planting goal to achieve the UK net-zero target by 2050.

1. Introduction

'Agroforestry (AF) is an approach to land use that incorporates trees into farming systems and allows for the production of trees and crops and/or livestock from the same piece of land' (Gordon et al., 2018). AF is a traditional land use type; many authors have pointed out that it has been practised for thousands of years in England (e. g. Carruthers, 1990) with different levels of sophistication and management demands. Several authors detail the advantages and opportunities AF expansion might create in rural England in the future, chiefly through the provision of a range of benefits not, or insufficiently, generated by current agricultural practices. For example, AF can improve farmland productivity, soil health, carbon sequestration, biodiversity, water management or livestock welfare (Raskin and Osborn, 2019; Soil Association and Woodland Trust, 2019; Newman et al., 2018; Graves et al., 2017; Gregory, 1997).

According to Hislop and Sinclair (2000), there are two main types of AF relevant to the temperate climate conditions prevailing in England: silvo-arable, where crops are grown between rows of trees with the row spacing designed to allow the use of agricultural machinery; and silvo-pastoral, where trees are grown in pasture which is grazed by farm animals. A variety of AF types designed for a specific purpose exists in addition to the two main types: trees are planted on farms as windbreaks, either along field boundaries or as clumps or blocks in fields; alongside water bodies as a riparian boundary; small farm woodlands with strong edge effects; or, indeed, hedgerows with mature trees (Gordon et al., 2018). Each of these formats can deliver a range of other benefits, in addition to its main purpose (e. g. Newman et al., 2018).

Numerous papers have reported on AF in England in the last 50 years, and a series of trials and experiments has been carried out (Newman et al., 2018). However, despite this research interest, the actual area of formal AF planted on commercial farms is still very small.

☆ Professor Jo Clark sadly passed away on 4 August 2022 while this paper was under review. Thus, the authors dedicate this paper to her memory.

* Corresponding author.
E-mail address: r.b.tranter@reading.ac.uk (R. Tranter).

https://doi.org/10.1016/j.landusepol.2023.106668
Received 9 September 2021; Received in revised form 24 March 2023; Accepted 26 March 2023
Available online 19 April 2023

A recent estimate by den Herder et al. (2017) suggested that there was a total of only 157,000 ha of AF in the UK, representing just 0.9 % of the total agricultural area. Around 117,000 ha of this area is represented by hedgerows (Forestry Commission, 2001a, 2001b, 2001c) leaving around 32,000 ha of other AF systems, including some 17,000 ha of 'traditional orchards' with grazing by livestock (Burrough et al., 2010) and 15,000 ha of 'wood pasture and parklands' supporting livestock grazing (Maddock, 2008). Carruthers (1990) and Newman et al. (2018) point out that most of these AF areas have been in existence for several hundred years, suggesting that any recent expansion of AF area has been very small. It should be noted that the woodland area of the UK in 2017 was 3.17 M ha, 13 % of the total land area; 978,000 ha of which was woodland on agricultural land (Defra, 2018).

Newman et al. (2018) observe that the area of the silvo-arable type of AF seems to be almost non-existent in England at present, although there is some very recent activity in experimenting with intercropping orchard fruit trees with either arable or vegetable crops, carefully designed to fit in with the CAP support regime under both Pillar 1 and Pillar 2. England has now left the EU and is in the process of developing a new agricultural support mechanism to replace the CAP. At the time of writing, little concrete information is available, however, the UK Government were undertaking an Agroforestry Test aimed at informing the development of support for future AF options in terms of an examination of both species, systems and support methods.

Whilst there are considerable advantages from the national and societal perspective to increasing the AF area, farmers in England have not, or are not, contributing to increasing tree cover on agricultural land to any meaningful extent. More generally, woodland planting in England has been lower than policy goals for some time, despite both the public and the Government perceiving tree planting as the most suitable tool contributing to the Net Zero target (UK Government, 2021).

These facts have stimulated increasing interest in understanding farmers' attitudes to tree planting generally and to AF specifically, and the various constraints they felt to adopting it. Broad reviews of the barriers to adoption of AF in England have been provided by the Soil Association and Woodland Trust (2019), Burgess (2017), Graves et al. (2009) and Newman et al. (2018). These sources highlight the long lead time before sales of timber or tree products as the primary barrier, followed by the attitude of landowners towards their tenants planting trees and other tenancy issues. Valatin et al. (2016) and Lawrence and Dandy (2014) identified farmer perception of low financial returns from AF as an additional barrier. They also note the importance of tailoring support to landowners' different attitudes, motivations and circumstances.

Several studies report on farmer and stakeholder attitudes to AF, sometimes with a focus on specific types of AF. The most detailed of these looks at silvo-arable systems in eastern England (Graves et al., 2017). Ducros and Watson (2002) focus on farmers planting trees by watercourses, Morris et al. (2002) investigated farmers planting hedgerows and McAdam et al. (1997) report on farmer attitudes to AF on sheep and cereal farms in Northern Ireland. Watkins et al. (1996) report on the attitudes of farmers in Nottinghamshire to farm woodland planting. Wynne-Jones (2013) explored these same attitudes in the North Wales context and Morgan-Davies et al. (2008) explore them in West Perthshire in Scotland. Finally, Thomas et al. (2015) look at what affects farm woodland expansion in Scotland, work which has been built on by Hopkins et al. (2017) and Barnes et al. (2022) finding that trees on farm is path dependant on whether farmers and landowners already have this form of land use.

This paper reports on a survey undertaken as part of a project that examined the potential for greenhouse gas removal by AF in lowland England over the next 30 years. We looked at lowland farming systems that cover England's most productive agricultural areas (i.e. East Anglia and the South- East). This is land that is typically considered on opportunity cost grounds to be least likely to be converted to large-scale conventional forestry. The key goals of the study were to identify socio-economic barriers to AF expansion and to suggest policy changes required to encourage such planting. The Theory of Planned Behaviour was selected as the conceptual framework for identifying these barriers and for describing the role of farmer attitudes to AF planting. This framework guided questionnaire design, the choice of analytical constructs and the data analysis.

The remainder of this paper takes the following form. The Method section details how the farmer questionnaire was designed, following an extensive literature review and a programme of stakeholder consultation, and administered. Next, the results from the farmer survey are presented, followed by a section that discusses our findings. Finally, conclusions, including for policy, are drawn.

2. Method

2.1. Construct and scale compatibility

Construct compatibility was prescribed by Ajzen (2006) that all beliefs about the TPB constructs used in any TPB survey should be elicited from a sub-sample of respondents in a pilot survey i.e.:

i) beliefs presented to survey respondents about outcomes of the behaviour (OA construct);
ii) the list of peers that might influence survey respondent behaviour (SN construct);
iii) the factors that might either facilitate or act as barriers to the behaviour (PBC construct).

In the current study, an enhanced or more rigorous version of this approach was used; i.e. beliefs were elicited from two sources, rather than one. First, a detailed literature review was undertaken to determine primary belief lists. Second, the literature-based beliefs were presented at two workshops of farmers and stakeholders for validation. This literature review step increased the efficiency of the TPB construct design process and allowed us to build upon the considerable body of existing knowledge.

We reviewed almost 150 sources on temperate AF; from these, the observed and/or perceived benefits or disbenefits of undertaking the behaviour shown in Table 1 were derived. They range from environmental and physical yield benefits, and animal welfare improvements to farm financial performance gains. Table 2 shows the set of perceived barriers to undertaking the behaviour (PBC) and social referents influencing the decision (SN) that was derived from the literature review.

The findings of the literature review were presented to participants at two workshops, which took place in November 2018 in Berkshire, England. The first workshop involved nine farmers, and the results were fed into the second workshop of 23 sector stakeholders, who discussed these issues in more detail. The workshops aimed to validate the belief set derived from the literature in terms of their relevance and completeness to practitioners. Additional beliefs were added to the list as they arose, and were validated by the discussions. The final phase of the discussion of each construct prioritised beliefs, based on their perceptions of the prevalence of each. This removed minor beliefs to reduce the number of statements presented to survey respondents, while still retaining the most important.

The findings of the literature review, the focus group and the broader group discussions, allowed the authors to ensure 'construct compatibility' i.e. delivery of a set of belief statements associated with the three TPB constructs as a true reflection of the range of beliefs actually existing in the target population. As an additional check, the belief statements associated with the TPB constructs were further tested when the questionnaire was piloted with four farmers before general release.

Scale compatibility is a prescription by Ajzen (2006) that: (a) the scale used to measure a construct should be appropriate for the construct itself, and (b) that there should be consistency of scales between contributors to constructs. These requirements were addressed through stakeholder workshops (the pilot study). To ensure (b) for all indirect

Table 1
Outcomes for farmers from adopting AF in temperate lowlands derived from a literature review (benefits and disbenefits).

Positive outcomes
Trees integrated into arable settings reduce soil erosion[a]
AF can be a cost-effective flood mitigation method[b]
AF can increase carbon sequestered compared with monocultures of crops or pasture[c]
AF can increase total financial yield and on-farm productivity[d]
AF can improve animal productivity and welfare by providing shelter and shade[e]
AF can increase biodiversity on farm[f]
Silvo-pastoral AF can result in earlier grass growth for livestock[g]
Benefits to agricultural crops from tillage, fertilising and weed control can benefit the tree crop[h]
Planting on lowland agricultural land means timber is produced nearer to processors and markets[i]
Trees grow better on lowland soils[j]
Negative outcomes
Might impact on the value of planted land[k]
Trees might affect other farm operations[l]
Long gap until income from the tree component[m]

Sources:
[a] Defra (2018); House of Commons EFRA Committee (2016); Young (1989).
[b] Newman et al. (2018); Young (1989); Raskin and Osborn (2019).
[c] Carruthers (1990); Defra (2018); Upson (2014); Pantera et al. (2018); Raskin and Osborn (2019).
[d] Soil Association and Woodland Trust (2019); Defra (2018); Graves et al. (2007); Pantera et al. (2018); Raskin and Osborn (2019).
[e] Defra (2018); Gregory (1997); Pent (2017); Wynne-Jones (2013); Raskin and Osborn (2019); Lawrence and Dandy (2014); Vandermeulen et al. (2018).
[f] Thevathasan and Gordon (2004); Varah et al. (2013); Dennis et al. (1996); Defra (2018); Newman et al. (2018); García de Jalón et al. (2018).
[g] Newman et al. (2018); Sibbald (2006).
[h] Pantera et al. (2018); Torralba et al. (2016); Raskin and Osborn (2019).
[i] Newman et al. (2018); Burgess and Rosati (2018).
[j] Hislop & Claridge (2000); Palma et al. (2007).
[k] Graves et al. (2017); Burgess et al. (2017); Valatin et al. (2016).
[l] Louah et al. (2017); Graves et al. (2017).
[m] Louah et al. (2017); Soil Association and Woodland Trust (2019); Burgess et al. (2017); Valatin et al. (2016).

Table 2
Perceived behavioural control and subjective norm beliefs about farmers planting AF in temperate lowlands derived from a literature review.

