Encouraging woodland creation, regeneration and tree planting on agricultural land:

A literature review

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Further information

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Executive summary

Background, aims and approach

Climate change and biodiversity loss are arguably the greatest challenges currently facing humanity. Establishing more trees, woodlands and hedges in the landscape will play a critical role in the delivery of the UK Government's Net Zero target, as well as the wider ambitions of the Government's 25 Year Environment Plan for people and nature. In the right place, the creation and natural regeneration of woodlands, trees outside of woodlands and agroforestry can deliver significant benefits for nature recovery and enhance public benefits from recreation as well as sequestering carbon. Without an in-depth understanding of the behaviours, motivations and barriers to landowners, however, initiatives to create and regenerate woodlands could fail to realise the step-change in scale needed. A large proportion of treescape expansion will need to occur on agricultural land, so it is crucial to understand the social and cultural opportunities and barriers which exist in relation to farmer decision-making and the associated behaviour change needed to bring about increases in tree cover within agricultural landscapes, while at the same time maintaining sustainable food production and guaranteeing food security.

The aim of this project was to undertake a literature review to summarise the social and behavioural science evidence relevant to woodland creation in the farmed environment. Included in woodland creation are wood pasture, agroforestry and hedgerow planting/establishment in agricultural landscapes. Woodland creation via planting and natural regeneration were both considered. The report highlights key insights for consideration in the design of interventions or schemes to encourage long-term land use change to increase tree cover.

Literature review methodology

The literature review methodology has drawn on techniques adapted from Rapid Evidence Assessment (REA) and Quick Scoping Review (QSR) methods. A search was undertaken using the search engines Web of Science, Google Scholar and Google, and included peer reviewed articles and grey literature published primarily since 2010. The focus was on England, but studies from further afield were included where relevant, but were limited to developed country contexts. After screening, a total of 104 documents were retained for analysis. Each document was coded using the qualitative analysis software Nvivo 12, identifying text fragments that addressed each of the research questions. The coding framework was structured using the COM-B behavioural change model (Michie et al. 2011) that recognises that behaviour is contingent on 'capacity', 'opportunity' and 'motivation', and interventions to influence behaviour change need to change one or more of these components.

Farmer attributes likely to enable or hinder change (capacity)

Younger farmers, or new entrants, and those with a relatively high level of education are more likely to plant. However, some older farmers who are looking to reduce production may see tree planting as a legacy for future generations, or as a pension for their retirement. There is some evidence that farmers with previous experience of woodland creation, environmental schemes or other forms of diversification are more likely to be considering further tree planting.

Environmental and structural contexts likely to enable or hinder change (opportunity)

Trees on farmland can be found in a wide range of contexts including woodland, hedgerows and in-field trees, or can be incorporated into agricultural practices through agroforestry or silvo-pasture. While agroforestry systems are increasing some of the barriers include a lack of human and financial resources, a lack of knowledge and skills related to woodland management, as well as a perception that such practices are not profitable and incompatible with existing farm practices.

The size of the farm or land under management and the vicinity to other areas of woodland are a important determinants of the potential to expand woodland (but not in all cases), with larger farms more likely to increase tree cover. Marginal land is often preferred for tree planting, with higher quality land perceived as 'too good for forestry'. This attitude is linked to a desire to be seen to be using farmland 'correctly' and to be seen by other farmers as a 'good farmer'. Economic factors will also influence decisions, such as the potential financial costs or benefits (e.g. realised through timber production or carbon credits), the loss of agricultural subsidies and opportunity costs. In addition, unlike agricultural land, woodland does not qualify for inheritance tax relief and land values are generally lower for woodland than farmland.

Land tenure can influence willingness or opportunities to plant trees, with tenanted farms less likely to engage in woodland planting due to the short-term nature (3-7 years) of most farm tenancies. With 30-40% of farms managed by tenants, this is a potentially large barrier to behavioural change.

Attitudes, values, and beliefs that will help or hinder behavioural change (motivation)

'Farming carbon' has rarely been the goal of tree planting/woodland creation for farmers. In most cases it has occurred as an additional benefit, alongside objectives related to biodiversity, conservation, landscape protection, climate change adaptation (e.g. flood risk alleviation; shade provision; soil protection) and amenity. Therefore, any incentives aimed at increased tree expansion need to include the ability to achieve a wider set of goals such as nature recovery, timber production, amenity, and addressing climate change adaptation. Perceptions about the degree to which tree planting can be integrated with existing and 'productive' practice can be both a barrier and an enabler.