Perceived Behavioural Control beliefs
Little knowledge of where advice can be obtained[a]
High establishment costs (young trees, stakes and tree protection)[b]
AF sits in a policy and delivery void[c]
AF falls into a grant funding gap[d]
Little knowledge of growing trees[e]
Subjective Norm beliefs
Negative attitudes of landlords[f]
Negative attitudes of social referents[g]

Sources:
[a] García de Jalón et al., 2018; Soil Association and Woodland Trust (2019).
[b] Soil Association and Woodland Trust (2019); Raskin and Osborn (2019).
[c] Soil Association and Woodland Trust (2019); Newman et al. (2018); Raskin and Osborn (2019).
[d] Soil Association and Woodland Trust (2019); Burgess and Rosati (2018); Raskin and Osborn (2019).
[e] McAdam et al. (1997); Louah et al. (2017); Burgess et al. (2017).
[f] Schirmer and Bull (2014); Doyle and Thomas (2000); Raskin and Osborn (2019); Lawrence and Dandy (2014).
[g] Burton (2004); Graves et al. (2017); Hopkins et al. (2017); Burgess (2017); Schirmer and Bull (2014).

(formative) construct-oriented belief statements, we consistently used 5-point Likert (level of agreement) scales. For subjective value statements (likelihood, importance etc.) 5-point semantic differential scales were adopted. Achieving (a) required the use of logical inference, past practice based on the peer-reviewed literature, and discussion of the meaningfulness of the 5-point Likert and semantic differential scales at the two workshops mentioned above.

2.2. Questionnaire design

The final farmer questionnaire resulting from eight iterations (available from the corresponding author) was a six-page A4-sized document with a covering letter/participant information sheet on the front page explaining what the project was about, why they were being consulted and that the Institution's Ethical Clearance procedure had been followed. At the foot of the covering letter page, three images of AF types in the UK were presented to show participants what AF might look like in practice.

The questionnaire was presented in three distinct parts. First, there were 14 contextual and background questions about the surveyed farm business and the farmer or manager. Second, there were four questions about whether participants had any existing AF or woodland on their farms, whether they saw any opportunities/potential for adopting more and, if so, what areas and systems they might establish and for what purpose. Third, there were 15 questions designed to establish the participants' attitudes towards AF. These attitudinal questions were all based on 5-point Likert scales (Likert, 1932) as appropriate for use with the theoretical model employed in this case i.e. the Theory of Planned Behaviour (TPB) after Ajzen (1991) and Ajzen and Fishbein (1980). Further details on the theoretical model used are provided below.

Using the search term 'farmers' and category 'farmers' on Yell.com on 30 January 2019 for each identified County Council and UA/City/Borough Council in the South-East and East of England regions, yielded a total of 5958 addresses.

Stratification filters were not used in creating the sampling frame, as no data on the characteristics of the sample members were available. Instead, the first 13 % of addresses listed alphabetically in each County/Unitary Authority were extracted generating 800 addresses which equated with the funds available for printing and postage. Thus, the sampling frame was randomly selected across socio-demographic characteristics. Based on past experience, a response rate in excess of 25 % was expected (Tranter et al., 2004) which would yield a sample of 200. Based on power calculations a sample of 200 respondents would meet the requirements for a 95 % confidence level and a 7 % margin of error, assuming a target population in these two regions of 6000.

The questionnaire, with a cover letter explaining the survey objectives and a reply-paid envelope for its return, was sent out to the 800 farmers on 11 April 2019. A reminder letter was sent out on 16 May 2019 and a further reminder letter together with a duplicate questionnaire was sent on 13 June 2019. All respondents were thanked. The questionnaire was also made available online through the Twitter and Facebook pages of the authors' institution for two 14-day periods in May and June 2019 (10–24 May and 3–17 June). Data from the returned questionnaires was entered into an excel database; a senior member of the research team then checked this. The survey was closed on 1 August 2019, 16 weeks after the initial mailing. A total of 191 'clean' replies by post were available for analysis, along with a further 33 responses from the online response platform.

In total, 224 completed questionnaires were available for analysis by 1 August 2019. After allowing for people who were no longer in farming (i.e. letters being returned stating addressee 'not known', 'gone away', 'deceased', 'non-farmers' or 'retired'), the response rate to the mail survey was 24.4 %.

2.3. Survey representativeness

Key socio-demographic characteristics of the sample were examined to verify if the sample was representative of the population of farmers from which it was drawn (Table 3).

Surveyed farmers had a mean total area farmed of 395 ha and their mean total number of regular workers, including themselves and their family, was 3.2. Official June Survey 2019 statistics show that for the

Table 3
Key respondent characteristics.

	Mean	Minimum	Maximum
Total area farmed (ha)	395.0	2.0	2631.00
Proportion of area farmed owner-occupied (%)	74.8	1.00	100.00
Proportion of respondents over 50 years old (%)	70.1	–	–
Total number of regular workers including respondent and their family	3.2	0	40

South-East and East of England Regions the corresponding means were 102 ha and 3.6 respectively (Defra, 2021), suggesting that survey respondents had larger farm sizes than the regional mean. The proportion of the survey respondents' area farmed that was owner-occupied was 74.8 %; the proportion for England was 67.2 % (Defra, 2020). Just over 70 % of the survey farmers were over 50 years old, while the median age of farmers in the UK was 60 years old, with only 35 % under 55 (Defra, 2020).

As with all surveys, there is a possibility of 'non-response bias' i.e. those that did not respond to the survey may be different in some pertinent way from those who did respond. To test this, we compared the characteristics shown in Table 3, for the fastest and the slowest responding tertiles of respondents. This test assumes that the respondents replying last are more likely to be similar to those who did not respond than those who replied earlier (Barclay et al., 2002; Groves, 2006; MacDonald et al., 2009; and Jones et al., 2015). No statistically significant differences between the 'early' and 'late' respondents were found for: total area farmed ($t = -0.72$, $P = 0.4715$); the proportion of farmed area owner-occupied ($t = -0.15$, $P = 0.8823$); and the number of full-time workers ($t = -1.25$, $P = 0.2132$). However, using Chi Square a significant difference was found in the proportion of farmers over 50 years ($X2 = 7.68$, $P = 0.0056$), with slightly fewer farmers over 50 years in the late responder group compared to the early group. Based on this analysis, there is no reason to suppose that respondents who did not respond to the survey are significantly different from those that did.

2.4. The theoretical model of farmer decision-making

2.4.1. Introduction

Because the farmer survey could not measure an actual AF adoption behavioural response, an appropriate proxy was needed as this lay in the future. The Theory of Planned Behaviour (TPB) (Ajzen, 1991) argues that the precursor to expression of any behaviour is the intention to engage in that behaviour i.e. intention to adopt AF. Expressions of intention to adopt AF can be elicited and are based on the responding farmers' expectations of both the technical requirements of adoption and the accompanying costs and benefits. TPB models behavioural intention based on both internal (such as psychological), and external (such as cultural and demographic) factors (Ajzen, 1991; Fishbein and Yzer, 2003) both believed to influence decision-making.

2.4.2. The theory of planned behaviour

TPB has been used widely to explain human decision-making behaviour in many fields, including agriculture and food production. For example, TPB was used by Lapple and Kelley (2013) to understand factors determining the adoption of organic farming by farmers, by Alarcon et al. (2014) to examine the disease-control decisions of pig farmers, by Jones et al. (2015) and Sok et al. (2015) to assess dairy farmers' intentions to reduce the use of antibiotics, by Jones et al. (2016) to assess organic dairy farmers' intentions to adopt herd-health prevention measures, and by Borges et al. (2016) to examine beef farmers' disease control strategies. TPB has also been used to understand farmers' intentions to engage in biodiversity conservation behaviours (Maleksaeidi and Keshavarz, 2019), to explore intention to engage in farm diversification activities (Senger et al., 2017), to assess intention to purchase farm equipment (Vaz et al., 2020) and to adopt agronomic changes to control crop diseases (Janssen et al., 2020).

TPB posits that a person's 'intention' to carry out a particular behaviour is the most accurate predictor of whether they actually will do it. TPB highlights three particular determinants of an individual's intention to perform a particular behaviour (Ajzen, 1991):

i) attitude towards the expected outcome of an action/behaviour (Outcome Attitudes) i. e. what they expect the outcome of their behaviour will be and the value placed on it;
ii) beliefs about what valued others expect them to do in relation to the behaviour (Normative Referents/Subjective Norms); and
iii) beliefs about their ability to implement the behaviour (Perceived Behavioural Control).

TPB, as a result, attempts to measure the extent to which these (above) and other determinants, such as socio-demographic factors and more general attitudes, determine intention to adopt. According to TPB theory, the more positive a person's attitudes to an outcome, the more favourable the perceived opinions of their peers, the stronger the person's belief that they can control their actions, the stronger the intention to undertake a behaviour is likely to be and, therefore, the greater the likelihood they will undertake it (see Fig. 1).

2.4.3. Model specification

A full specification of the elements of the TPB model is shown in Fig. 2. The TPB model contains three broad dimensions i. e., Outcome Attitudes (OA), Subjective Norms (SN) and Perceived Behavioural Control (PBC). The OA dimension is the sum of two sub-components: belief strengths (bs) i. e., the expected probability of an outcome occurring, and outcome evaluation (oe) i. e. the value placed on the outcome (utility).

$$OA = \sum_{i=1}^{n} bs_i * oe_i \tag{1}$$

where i = beliefs about outcome i.

For experimental measurement, both bs_i and oe_i are based on respondent self-rating, using a 1–5 scale. Fishbein and Ajzen (2010) identify two dimensions of OA, i. e. 'instrumental' and 'experiential'. Instrumental attitude is contingent on the outcome, or payoff, of undertaking the behaviour, while experiential attitude is based not on the payoff but on the experience of undertaking the behaviour itself. Only instrument attitudes were surveyed in this study as the primary focus was on the payoff from possessing trees rather than the husbandry experience itself.

The Subjective Norms (SN) dimension captures respondent perceptions of the social pressure that arises from others about a behaviour that the respondent may be considering - in this case planting AF on their farm. The SN construct is the sum of two related norms, injunctive SN(I) and descriptive SN(D). Injunctive norms are respondent perceptions about what others think they should do (or their level of approval of the respondent undertaking an action). In contrast, descriptive norms are respondent perceptions about what others will themselves do. Each of these two norms is based on two components i. e., the strength of the normative beliefs about the opinion or actions of others (n[I] or n[D]) and motivation to comply with, or replicate, these (mc[I] or mc[D]). Therefore,

$$SN[I] = \sum_{i=1}^{n} (n[I]_i * mc[I]_i) \tag{2a}$$

$$SN[D] = \sum_{i=1}^{n} (n[D]_i * mc[D]_i) \tag{2b}$$

Where i is a vector of different social referents.

The Perceived Behavioral Control (PBC) dimension captures re-

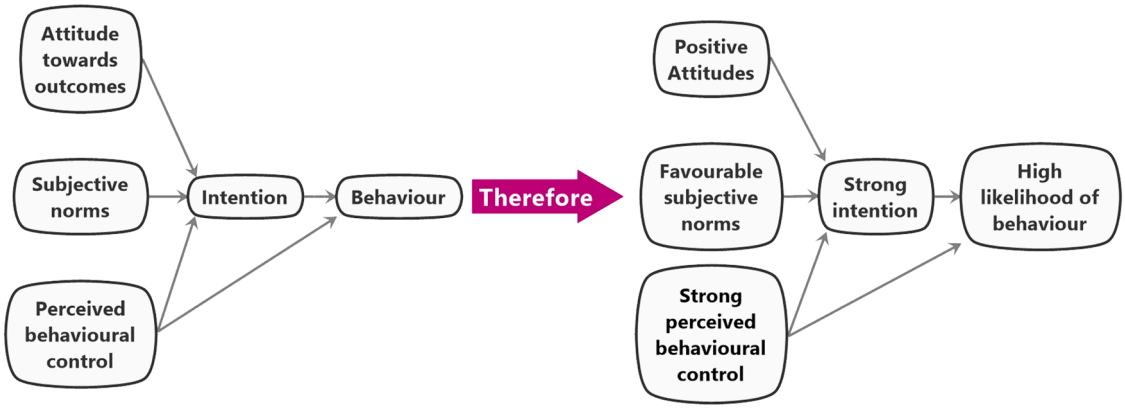


Fig. 1. The components of TPB and their relationship to behavioural intent.

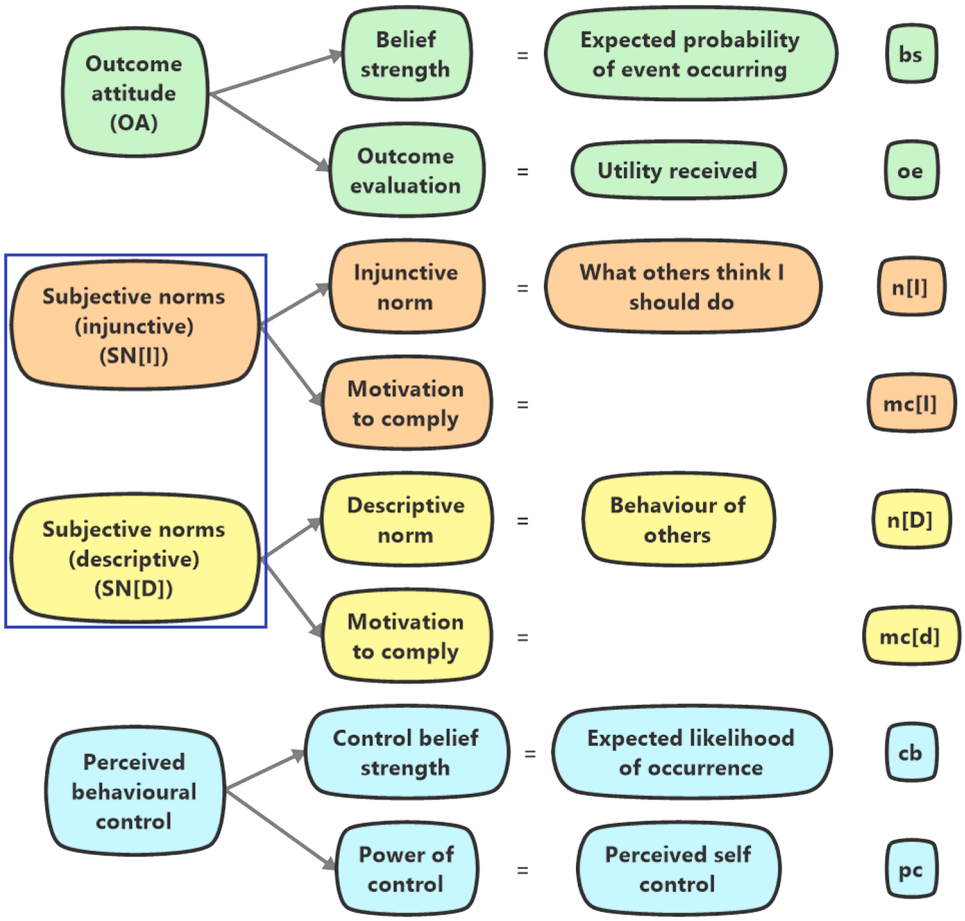


Fig. 2. The full specification of the TPB model used.

spondents' perception of factors that might either facilitate or impede their performance of a behaviour. The PBC dimension is derived from two sub-components: control beliefs (cb) i. e. beliefs about the likelihood of occurrence of different control factors (i) and the power of control (pc) i.e. the perceived ability of these control factors to facilitate or impede the performance of the behaviour. Fishbein and Ajzen (2010) identified two dimensions of PBC: 'capacity' i.e. a respondent's perception of their ability to perform a behaviour; and 'autonomy' i.e. level of discretion or control over performing a behaviour, but these are pooled in this case.

$$PBC = \sum_{i=1}^{n} (cb_i * pc_i) \tag{3}$$

Where I = control factor.

Ajzen (2005) assumed that all other factors that may impact intention, such as respondent socio-demographic characteristics and the structural and economic environment in which decisions are taken, are mediated through the three aggregate TPB constructs. However, Lo et. al (2014) and others have demonstrated that contextual factors may be only partially mediated by TPB constructs and can also operate directly on intent. As our objective was to identify all drivers and barriers to

intention to plant AF on farms, the unmediated effect of these contextual factors is also tested.

2.4.4. Constructing the TPB variables

2.4.4.1. Measuring intent. Survey respondents were given three separate statements expressing varying degrees of intention to plant AF in the next 5 years and asked to indicate the extent to which these statements reflected their own intentions. A difference in the degree of intention was reflected in these statements through the use of the terms 'I might', 'I will try' and 'I intend'. The intention here was that if responses to these three statements were materially different, all three would be tested as dependent variables in regression models with potential determinants of intention. The dependent variable/intention statement that was best predicted by the explanatory variables, as expressed by the model R-square statistic, would be used in the final analysis. However, if these three statements were highly correlated with one another, then they could be assumed to capture the same latent phenomenon, so any of them would suffice in the regression-based TPB analysis. Spearman's Rho correlations between these dependent variables ranged from 0.6 to 0.8 with all coefficients significant at $p < 0.0001$. Mean statement rating scores varied between 2.9 and 3.27. We thus concluded that the three intention variables are heavily correlated and largely capture the same phenomenon. Combining these variables into a composite would likely add little new information, so a single variable that declared the highest certainty of intent, i.e. 'I intend to plant farm woodland or AF', was used in all subsequent analyses. The behaviour on which this intention statement was based is consistent with the Target, Action, Context and Time principles (TACT) of Ajzen (2006) i.e. where the 'Target' is securing new areas of AF planting, the 'Action' is the planting of areas of AF, the 'Context' is the farm operated by the respondent which will host the new AF, and the 'Time' (or timescale) is within the next five years. All the TPB new constructs described below are also consistent with these same TACT settings i.e. the wording of all questions relating to these constructs explicitly frames the same target action.

2.4.4.2. OA variables. Both direct (reflective) and indirect (formative) metrics of the TPB outcome attitude latent variable were constructed; the two questionnaire items for each are shown in Table 4. In the indirect case, a range of OA statements was presented to respondents in the survey, each capturing beliefs about the different outcomes of planting AF and the valuations put on these (see Table 4). These were combined into a formative composite construct of outcome attitude through aggregation to increase the efficiency of the statistical analysis. Five direct OA questionnaire items were combined into a reflective construct in like manner. Table 4 shows the individual questionnaire items used.

Table 4
Questionnaire items, reported verbatim, used in the construction of the direct and indirect OA composite variables.

Items contributing to the direct (reflective) OA construct	Items contributing to the indirect (formative) OA construct
Please indicate, using the 5-point scale below the extent to which adopting farm woodland or AF for you, in the next 5 years, would be: 1. Disadvantageous – Advantageous 2. Unsatisfying – Satisfying 3. Necessary – Unnecessary 4. Unimportant – Important 5. Pleasant – Unpleasant	How well do the following statements match your opinions about farm woodland or AF for your farm, in the next 5 years? 1. AF would make a positive contribution to my farm income once operational 2. AF would improve the visual appearance of my farm landscape 3. AF will help stabilise my farm soil and reduce erosion 4. Suitable markets/end uses for AF products are available 5. Planting trees significantly reduces food/feed production on adjoining land 6. Planting AF will add to my job satisfaction 7. Planting AF will enhance my reputation as a farmer 8. Planting AF will offset greenhouse gas emissions

To test the coherence of these direct and indirect composite constructs, Cronbach's Alpha was calculated (see Table 5). An Alpha statistic of > 0.7 would indicate an acceptable degree of coherence within the group of variables forming the composite (Bland and Altman, 1997). In this study, a coefficient of 0.79 was obtained for the indirect measure, with no single contributing variable scoring less than 0.75. For the direct measure, the Alpha coefficient was 0.71, with no contributing variable scoring less than 0.58. While both composite outcome attitude measures correlated significantly with Intent (Table 7), OA-Indirect correlated more highly, so this was taken into the regression analysis (see below).

This use of indirect measures of attitudes is consistent with the argument of Singh (1988) and others that attitudes can only be measured indirectly. While Ajzen and Fishbein (1980) state their belief that direct measurement is possible, they do concede that use of direct measures provides very little information about why respondents judge outcomes positively or negatively. Reliance on indirect measures of attitudes is therefore seen as preferable in this case, first because of the greater observed statistical association of these with intent, and second, because they allow for the specific attitudes that drive intention to be mapped.

2.4.4.3. Normative belief variables. Internal consistency measurement of the subjective norm variables is not strictly required, as it is quite permissible for divergence in the perceived level of approval for the target behaviour among the different referents. However, in our study, the Cronbach's Alpha tests of the composite indicators showed a high degree of internal consistency, suggesting that levels of approval, or otherwise, of the target behaviour were perceived to be consistent across all social referents. The referents were: scientists/researchers; produce buyers; the National Farmers' Union; neighbouring farmers; input suppliers; farm advisers; family members or friends; and the general public. Direct and indirect measures of the two forms of normative belief indicators (Injunctive and Descriptive) were recorded. Taking the direct measures first, Cronbach's Alpha for the Injunctive norm was 0.86, while there was only a single component variable for the Descriptive norm. For the Indirect measures, the Cronbach's Alpha for the Injunctive norm was 0.74, with no single component variable scoring less than 0.70 and the Descriptive norm 0.83. No component variables had to be dropped from any of the four composite variables to increase internal consistency. All four subjective norm variables correlated positively and significantly with intent (see Table 6), but the two direct variables were by some margin the most highly correlated, so they were retained for further analysis.

2.4.4.4. Perceived behavioural control variables. Perceived Behavioural Control (PBC) based on the questionnaire elements presented in Table 4, was measured by a combination of two component dimensions (E. 3), i.e. control beliefs and power of control. Cronbach's Alpha score for the combined PBC measure was 0.867, with no single component having an Alpha coefficient less than 0.84 (Table 5).

2.4.5. Correlation of TPB variables with intent

Table 7 (see also Fig. 3) shows that four of the six composite TPB variables were significantly correlated with intent. Those that were not correlated were the two indirect forms of Subjective Norms (i. e. Indirect injunctive and descriptive). These two variables were, therefore, dropped from further analysis. Both the indirect and direct forms of Outcome

Table 5
Mean, median and maximum permissible range for the direct and indirect forms of the composite OA, SN and PBC measures, plus Cronbach's Alpha test coefficients.

Measure		Number of questions (i) included in the composite measure	Sample mean for the composite measure	Sample median for the composite measure	Maximum permissible range for composite measure	Cronbach's Alpha (Standardised)
Outcome Attitude (Indirect)		8	22.7	22.0	8 – 40	0.797
Outcome Attitude (Direct)		5	14.61	15.0	5 – 25	0.710
Subjective norms (Injunctive)	Direct	3	7.95	9	3 – 15	0.861
	Indirect	8	27.67	28	8 – 40	0.744
Subjective norms (Descriptive)	Direct	1	3.24	3	1 – 5	N.A.
	Indirect	3	9.11	9	3 – 15	0.833
Perceived Behavioural Control		7	59.0	57.0	7–175	0.867

Table 6
Questionnaire items, reported verbatim, used in the construction of the Control Beliefs and Power of Control composite constructs.