Grants and other financial incentives only appeal to a proportion of the potential farmers being targeted. They are most successful when they align with existing practices and farmer values. Although grants and other financial incentives have a role, they have only driven a relatively small behaviour change in a proportion of farmers, and there is some evidence of deadweight, as a proportion of farmers receiving woodland grants may have undertaken such work anyway.

The long-term nature of tree planting is a clear barrier to woodland expansion, with a perceived loss of control over land use, and uncertainty about the possibility to revert to alternative land uses. For those who would plant trees for timber rather than biodiversity or other goals there are also the issues of financial risk and inconsistent income streams. A barrier would appear to be that some farmers view forestry as unprofitable, even when it is more profitable than their current farming business.

Societal 'norms' and the issue of self-identity is important (e.g. 'I'm a farmer not a forester'). Self-identity, which can underpin decisions, might in some cases override economic considerations and financial incentives and, along with public attitudes can also affect decisions by influencing the perception of what is considered 'good' farming. In terms of social context, personal and family attitudes, characteristics and social norms are likely to influence decisions to plant. Social networks, including family, may increase resistance to change or conversely may offer a conduit to new actions and behaviours. Alongside this, expectations from the wider community can inhibit or support change.

Land manager segmentation models for addressing increasing tree cover

Landowner segmentation models typically use variables such as individual attitudes, values, experience, behaviour and socio-economic factors to identify discrete 'types' of owner. Eves et al. (2015) undertook a survey and segmentation analysis to create a typology of farmers focused on tree planting and attitudes to woodland ownership. It identified five 'types': Pragmatic Planters, Willing Woodland Owners, Casual Farmers, Farmers First, and Business-oriented Farmers, with the first two being most likely to engage in woodland planting. These two types typically have large or average land holdings and the land is predominantly owned, whereas farmer types unlikely to plant tend to have higher tenancy rates.

This review suggests another segmentation model or large-scale questionnaire-based survey will not add value to the existing understanding of the target population. Existing segmentation studies provide a wide range of information about different farmer 'types' in relation to woodland management and creation. Existing segmentation models (Eves at al. 2015) have also demonstrated high levels of variability within 'types' (e.g. there is evidence of a willingness to engage in tree planting in all of the five types generated by the Eves et al. model). Deeper engagement with representatives of the target population through workshops and discussion groups with farmers and other stakeholders will provide more valuable information on which to develop a woodland expansion framework. Such an approach would provide up-to-date insight into factors

affecting the issues related to capability, opportunity, and motivation described in the preceding paragraphs, i.e. willingness to plant, perceived opportunities and needs, and identification/confirmation of barriers in a rapidly changing environmental and policy context.

Recommendations for policy and further research

We propose three strands of recommendations, operational over different timescales:

Strand A: Understanding the capacity for expansion (short term – 1-3 years)
Strand B: Developing 'innovative interventions' (medium term – 1-5 years)
Strand C: Influencing cultural beliefs and attitudes (long term – 1-10 years+)

Strand A is about understanding the capacity for expansion. The agricultural policy landscape is changing rapidly as the UK comes out of the Common Agricultural Policy and develops new policy based on the principle of public money for public goods. This is likely to influence farmers' capacity and opportunity to engage in tree planting indicating a need to improve understanding around tailoring of policy tools that will alter behaviour. In terms of policy recommendations, an initial entry point would be to target farmers who are most likely to engage in tree planting such as those already engaged and those who have the highest potential to plant (identified in the Eves et al. 2015 segmentation model as 'Pragmatic Planters' and 'Willing Woodland Owners').

The literature review identified that policy tools aligned with farmers' motivations are more likely to succeed, therefore it is important that new tools are designed in partnership with farmers and other stakeholders. This will require the development of engagement or co-design approaches that are likely to encourage participation from farmers. It is likely that a flexible suite of policy options capable of being 'bundled' in multiple ways to target different segments will be required, to avoid the one-size-fits-all approach that appeals to very few. Focused workshops and discussions with representative groups of farmers accessed through trusted stakeholders and networks would provide deeper insight. Although the stakeholder landscape for farmers in terms of agricultural production is well understood, integrating trees in farmed landscapes is likely to involve different actors, and there is a need to update understanding of existing social networks to identify the gaps, key intermediaries, brokers and influencers.