Items contributing to the Control Beliefs and Power of Control composite constructs
Please indicate the likelihood that adopting farm woodland or AF on your farm in the next 5 years will:
1. Fit in with your regular farm operations
2. Be too costly in time or money terms
3. Be difficult without new specialist equipment
4. Be feasible – I know how this should be done
5. Will take too much farm labour away
6. Be difficult in terms of desired results
7. Only be achievable with advisory backup

Attitudes were significantly correlated with intent, but also significantly correlated with one another. Direct OA was also dropped from further analysis as it was less strongly and negatively correlated with intent.

2.5. Regression model specification

The TPB variables found to correlate with the intent variable were used in a regression model, together with an array of socio-demographic variables to test the conceptual model. More broadly, we aimed to identify those variables that acted as drivers of, and barriers to, intention to plant new farm woodland/AF areas in the next five years. The intent dependent variable, in this case, was a 5-point ordinal scale, where 1 = Strongly disagree and 5 = Strongly agree and, as such, was an ordered (indexed) response variable, representing an underlying (unobserved), latent, utility variable (McKelvey and Zavoina, 1975). An Ordered Probit regression was undertaken to take advantage of the ordinality of the data. Responses to the dependent variable were not evenly distributed among the categories, particularly categories 4 and 5. Categories 4 and 5 were thus merged, along with categories 1 and 2, to create a 3-category ordinal variable with the first category normalised to zero (i. e. variable categories are 0, 1 and 2). The ordered probit regression can be presented as:

$$Y_i^* = \beta_i x_i + \varepsilon \quad (4)$$

Where: $_i$ = individual farmers: 1, 2 . . . N.

x_i = a vector of explanatory variables
β_i = a vector of parameters to be estimated and,
ε_i = normally distributed error (or disturbance)

The vector x_i included the four TPB dimensions, plus a vector (A′) of the attitudinal and background factors listed in Appendix A i.e.:

$$x_i = \mathrm{OA} + \mathrm{SN(I)} + \mathrm{SN(D)} + \mathrm{PBC} + \mathrm{A'\_} \quad (5)$$

All statistical analysis was undertaken using the analytics packages, SAS and Stata.

3. Results

3.1. Existing forestry or woodland

Of the 224 survey respondents, 173 (77.2 %) reported already having forestry or woodland on their farm. Of the 51 farmers with no woodland or forestry areas on their farm (Table 8), only three indicated that they had previously investigated undertaking such planting.

The median number of plots of woodland/AF on the farms is

Table 7
Pearson correlation coefficients for OA, SN and PBC measures with intent.

Pearson Correlation Coefficients							
Prob > |r| under H0: Rho = 0							
	OA_I	OA_dir	SNI_D	SND_dir	SNI_ind	SND_ind	PBC
OA_dir	-0.66870						
	< 0.0001						
SNI_dir	0.6105	-0.51516					
	< 0.0001	< 0.0001					
SND_dir	0.65145	-0.59238	0.63652				
	< 0.0001	< 0.0001	< 0.0001				
SNI_ind	-0.15804	0.04208	-0.26328	-0.19628			
	< 0.0351	0.5792	0.0004	0.0081			
SND_ind	0.06577	-0.11427	0.20182	0.11490	0.33620		
	< 0.3777	0.1267	0.0054	0.1154	< 0.0001		
PBC	0.51412	-0.44084	0.42982	0.44073	0.05577	0.18523	
	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.4610	0.0131	
Intent	0.45015	-0.34716	0.50235	0.61500	-0.07642	0.10937	0.54772
	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.3065	0.1362	< 0.0001

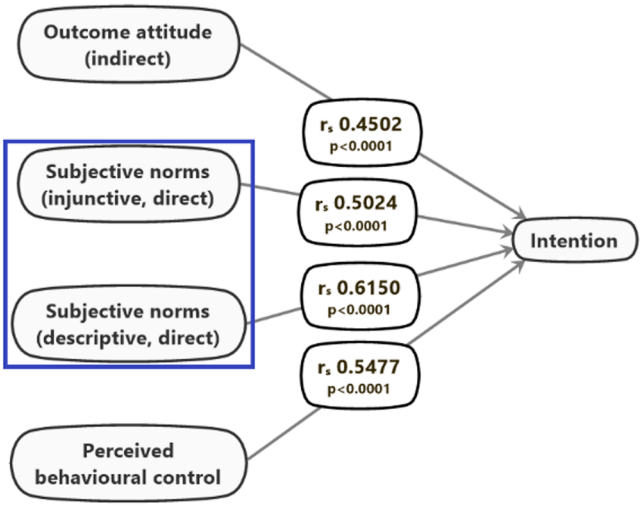


Fig. 3. Correlation between direct OA, SN and PC variables with intent.

Table 8
The number of plots and average area of different woodland types and AF on the survey farms.

Type of forestry or woodland	Number of farms with each type of AF/woodland (N)	Median number of plots per farm	Average area on each farm (ha)	Min. plot size (ha)	Max. plot size (ha)
Silvo-arable AF	14	2	12.3	0.2	100.0
Silvo-pastoral AF	14	3	5.1	0.1	20.0
Windbreaks	20	3	4.1	0.5	20.0
Woods or plantations	149	3	33.3	0.1	850.0

relatively small and relatively uniform, albeit a small number of farms had much larger plots. The average area of AF and windbreaks is also small, with the largest being silvo-arable at 12.3 ha. The most common tree planting format was farm woodlands, with 67 % of the sample having this land-use type averaging 33.3 ha per farm.

Table 9 shows farmer perceptions of the diversification and economic development opportunities that woodland/AF on their farms could contribute to. The development opportunities most commonly perceived as feasible by surveyed farmers for their farms were recreational activities (64 %), followed by the potential for either marketing wood or using it on-farm for fuel. Only a quarter of respondents already saw development opportunities for marketing timber or on-farm use.

Table 9
Perceived development opportunities from the output from existing woodland or AF on survey farms (per cent).

	Very clear/ possible opportunity	Uncertain	Probably or definitely not possible
Local market opportunities for timber	25.1	32.8	42.1
Local market opportunities for wood-fuel	52.5	21.8	25.7
On-farm potential for wood-fuel use for heating	54.4	19.4	26.2
On-farm potential for timber for fencing/ building	21.8	27.7	50.5
Shooting or other recreational activities	64.2	11.8	24.0

3.2. *Future possibilities for adopting forestry and woodland*

Asked if they would consider planting additional areas of woodland or forestry on their farms, 91 farmers, or 41 % of the sample, said flatly 'no'. The likelihood of a farmer saying 'no' to future planting increased, in statistically significant terms, if they currently had no existing woodland (χ^2 =9.63, P < 0.0019).

The most influential reason for saying 'no' to further planting, with an average rating score of 4.25 out of 5, is the perception that the financial returns are too low (Table 10). The next most influential reason was the possibility that woodland/forestry would interfere with other farm operations, followed by the length of the wait, after establishment, for financial returns.

Around 60 % of the respondents (133) indicated that they might consider planting new areas of woodland/AF in the future. The majority of farmers could thus be willing to plant new areas of woodland or plantations, but only relatively small areas on average (6 ha). The largest systems they would consider were silvo-arable AF, but only some 9 % of farmers would choose this option (Table 11).

The finding that farmers most likely to plant woodland/AF in the future already had it, is backed up by the comment of a respondent with a 480 ha mixed farm with woodland who said they would plant 20 ha more as: 'Farm woodlands are a very good idea on arable farms on appropriate land'.

When these intentions are 'extrapolated' to the combined UK Government Office South-East and East of England regional levels, using

Table 10
The reasons given by respondents for not considering planting a new area of farm woodland/AF on their farms (respondent rating of each reason).

	Proportion of respondents (%) indicating:			
	'Not very' or of 'No' importance	Neither important nor unimportant	'Very' or 'Quite' important	Mean rating score
Capital costs for establishment are too high	16.2	13.2	70.6	3.90
The wait for income is too long	12.7	9.9	77.5	4.06
I don't have knowledge of tree management	28.4	37.3	34.3	3.03
Attitude of landlord/ tenancy constraints	46.4	13.0	40.6	2.83
Uncertainty about the market for the products	11.9	25.4	62.7	3.72
It would interfere with other farm operations	14.3	9.1	76.6	4.12
It would impact the resale value of my land	22.1	22.1	55.9	3.59
Financial returns are too low	7.0	11.3	81.7	4.25
Lack of equipment for woodland management	16.7	33.3	50.0	3.42
Insufficient grant support for capital expenditure	13.2	23.5	63.3	3.75

Note: Rating score 5 = 'Very important'.

Table 11
Additional areas of woodland/AF that farmers indicated they might be willing to plant in the future, by planting format.

Type of forestry or woodland	Number of farmers Indicating each type	Median number of individual plots	Mean total area that might be planted per farm (ha)	Most common current use of land that might be planted
Silvo-arable AF	20	2	16.0	Arable
Silvo-pastoral AF	20	1	8.0	Grassland
Windbreaks	23	1	4.8	Grassland/ arable
Woods or plantations	81	2	6.0	Arable (some indicated as marginal)

farm holding and farmed area estimates (24,978 holdings and 2,548,141 ha total farmed area) provided by the 2019 June Survey (Defra (2021), we find that some 119,984 ha of new woodland/AF might be planted. This is around 5 % of the total farmed area of these two regions combined; just over 45 % of this would be woods or plantations on farms.

Farmers who said they might consider establishing a new area of woodland or AF on their farms were also asked to indicate why they would plant - by selecting one or more from a list of 12 options. By far, the most commonly-reported reason for the proposed planting was the improvement of wildlife habitats on the farm (77 %), reported twice as many times as the next most common reason, offsetting GHG emissions. Equal in third place (32 %) were the on-farm use of wood as fuel and the provision of commercial recreation (e. g. shooting). The least popular reason was flood control, cited by just 7 % of the sample.

3.3. Attitudes to the outcomes of adopting AF

Survey respondents were asked what they believed to be the likely outcomes associated with having farm woodland or AF on their farms (see Fig. 4). To facilitate this enquiry, and provide consistency in the issues covered, respondents were asked to indicate the extent to which they agreed or not with eight statements suggesting different outcomes. Respondents were also asked to rate the importance of each of these outcomes (Fig. 4).

Widespread agreement across the sample is apparent that adopting farm woodland or AF would lead to carbon offsetting and improve landscape appearance. On the downside, it was also a widely held view that AF would reduce yields on adjoining land due to competition for water, nutrients and light. There was less universal agreement, although still believed by most sample farmers, that AF adds to job satisfaction and enhances their reputation as farmers. There is much less acceptance that AF can positively contribute to farm income, reduce soil erosion, or that there are suitable markets available for AF products, or even on-farm uses for these. The contribution of farm woodland or AF to farm income was by far the most important statement. This perception is a significant barrier to adoption, especially when coupled with the fact that farm woodland or AF is widely believed not to positively contribute to farm income and reduces the productivity of adjoining land. In support of this finding is the respondent with a 100 ha general cropping farm who opined: 'Agroforestry won't work because of the long time between planting and any saleable produce'. The most important positives of farm woodland or AF are the potential for improvements in landscape appearance, job satisfaction and carbon sequestration. The least important positive features of farm woodland or AF were reducing soil erosion and reputational enhancement.

The Indirect OA measure is the most highly correlated with intent to plant trees. It is instructive to note the differences in outcome attitudes between those who reported a willingness to consider planting and those who did not. TPB theory would suggest that those who do not consider planting additional areas would have less favourable attitudes towards the outcomes of planting than those who did. For example, they could find planting less satisfying, less advantageous, less necessary, less important and less pleasant. The mean aggregate indirect OA rating score of the group that would not consider planting was 22.15, compared to 27.30 for the group that would consider planting, a statistically significant difference ($t = -7.00$, $df = 194$, $P < 0.0001$, variances equal).

3.4. Subjective norms

This analysis is focused on the direct Injunctive and Descriptive forms of Subjective Norms, as these were better correlated with the intention to plant woodland/AF than the indirect forms. Before analysing these direct measures, it is instructive to examine the indirect measures, as these allow us to explore survey farmers' perceptions of how their social referents would approve of them planting additional areas of woodland/AF on their farms in the next five years. The respondents generally viewed all their social referents as likely to view such planting positively, thus passively expressing approval in TPB terms. By some margin, the highest perceived approval levels were

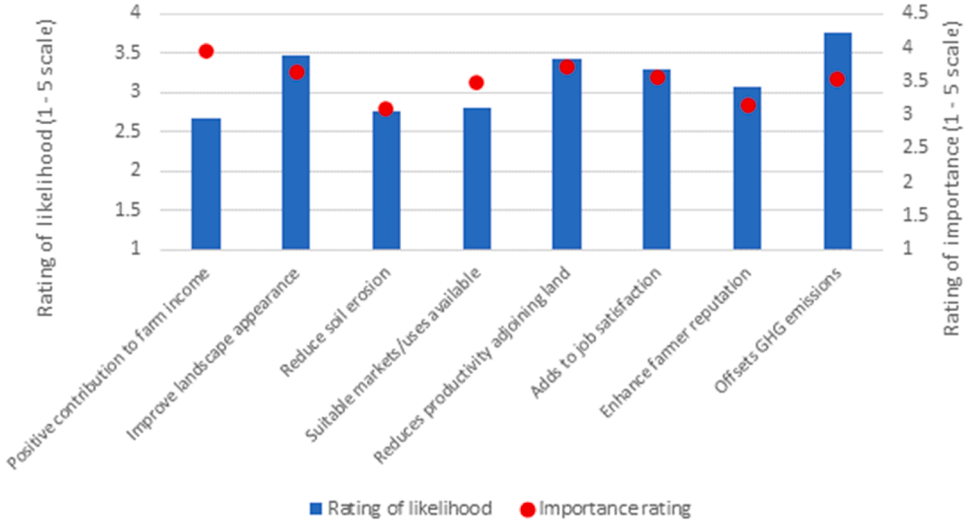


Fig. 4. Outcome attitudes to adopting farm woodland or AF.

attributed to scientists/researchers and members of the general public, the two groups with the highest importance in the minds of survey farmers. The lowest perceived approval ratings were attributed to neighbouring farmers, input suppliers and buyers, but the opinions of these social referents were reported as of relatively low importance. Interestingly, while the views of farm advisers and friends and family were considered of relatively high importance, they were not reported as the most positively disposed to additional woodland/AF planting.

Returning to the Injunctive form, survey farmers were asked for their level of agreement with the assertion that three groups associated with them, or their farm, would approve of, or expect, them to plant new areas of woodland/AF on their farms. The responses to these questions are shown in Table 12. The average level of agreement with each statement is not high, with most lying in the zone of neutrality. However, the high level of correlation of this measure with intention to plant AF, clearly shows that the distribution of rating scores is predictive of the intention to plant. To explore Descriptive norms, direct form, survey farmers were asked to express their level of agreement with the statement: 'Farmers like me will be adopting farm woodland or AF in the next 5 years'. The level of agreement with this statement, expressed as an average rating score is 2.74, in the zone of neutrality, again, the distribution around this mean shows that farmers expressing higher levels of agreement also demonstrate greater intention to plant.

3.5. Perceived behavioural control

The PBC variables capturing expected likelihood (of occurrence) indicate that planting additional areas of woodland/AF would be feasible and that those responsible for planting knew what needed to be done (Fig. 5). There was also a strongly held view that having more woodland/AF would require more farm labour than was currently available. This negative view towards labour requirements was, however, not considered to be particularly impactful, perhaps due to the relative ease of hiring contractors and casual staff. The financial costs of planting and managing woodland/AF are not viewed as prohibitively high, as the respondents gave this factor a relatively low impact rating.

This perceived lack of requirement for advisory support by survey farmers is quite impactful, suggesting that a lack of available advisory support would not be an important barrier to the adoption of AF, at least for some (Fig. 5).

3.6. Intent to plant farm woodland/AF in the next five years

Survey farmers were asked for their level of agreement with a statement expressing an intention to plant farm woodland/AF in the next five years on their farms. The most common response to the statement was neutrality (35 %), followed by strong disagreement; only around 24 % of respondents expressed any level of positive agreement with this statement.

Table 12
Survey farmers' level of agreement with the assertion that each of three groups of people associated with them would approve of them planting new areas of woodland/AF.

	Average rating agreement score
People who have something to do with my farm expect me to establish an area of farm woodland or AF	2.27
People in the industry, whose opinions I value, would approve of me establishing an area of farm woodland or AF on my farm	2.99
People who are important to me think that I should establish an area of farm woodland or AF on my farm	2.71

Note: Rating score 5 = 'Strongly agree'.

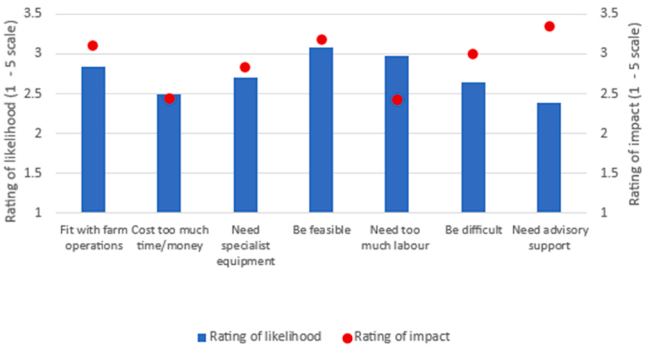


Fig. 5. Expected likelihood of a range of potential outcomes from planting woodland/AF and the importance of these outcomes.

3.7. Background attitudes

We explored farming goals by presenting a series of seven statements such as: 'I want to get as much profit as I can' or 'I want to be seen as a good farmer' and asking respondents to indicate their level of agreement with them. There is a uniformly high level of agreement with all the statements, with only profit maximisation rated lower than four (Fig. 6). The farmers also ascribed high importance ratings to each of these farming goals which could be evidence of multi-goal farming, with farmers trying to simultaneously balance the pursuit of profit with job satisfaction, productivity, good husbandry, image projection and environmental concerns. This suggests that the business of farm management has now become rather more complex than in the past with implications for tree planting as it can increase complexity.

3.8. Drivers of intention to plant

The drivers of and barriers to intention to plant woodland/AF, were explored though the use of an Ordered Probit regression model based on the TPB variables together and a set of socio-demographic variables. These non-TPB variables were included as the main effects in the regression model testing the TPB 'sufficiency' assumption (Table 13). Three of the TPB variables are positive drivers of intent to plant, while no predictive relationship for outcome attitudes was observed. Farm ownership is seen to have a positive relationship with intention to plant, this being the farm ownership arrangements, which increased where the farm has 'non-standard' ownership arrangements, for example, farms owned by charitable trusts or public bodies. Current profitability of the farm and the desire of the farmer to be perceived positively by others are seen to be negatively associated with the intention to plant. This implies that the more profitable the farm, the lower the likelihood of planting, perhaps because farmer motivation for profits is strong, or because the land is highly productive. The negative sign on the variable capturing the strength of desire to be seen as a good farmer suggests that planting woodland or AF on the farm is not perceived to be the mark of a 'good farmer'. This suggests that survey farmers' own perception of a 'good farmer' is someone who keeps their land productive for food or feed crops. This is backed up by a survey farmer with a 400 ha cropping farm saying: 'Farmers need to feed an increasing world population as cheaply as possible'.

We calculated marginal effects of the IVs to gauge the magnitude of the effects of IVs on intention to plant i.e. the partial changes in the probability of an outcome (which represents the probability of falling into a particular DV rating), caused by a change in the value of an explanatory variable. These marginal effects (see Table 14) were calculated as:

$$\text{Prob}\,(y = j|x)$$

where: j = the different levels of the DV (0, 1 & 2). The sum of the

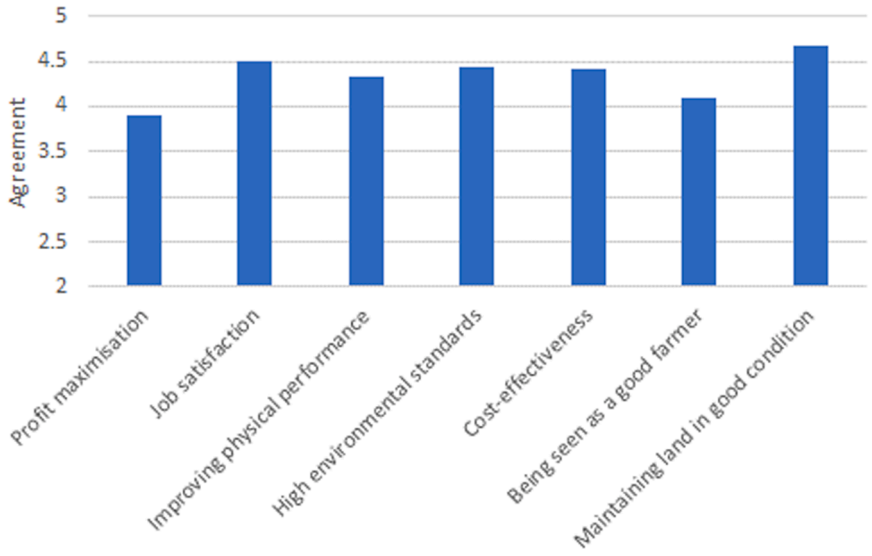


Fig. 6. Survey farmers' agreement levels with a series of statements relating to farming goals.

Table 13
The results of the Ordered Probit model testing for significant determinants of intentions to plant additional woodland/AF. (The sign of the parameter estimate indicates whether a unit increase in determinant variable increases or decreases the likelihood of adoption.).

Effect	Description	Parameter estimates	Std error	Z value	Pr > z
SN_I_dir	Subjective norm (Injunctive)	0.1567152	0.0611276	2.56	0.010
SN_D_dir	Subjective norm (Descriptive)	0.691593	0.1721224	4.02	0.000
PBC	Perceived Behavioural Control	0.0221213	0.0067889	3.26	0.001
Profit	Business is currently profitable	-0.7007808	0.3640678	-2.30	0.021
Q32_fx	Respondent wants to be seen as a good farmer	-0.3962815	0.1837572	-2.16	0.031
Q5_d	Other ownership arrangements (not: sole proprietorship, family partnership, or Company)	2.03616	0.6994672	2.91	0.004

Log likelihood = −95.424911; N = 146. Pseudo R2 = 0.3918.

Table 14
Marginal effects for explanatory variables on the likelihood of planting additional woodland/AF.

Effect	Description	P (y = 0|x)	P (y = 1|x)	P (y = 2|x)
SN_I_dir	Subjective norm (Injunctive)	-0.0592837*	0.0287645*	0.0305191*
SN_D_dir	Subjective norm (Descriptive)	-0.2616221**	0.1269396**	0.1346826**
PBC	Perceived Behavioural Control	-0.0083683**	0.0040603*	0.004308**
Profit	Business is currently profitable	0.2490066*	-0.0921078*	-0.1568989*
Q32_fx	Respondent wants to be seen as a good farmer	0.149909*	-0.0727361	-0.0771729*
Q5_d	Other ownership arrangements (not: sole proprietorship, family partnership, or Company)	-0.3879096**	-0.288573	0.6764827**

Significance: 5 % (*); 1 % (**).

marginal effects associated with each explanatory variable is equal to zero, because any increase in the likelihood(probability) of falling into one category of the DV, as a result of moving between levels of an IV is offset by compensating decreases in the likelihood of falling into other categories. The marginal estimates are derived as margin at means (MEM).

The marginal effect of the dummy variables (i. e. PROFIT; Q32_fx; and Q5_d) captures the effect on the DV of a discrete change of the dummy variable value from zero to one (Table 14). A 1 unit increase in the value of SN_I_dir (Subjective norm direct) increases the likelihood of attaining the highest level of intention to plant by 3 % and decreases the likelihood of falling into the lowest intention category by 6 %. The effect of the descriptive form of the subjective norms (perception that others will be planting trees) SN_D_dir, is even more marked, with a one-unit increase in the value of this variable increasing the likelihood of falling into the highest intent category by 13 %. PBC has only marginal effects on the likelihood of falling into the top category of intention, less than 1 % in any case. Business profits have a marked effect, with a switch from low profitability to high profitability (binary variable) decreasing the likelihood of falling into the highest intention category by 15 %. Respondents' desire to be seen as a good farmer increases the likelihood of falling into the lowest intent category (reluctance to plant) by 15 %. However, the most marked effects result from ownership arrangements, with unusual forms of ownership of farms increasing the likelihood of falling into the highest intention category by 68 %.

4. Discussion

4.1. The TPB dimensions

4.1.1. Outcome attitudes

The outcome attitudes (OA) variable was not found to be a significant determinant of intention to plant in the presence of other explanatory variables. It is not uncommon in the literature for the OA variable to have low or no explanatory power (e.g. Bozionelos and Bennett, 1999 and Jones et al., 2015). However, the non-significance of the attitude variable is somewhat unexpected, so some examination of the possible reasons is necessary. We can discount the failure to follow TACT principles in the elicitation of attitudes (Sok et al., 2021), as attitude elicitation statements in this study are closely predicated on the target action. AF generates a wide range of acknowledged outcomes, some environmental, some financial, and past studies have established the large majority of these as both delivered and beneficial. Because of the

nature of farming, and many of the respondents already have farm woodland, some have knowledge of farm woodland and will be aware of its benefits. If farmers hold broadly similar attitudes to each of these outcomes/benefits, then there will be low variation in the population's attitude dimension, lowering the heterogeneity of responses. It is not uncommon that people attribute positive outcomes to a particular behaviour. Yet, not all of them will ultimately engage in it due to other constraints. The Cronbach's Alpha test confirmed a high degree of coherence between the eight outcomes in terms of respondents' attitudes toward them. Assuming these attitudes were all broadly positive, the factor will not discriminate those who express an intention to plant AF from those who do not. However, there are known negative outcomes to planting on farms. When both positive and negative outcomes are anticipated, respondents can become ambivalent to the behaviour (Ajzen, 2006).

4.1.2. Subjective norms

We examined survey farmers' perceptions of the extent to which they think their social referents would approve of them planting more woodland/AF on their farms in the next five years. All are broadly reported as approving; the highest perceived approval levels were attributed to scientists/researchers and the general public. However, neighbouring farmers, input suppliers and buyers would not approve so much of this possible action as found by other researchers (e.g. Graves et al., 2017 and Schirmer and Bull, 2014).

4.1.3. Perceived Behavioural Control (PBC)

As measured by the PBC variables, there was a high level of confidence amongst study farmers that they could plant more woodland/AF, and they believed they knew how to do it. There was some worry that doing this would need more on-farm labour than was available, but this was not seen as too impactful, perhaps because they thought they could hire-in contractors for planting.

4.2. Non TPB-mediated determinants of planting

It is sometimes assumed that Fishbein and Ajzen prohibit the use of background factors as determinants of intention alongside the three TPB factors. Lo et al. (2014), and others, have shown that some factors not mediated through the three TPB dimensions might still have direct effects on intention. A number of non-mediated factors have been proposed, including self-identity (Conner and Armitage, 1999), anticipated effect (Van der Pligt and De Vries, 1998) and past behaviour (Bentler and Speckart, 1979). Our study tested Fishbein and Ajzen's (2010) 'sufficiency' assumption by including a number of background factors in modelling intentions, alongside the typical TPB variables. Interestingly, tenure type, farm business profitability and the perceived self-image of the farmers' actions are not wholly mediated through the TPB variables. Self-identify, being based on self-verification, rather than instrumental motivations has different motivational roots to outcome attitudes (Rise et al., 2010). In confirmation, several authors have found that self-identification predicts actions even after the TPB dimensions have been taken into account (e.g. Sparks and Shepherd, 1992; Rise et al., 2010). It is, therefore, quite legitimate that we included this variable alongside TPB variables in the regression model and, quite unsurprisingly, that its inclusion increases model explanatory power.

4.2.1. Tenure type

A higher likelihood of planting AF was found on farms with 'non-standard' land ownership. This includes ownership by utility or transport companies, national charities such as the National Trust, or public bodies such as the Ministry of Defence. This type of ownership tends to reduce the importance of income generation in land management goals and typically shows increased interest in the provision of public goods e.g. Barnes et al. (2022). The non-sufficiency argument posits that land ownership captures some form of self-identity; respondents with landlords with non-standard ownership arrangements and goals may perceive themselves as a distinct type of farmer from whom increased public goods delivery is expected. As woodland planting usually provides more public goods than other forms of land use, tree planting would be seen as desirable. Our data then begs the question: if these motivations are reflected in greater perceived benefits of AF planting, why are these value judgements not mediated through attitudes to the outcomes of planting AF? In other words, more favourable attitudes towards expected non-monetary and societal benefits should be mediated through OA.

The answer could be methodological, as there were several statements in our OA question set reflecting 'public good' AF outputs, such as improved amenity or carbon sequestration. The OA variable itself was not a significant determinant of intention to plant, so was excluded from the regression model. Factors that would normally be mediated through the OA variable, were then directly expressed in our model, including different attitudes towards public goods provision through the tenure variable and, perhaps, the variable capturing the current level of profitability of the farm business. This latter variable may, of course, be a proxy for the productive capacity of the land.

4.2.2. Farm profitability

As also found by García de Jalón et al. (2018) and Graves et al. (2017), the more profitable the farm business, the lower the intention of respondents to plant AF. This result may reflect two background factors: the business motivation of the farm decision-maker and the productive capacity of the land. First, farmers most motivated by profit maximisation would be least interested in AF planting as tree planting is typically viewed as an activity with a large opportunity cost (Raskin and Osborn, 2019). Second, business motivation might be understood as a form of self-identity, but the productive capacity of the land represents an objective limiting constraint not mediated through the OA construct.

4.2.3. Desire to be seen as a good farmer

The greater the desire to be seen as a good farmer, the lower the intention to plant AF. We have no direct information on what our study farmers perceive as the characteristics of a good farmer, but many clearly believe that planting AF on agricultural land is not something that a 'good' farmer would do. This has resonance with the seminal work of Burton (2004) on 'good farmers' and their 'Productivist' behaviour through an examination of a dataset on uptake of a farm woodland grant scheme.

Three pieces of evidence we found may explain this observation. First, when asked to rate the importance of a set of different farming goals, maintaining land in good agricultural condition came out top (Fig. 6). Second, in a self-supporting argument, the adoption of AF was not generally seen as something that would enhance the reputation of any farmer (Fig. 4). Third, and despite evidence to the contrary (Defra, 2018), tree planting is not seen as useful for preventing soil erosion. Burgess (2017), Lawrence and Dandy (2014) and Valatin et al. (2016) reported similar findings, as maintaining land in good agricultural condition was viewed by farmers as maintaining its productivity and readiness for commercial cropping. Land bearing trees is not seen as agricultural practice. This reflects a relatively rapid change of perception over 1–2 generations of farmers. Historically, trees were part of the English farming landscape (James, 1981), but a succession of farming policies aimed at enhancing productivity led to the now established view of what the good farmer does (Hopkins et al., 2017). It will be interesting to observe how fast the reverse change of perception may happen, should the Environmental Land Management Scheme be rolled out widely in England in the next few years.

4.3. The finances of AF

According to TPB, any effect of perceived beliefs about the poor financial performance of AF, should be mediated by the compound OA

variable. Thus, the statement 'AF would make a positive contribution to my farm income once operational' was included among the OA measures specifically to capture any negative attitudes towards the perceived financial viability of AF.

This OA variable is not a significant determinant of intent, so we, therefore, did not include a separate financial perception variable in the regression model. Since several other studies identified contribution to farm profitability as a significant barrier to AF adoption (Burgess et al., 2017; Graves, and Valatin et al., 2017, 2016), this could be viewed as a weakness of our study. Indeed, while there is a strong opinion amongst our sample that adoption of AF will not make a positive contribution to farm profit, at the same time, our farmers gave a very low rating of the significance to the impact of this. We think that the tenure variable discussed above is, at least in part, acting as a proxy for financial attitudes in the regression model: in other words, farmers with stronger non-profit motivations are more favourable to AF planting.

4.4. Emerging issues to consider

One intriguing finding of our study is that the farmers most likely to plant woodland/AF in the future already have woodland/AF on their farm. Could it be that these farmers, due to their familiarity with the non-monetary benefits of AF, such as landscape enhancement, wind protection and flood control, value them more? Or does this simply reflect that the farms with woodland or AF are likely to have marginal land, some of which was not used for agriculture in the past? Does having once overcoming the psychological barrier of turning food-producing land over to non food-producing uses make it easier to do it a second time? Alternatively, does inheriting land with trees alter the perception of what a good farmer does? Past studies shine a little light on this question. For example, Carruthers (1990) and Doyle and Thomas (2000) say that exploring these issues further could aid future tree planting efforts on farmland in the UK and elsewhere.

5. Relevance to current policy issues

Our responding lowland farmers in England held a rather polarised view on planting woodland/AF in the future: nearly 60 % said they would consider it under the current policy environment while 40 % said they definitely would not plant. We can characterise the farmer most likely to adopt AF as someone who: is not solely focussed on farm financial performance; views the land as the provider of ecosystem services in addition to food; is a tenant farmer where the farm owner is a public body or charity, who perceives their social referents to be in favour of AF planting or, more importantly, where some amongst them are themselves intending to plant AF and who believe that there are no technical obstacles to adoption. Crucially, in contrast to the findings of Lawrence and Dandy (2014), the traditional landlords are not necessarily against the planting of trees by their tenants. This widens the scope for tree planting effort, one of the measures recommended by the Climate Change Committee (2020) to meet UK net-zero commitment by 2050 to increase tree cover from the current 13 % of the total land area to 19 %. In May 2021, the England Trees Action Plan (ETAP) was produced (UK Government, 2021) in which the Government committed to increasing the rate of tree planting in England to 30,000 ha per year by 2024. Interestingly, UK Government (2021) stated that: 'Agroforestry will also play an important role in delivering more trees on farms and in our landscape, improving climate resilience and encouraging more wildlife and biodiversity in our farming systems'. Realising that a number of barriers to farmers planting trees exist, as recommended by Lawrence and Dandy (2014), a series of planting grants are to be instituted as well as maintenance payments. In addition, improved advice and guidance on forestry matters will be provided. The latter are two ways that Valatin et al. (2016) suggested farmers and landowners could be 'nudged' to plant more trees. The study reported here, which is the first to specifically address the issue of farmers' attitudes to adopting AF, suggests that these measures will be only partially successful in addressing known barriers to the adoption of AF.

6. Conclusions

Our survey of lowland farmers in England is unique in that it surveyed a considerable number of farmers and landowners to assess their attitude to the planting of farm woodland/AF on arable farming land. It showed that, although they may welcome tree planting grants, the establishment cost is not an important barrier to adoption. Similarly, while annual maintenance grants will improve the profitability of AF systems, they are unlikely to offset the widespread perception that replacing food production with trees is an opportunity cost to society. The current study also does not support the long-held view (e.g. Burgess, 2017) that a lack of knowledge of tree management and inadequate sources of management advice, is another major barrier to AF adoption by farmers possibly reflecting the growing awareness by farmers of AF in recent years. However, just because farmers think they know how to manage trees does not necessarily mean they do. Some of the key barriers identified in this study are not addressed by the ETAP support measures at all, for example, the notion that putting forestry on good agricultural land is something that good farmers simply do not do. Here, AF could be seen as a good option as it includes both trees and food production. Based on these observations, the authors are not convinced that the current tree planting support proposed by the UK Government will be any more successful than those of the past.

7. Methodological critique

The survey of farmers was carried out very carefully and followed all recommended procedures from both the survey method literature and that on the use of TPB including compliance with the TACT principles in the design of questions used in the construction of variables. All data entry was also double-checked. However, it is possible that the sample of respondents' bias towards larger farms could also affect their responses positively in favour of intention to adopt AF. For example, it is a reasonable assumption that larger farms are more likely to have 'spare' parcels of land, perhaps less-productive land, which could be made available for AF and, also, larger farms are less likely to be labour-constrained as forestry management competes for labour with other activities on the farm. If this is the case, then the study estimates of likely future planting and farmer willingness to adopt AF, would likely be overestimates. However, several results from the survey analysis suggest that this bias towards larger farms is not so critical. First, farm size was not found, in the regression model, to be a significant determinant of intention to plant. Second, while there was some agreement that planting AF increased demands on farm labour, this was viewed by farmers as being an unimportant consideration, perhaps because of the perceived ease of hiring in contractors to carry out forestry management operations. It is also possible that while farm size might influence intention to adopt AF, its effect is mediated through other variables that are found in the regression model to be significant determinants of intention. For instance, the TPB variable perceived behavioural control, or the non-TPB main effects of ownership type and profitability.

Declaration of interest

None.

Data Availability

Data will be made available on request.

Acknowledgements

This paper results from a project in the UK Government's research

programme on Greenhouse Gas Removal from the Atmosphere under Natural Environment Research Council grant agreement NE/P019706/1. Funding was also received from the QR Strategic Priorities Fund of Research England. In addition, co-author Tristan Quaife was part-funded by the UKRI's National Centre for Earth Observation. We are grateful for this funding, as we are to the many farmers and stakeholders who took part in the research, and to Teresa Hicks for skilled questionnaire design, survey adminstration and accurate data entry.

Appendix A. The background variables on the farms and farmers used in the TPB regression analysis

Variable name	Description of variable	Format
Q1_a	Total area farmed	Interval scale
RENTED	Has an area of rented land	Nominal (binary)
Q2_a	Specialist dairying	Nominal (binary)
Q2_b	Lowland sheep/cattle	Nominal (binary)
Q2_c	Cropping	Nominal (binary)
Q2_e	Mixed farming	Nominal (binary)
Q3_a	Full-time farmer	Nominal (binary)
Q5_a	Sole proprietorship	Nominal (binary)
Q5_b	Company	Nominal (binary)
Q5_c	Family partnership	Nominal (binary)
Q5_d	Other ownership arrangement	Nominal (binary)
Age	Respondent age	Interval scale
Q7_a	Formal agricultural education	Nominal (binary)
Q10	Proportion of income from non-ag sources (high/low)	Nominal (binary)
SUCCESSOR	An identified successor is present	Nominal (binary)
Q13_a	Member of agri-environment scheme	Nominal (binary)
Q15_a	Presence of existing woodland on farm	Nominal (binary)
Q16_a	Has local market opportunities for timber	Ordinal scale
Q16_b	Has local market opportunities for fuel wood	Ordinal scale
Q16_c	On-farm use for wood	Ordinal scale
Q16_d	On-farm use for timber	Ordinal scale
Q16_e	Shooting/recreational opportunities	Ordinal scale
Q32_ax	Respondent is profit maximiser	Ordinal scale
Q32_bx	Respondent seeking job satisfaction	Ordinal scale
Q32_cx	Respondent seeking to improve physical yields	Ordinal scale
Q32_dx	Respondent seeking high environmental standards	Ordinal scale
Q32_ex	Respondent seeking greater cost effectiveness	Ordinal scale
Q32_fx	Respondent wants to be seen as good farmer	Ordinal scale
Q32_gx	Respondents wants to maintain land in good condition	Ordinal scale
PROFIT	Farm is making an operating profit	Nominal (binary)
STILL_IN	Respondent believes they will still be farming in ten years	Nominal (binary)
OA_dir	Composite TPB variable – Outcome Attitudes – direct measurement	Interval scale
SN_I_dir	Composite TPB variable – Subjective Norms – Injunctive form – direct measurement	Interval scale
PBC	Composite TPB variable – Perceived Behavioural Control	Interval scale

References

Ajzen, I., 2006. Constructing a TPB Questionnaire: Conceptual and Methodological Considerations. Available from: ⟨https://people.umass.edu/ajzen/pdf/tpb.measurement.pdf⟩.
Ajzen, I., 1991. The theory of planned behaviour. Org. Behav. Hum. Dec. 50, 179–211.
Ajzen, I., 2005. Attitudes, Personality and Behaviour, 2nd ed. Open University Press, New York.
Ajzen, I., Fishbein, M., 1980. Understanding Attitudes and Predicting Social Behaviour. Prentice-Hall, Englewood Cliffs, N.J.
Alarcon, P., Wieland, B., Mateus, A.L.P., Dewberry, C., 2014. Pig farmers' perceptions, attitudes, influences and management of information in the decision-making process for disease control. Prev. Vet. Med. 116, 223–242.
Barclay, S., Todd, C., Finlay, I., Grande, G., Wyatt, P., 2002. Not another questionnaire! Maximising the response rate, predicting non-response bias and assessing non-response bias in postal questionnaire studies of GPs. Fam. Pract. 19, 105–111.
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 renewals. Land Use Policy 112, 105861.
Bentler, P.M., Speckart, G., 1979. Models of attitude-behavior relations. Psychol. Rev. 86, 452–464.
Bland, J.M., Altman, D.G., 1997. Statistics notes: Cronbach's alpha. Br. Med. J. 314, 572.
Borges, J.A.R., Tauer, L.W., Lansink, A.G.J.M.O., 2016. Using the Theory of Planned Behavior to identify key beliefs underlying Brazilian cattle farmers' intention to use improved natural grassland: a MIMIC modelling approach. Land Use Policy 55, 193–203.
Bozionelos, G., Bennett, P., 1999. The theory of planned behaviour as predictor of exercise: the moderating influence of beliefs and personality variables. J. Health Psychol. 4, 517–529.
Burgess, P., Schmutz, U., Balaguer, F., Boosten, M., Csikvari, J., Hannanchi, Y., Pecenka, R., Poza Llorente, J., Sepp, M., Vityi, A., 2017. EIP-AGRI Focus Group. Agroforestry. Minipaper: Financial Impact of Agroforestry. European Commission, Brussels.
Burgess, P.J., 2017. Agroforestry in the UK. Q. J. R. For. Soc. 111 (2), 111–116.
Burgess, P.J., Rosati, A., 2018. Advances in European agroforestry: results from the AGFORWARD project. Agroforest. Syst. 92, 801–810.
Burrough, A.E., Oines, C.M., Oram, S.P., Robertson, H.J. 2010. Traditional orchard project in England – the creation of an inventory to support the UK Habitat Action Plan. Natural England Commissioned Reports, Number 77. Natural England, Peterborough.
Burton, R.J.F., 2004. Seeing through the 'Good Farmer's' eyes: towards developing an understanding of the social symbolic value of 'productivist' behaviour. Sociol. Rural. 44 (2), 195–215.
Carruthers, P., 1990. The prospects for agroforestry: an EC perspective. Outlook Agric. 19, 147–153.
Climate Change Committee, 2020. Land use: Policies for a Net Zero UK. CCC, London.
Conner, M., Armitage, C.J., 1999. The Theory of Planned Behaviour: assessment of predictive validity and 'perceived control'. Br. J. Soc. Psychol. 38, 35–54.
Defra, 2018. The future farming and environment evidence compendium. Defra, London.
Defra, 2021. Structure of the agricultural industry in England and the UK at June. Data series: 'Regional and county/unitary authority (2018/19)'. ⟨https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/927036/structure-june-eng-county-15oct2020.ods⟩.
Defra, 2020. Agriculture in the UK, 2019. National Statistics, London.
Dennis, P., Shellard, L.J.F., Agnew, R.D.M., 1996. Shifts in arthropod species assemblages in relation to silvopastoral establishment in upland pastures. Agrofor. Forum 7 (3), 14–17.
Doyle, C., Thomas, T., 2000. The social implications of agroforestry. In: Hislop, A.M., Claridge, J. (Eds.), Agroforestry in the UK. Bulletin, 122. Forestry Commission, Edinburgh.
Ducros, C., Watson, N.M., 2002. Integrated land and water management in the United Kingdom: narrowing the implementation gap. J. Environ. Plan. Manag. 45, 403–423.

Fishbein, M., Yzer, M.C., 2003. Using theory to design effective health behaviour interventions. Commun. Theor. 13, 164–183.
Fishbein, M., Ajzen, I., 2010. Predicting and Changing Behaviour. The Reasoned Action Approach. Taylor and Francis, New York.
Forestry Commission, 2001a. National Inventory of Woodland and Trees - England. Forestry Commission, Edinburgh. ⟨http://www.forestry.gov.uk/pdf/niengland.pdf/$FILE/niengland.pdf⟩.
Forestry Commission, 2001b. National Inventory of Woodland and Trees - Scotland. Forestry Commission, Edinburgh. ⟨http://www.forestry.gov.uk/pdf/niscotland.pdf/$FILE/niscotland.pdf⟩.
Forestry Commission, 2001c. National Inventory of Woodland and Trees - Wales. Forestry Commission, Edinburgh. ⟨http://www.forestry.gov.uk/pdf/niwales.pdf/$FILE/niwales.pdf⟩.
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., 2018. How is agroforestry perceived in Europe? An assessment of positive and negative aspects by stakeholders. Agrofor. Syst. 92, 829–848.
Gordon, A.M., Newman, S.M., Coleman, B.R.W., Thevathasan, N.V., 2018. Temperate agroforestry: an overview. In: Gordon, A.M., Newman, S.M., Coleman, B.R.W. (Eds.), Temperate Agroforestry Systems, 2nd ed. CAB International, Wallingford.
Graves, A.R., Burgess, P.J., Liagre, F., Dupraz, C., 2017. Farmer perception of benefits, constraints and opportunities for silvoarable systems: preliminary insights from Bedfordshire, England. Outlook Agric. 46, 74–83.
Graves, A.R., Burgess, P.J., Palma, J.H.N., Herzog, F., Moreno, G., Bertomeu, M., Dupraz, C., Liagre, F., Keesman, K., van der Werf, W., Koeffeman, de Nooy, A., van den Briel, J.P., 2007. Development and application of bio-economic modelling to compare silvoarable, arable and forestry systems in three European countries. In: Ecol. Eng, 29,, pp. 434–449.
Graves, A.R., Burgess, P.J., Liagre, F., Pisanelli, A., Paris, P., Moreno, G.M., Bellido, M., Mayus, M., Postma, M., Schlinder, B., Mantzanas, K., Papanastasis, V.P., Dupraz, C., 2009. Farmer perceptions of silvoarable systems in seven European countries. In: Rigueiro-Rodriguez, J.H., McAdam, J.H., Mosquera-Losada, M.R. (Eds.), Agroforestry in Europe: Current status and future prospects. Springer, pp. 67–86.
Gregory, J.G., 1997. The role of shelterbelts in protecting livestock: a review. N. Z. J. Agric. Res. 38, 423–450.
Groves, R.M., 2006. Non-response rates and non-response bias in household surveys. Public Opin. Quart. 70, 646–675.
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. Agr. Ecosyst. Environ. 241, 121–132.
Hislop, A.M., Sinclair, F., 2000. Introduction. In: Hislop, A.M., Maxwell, A., Claridge, J. N. (Eds.), Agroforestry in the UK. Bulletin, 122. Forestry Commission, Edinburgh.
Hislop, A.M., Claridge, J.N., 2000. Agroforestry in the UK. Bulletin, 122. Forestry Commission, Edinburgh.
Hopkins, J., Sutherland, L.-A., Ehlers, M.-H., Matthews, K., Barnes, A., Toma, L., 2017. Scottish farmers' intentions to afforest land in the context of farm diversification. For. Policy Econ. 78, 122–132.
House of Commons Environment, Food and Rural Affairs Committee, 2016. Future flood prevention. Second Report of Session 2016–17. House of Commons: London.
James, N.D.G., 1981. A history of English forestry. Oxford University Press.
Janssen, E.M., Mourits, M.C.M., van der Fels-Klerx, H.J., Lansink, A.G.J.M.O., 2020. Factors underlying Dutch farmers' intentions to adapt their agronomic management to reduce Fusarium species infection in wheat. PLoS One 15 (9).
Jones, P.J., Marier, E.A., Tranter, R.B., Wu, G., Watson, E., Teale, C.J., 2015. Factors affecting dairy farmers' attitudes towards antimicrobial medicine usage in cattle in England and Wales. Prev. Vet. Med. 121, 30–40.
Jones, P.J., Sok, J., Tranter, R.B., Blanco-Penedo, I., Fall, N., Fourichon, C., Hogeveen, H., Krieger, M.C., Sundrum, A., 2016. Assessing, and understanding, European organic dairy farmers' intentions to improve herd health. Prev. Vet. Med. 133, 84–96.
Lapple, D., Kelley, H., 2013. Understanding the uptake of organic farming: accounting for heterogeneities among Irish farmers. Ecol. Econ. 88, 11–19.
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.
Likert, R., 1932. A technique for the measurement of attitudes. Arch. Psychol. 140, 1–55.
Lo, S.H., Peters, G.-J.Y., van Breukelen, G.J.P., Kok, G., 2014. Only reasoned action?: An interorganizational study of energy-saving behaviours in office buildings. Energy Effic. 7, 761–775.
Louah, L., Visser, M., Blaimont, A., Canniere, C., 2017. Barriers to the development of temperate agroforestry as an example of agroecological innovation: mainly a matter of cognitive lock-in? Land Use Policy 67, 86–97.
MacDonald, S.E., Newburn-Cook, C.V., Schopflocher, D., Richter, S., 2009. Addressing non-response bias in postal surveys. Public Health Nurs. 26, 95–105.
Maddock, A. 2008. Wood-pasture and parkland. In: Maddock, A. (Ed.), UK Biodiversity Action Plan; Priority Habitat Descriptions. Available at: ⟨http://www.ukbap.org.uk/library/UKBAPPriorityHabitatDescriptionsRevised20100730.pdf⟩ (Accessed 15 August 2019).
Maleksaeidi, H., Keshavarz, M., 2019. What influences farmers' intentions to conserve on-farm biodiversity? An application of the Theory of Planned Behavior in Fars province, Iran. Glob. Ecol. Conserv. 20, 1–13.
McAdam, J., Gazeau, S., Pont, F., 1997. An assessment of farmer attitudes to agroforestry on sheep and cereal farms in Northern Ireland. Agrofor. Forum 8 (3), 5–8.
McKelvey, R., Zavoina, W., 1975. A statistical model for the analysis of ordinal level dependent variables. J. Math. Sociol. 4, 103–120.
Morgan-Davies, C., Waterhouse, A., Pollock, M.L., Holland, J.P., 2008. Integrating hill sheep production and newly established native woodland: achieving sustainability through multiple land use in Scotland. Int. J. Agric. Sustain. 6, 133–147.
Morris, R.M., Oreszczyn, S.M., Sloate, C., Lane, A.B., 2002. Farmers' attitudes, perceptions and the management of field boundary vegetation on farmland. In: Frame, J. (Ed.), Conservation pays? Reconciling environmental benefits with profitable grassland systems. Proceedings of the joint British Grassland Society/British Ecological Society conference 15–17 April 2002, University of Lancaster, Lancashire, UK. British Grassland Society, Stoneleigh.
Newman, S.M., Pilbeam, D.J., Briggs, S., 2018. Agroforestry in the UK. In: Gordon, A.M., Newman, S.M., Coleman, B.R.W. (Eds.), Temperate Agroforesty Systems, 2nd ed. CAB International, Wallingford.
Palma, J.H.N., Graves, A.R., Burgess, P.J., Van Der Werf, W., Herzog, F., 2007. Integrating environmental and economic performance to assess modern silvoarable agroforestry in Europe. Ecol. Econ. 63, 759–767.
Pantera, A., Burgess, P.J., Mosquera Losada, R., Moreno, G., López-Díaz, M.L., Corroyer, N., McAdam, J., Rosati, A., Papadopoulos, A.M., Graves, A., Rigueiro Rodríguez, A., Ferreiro-Domínguez, N., Fernández Lorenzo, J.L., González-Hernández, M.P., Papanastasis, V.P., Mantzanas, K., Van Lerberghe, P., Malignier, N., 2018. Agroforestry for high value tree systems in Europe. Agrofor. Syst. 92, 945–959.
Pent, G.J. 2017. Lamb performance, behaviour, and body temperatures in hardwood silvopasture systems. PhD Thesis. Virginia Polytechnic Institute and State University, USA. ⟨https://vtechworks.lib.vt.edu/bitstream/handle/10919/76730/Pent_G_D_2017.pdf?sequence=2⟩.
Raskin, B., Osborn, S., 2019. The Agroforestry Handbook. Agroforestry for the UK. Soil Association, Bristol.
Rise, J., Sheeran, P., Hukkelberg, S., 2010. The role of self-identity in the theory of planned behaviour: a meta-analysis. J. Appl. Soc. Psychol. 40, 1085–1105.
Schirmer, J., Bull, L., 2014. Assessing the likelihood of widespread landholder adoption of afforestation and reforestation projects. Glob. Environ. Change 24, 306–320.
Senger, I., Borges, J.A.R., Machado, J.A.D.M., 2017. Using the theory of planned behavior to understand the intention of small farmers in diversifying their agricultural production. J. Rural Stud. 49, 32–40.
Sibbald, A.R., 2006. Silvopastural agroforestry: a land use for the future. Scott. For. 60 (1), 4–7.
Singh, J., 1988. Measurement approaches for consumer behavior constructs: a multidimensional perspective. Adv. Consum. Res. 15, 487–492.
Soil Association, Woodland Trust, 2019. Agroforestry in England. Benefits, Barriers and Opportunities. Soil Association, London.
Sok, J., Hogeveen, H., Elbers, A., Lansink, A.O., 2015. Farmers' beliefs and voluntary vaccination schemes: Bluetongue in Dutch dairy cattle. Food Policy 57, 40–49.
Sok, J., Borges, J.R., Schmidt, P., Ajzen, I., 2021. Farmer behaviour as reasoned action: a critical review of research with the Theory of Planned Behaviour. J. Agric. Econ. 72, 388–412.
Sparks, P., Shepherd, R., 1992. Self-identity and the Theory of Planned Behaviour: assessing the role of identification with 'green consumerism'. Soc. Psychol. Q. 55, 388–399.
Thevathasan, N.V., Gordon, A.M., 2004. Ecology of tree intercropping systems in the North temperate region: experiences from southern Ontario, Canada. Agrofor. Syst. 61, 257–268.
Thomas, H.J.D., Paterson, J.S., Metzger, M.J., Sing, L., 2015. Towards a research agenda for woodland expansion in Scotland. For. Ecol. Manag. 349, 149–161.
Torralba, M., Fagerholm, N., Burgess, P.J., Moreno, G., Plieninger, T., 2016. Do European agroforestry systems enhance biodiversity and ecosystem services? A meta-analysis. Agr. Ecosyst. Environ. 230, 150–161.
Tranter, R., Costa, L., Knapp, T., Little, J., Sottomayor, M., 2004. Asking farmers about their response to the proposed Bond Scheme. In: Swinbank, A., Tranter, R. (Eds.), A Bond Scheme for Common Agricultural Policy Reform. CABI Publishing, Wallingford.
UK Government, 2021. The England Trees Action Plan 2021–2024. HMSO, London.
Upson, M.A., 2014. The carbon storage benefits of agroforestry and farm woodlands. Unpublished PhD thesis. Cranfield University, Cranfield. 319 pp.
Valatin, G., Mosely, 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. For. Policy Econ. 72, 27–36.
Van der Pligt, J., De Vries, N.K., 1998. Expectancy-value models of health behavior: the role of salience and anticipated affect. Psychol. Health 13, 289–305.
Vandermeulen, S., Ramirez-Restrepo, C.A., Beekers, Y., Classens, H., Bindelle, J., 2018. Agroforestry for ruminants: a review of trees and shrubs as fodder in silvopastoral temperate and tropical production systems. Anim. Prod. Sci. 58, 767–777.
Varah, A., Jones, H., Smith, J., Potts, S.G., 2013. Enhanced biodiversity and pollination in UK agroforestry systems. J. Sci. Food Agric. 93, 2073–2075.
Vaz, E.D., Gimenes, R.M.T., Borges, J.A.R., 2020. Identifying socio-psychological constructs and beliefs underlying farmers' intention to adopt on-farm silos. NJAS-Wagening. J. Life Sci. 92, 100322.
Watkins, C., Williams, D., Lloyd, T., 1996. Constraints on farm woodland planting in England: a study of Nottinghamshire farmers. Forestry 69, 167–176.
Wynne-Jones, S., 2013. Carbon blinkers and policy blindness: the difficulties of 'Growing Our Woodlands in Wales'. Land Use Policy 32, 250–260.
Young, A., 1989. Agroforestry for Soil Conservation. CAB International, Wallingford, UK.