Strand B, running over the medium term, is about developing innovative interventions in order to create opportunities that attract a wider set of farmers to increase the trees on their farm. We know that previous grant schemes often attract 'the usual suspects', those who are already interested in tree planting, while wider uptake has been limited. There is thus a need to develop mechanisms that shift a broader cohort of farmers into tree planting. A combination of 'sticks, carrots and sermons' will be needed to generate behaviour change on the scale needed. Flexible and tailored bundles of regulation, economic incentives and information that can be applied across different local contexts and will appeal to a range of farmer types or segments, will be required, with a focus not just on carbon objectives, but delivering

local and direct benefits (e.g. biodiversity, income generation). All of this needs to be done with wider stakeholder engagement and knowledge exchange in order to enhance capacity and enable adaptation of the tools to the changing circumstances of farmers and in response to shifting norms over time.

Strategies and tools for developing markets must be incorporated into medium-term planning to encourage farmers to invest in tree planting and recognise the value of such long-term assets. Analysis that identifies market-based approaches for incentivising tree planting and generating long-term financial benefits for woodland creation (such as: carbon offsetting, payments for ecosystem services, secure long-term market for wood and wood products) will be essential.

Strand C has longer-term goals involving influencing farmers' cultural beliefs and attitudes in order to shift social norms in relation to trees on farmland. This will require a longer-term strategy and is crucial for enabling wider uptake of woodland creation (including the more unlikely planter segments in the Eves et al. 2015 model) or incorporating trees outside of woodland into farmed landscapes. Policy interventions that can support a shift in social norms are likely to be more effective in terms of awareness raising, advisory, or capacity building approaches. Also significant are how public perceptions of farming and landscape change influence farmers' willingness to plant trees. Approaches will include support for peer-to-peer and multi-actor learning, such as through a network of woodland creation and agroforestry demonstrations on farms. A tool for long term change is through education – embedding woodland management and wider ecosystem science into agricultural training, with the provision of advice/training for woodland management to farmers more broadly.

Conclusion

There are a wide range of reasons for owning and managing woodland, including tree planting, timber production, biodiversity, and amenity; carbon is rarely cited as a motivation for woodland ownership in existing studies. Decisions to expand tree cover on farmland are influenced by farmer attitudes, values, skills, business aims, market drivers and social pressures. Farmers are more likely to plant trees if the objectives of tree planting schemes are closely aligned to their own objectives. In this regard, policy tools need to appeal to multiple 'types' of farmer, who may have different motivations for and attitudes towards tree expansion. These requirements suggest the need for a 'woodland expansion framework' to develop flexible and adaptable policy tools capable of being bundled in different ways.

Farmers must also be able to perceive local on-farm benefits (e.g. soil protection, livestock welfare, biodiversity) and/or receive financial reward for the provision of ecosystem services (public goods) emanating from tree planting on their farm, rather than just the more 'indirect' and long-term global benefits arising from climate change mitigation.

In order to realise the behavioural changes needed for the scale of treescape expansion planned, there will need to be a change in farmers' values, cultural beliefs and social norms. This requires starting with those most likely to engage in tree planting, with a longer-term goal of shifting social norms over time to encourage a wider set of farmers to engage in expansion of farm tree cover

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1. BACKGROUND AND PROJECT AIM

Climate change is arguably the greatest challenge facing humanity over the next few decades (IPCC 2014). To minimise the impacts of climate change on ecosystems and society there is an urgent need to both reduce greenhouse gas emissions and increase their removal from the atmosphere. Because of the central role of vegetation and soils in the terrestrial carbon cycle, there is the potential for altered land management and specifically woodland creation and tree planting to help in mitigating climate change (IPCC 2019). The UK government has committed to net zero carbon emissions by 2050, and woodland creation and expansion are expected to play a significant role in meeting the target. The UK Committee on Climate Change has recommended that at least 30,000 hectares of new planting is required per year (i.e. 90-120 million trees) in order to increase UK tree cover from 13% to 17% by 2050 (CCC 2019).

Scientific evidence (IPCC 2019) suggests that more permanent vegetation cover, including trees (as opposed to conventional arable systems) would greatly assist in carbon sequestration and help move towards the UK net zero emission pledge. The role that woodland planting can play in 'net zero' is in addressing the residual emissions from fossil fuels after reduction through efficiency improvements in energy use, fuel-switching from carbon-based to renewable power sources, and wide-ranging changes to transport, manufacturing processes and food production.

A Natural England (Gregg *et al*. 2021) report reviewed the scientific evidence base relating to carbon storage and sequestration by different UK habitats. It found that woodlands had highest rates of carbon sequestration – depending on the species, age and location (see Box 1 below).

Box 1. Carbon storage and sequestration by habitat: a review of the evidence – summary findings on woodland, trees and scrub (Natural England, 2021)

"The largest carbon sequestration rates amongst semi-natural habitats are in woodlands. Native broadleaved woodlands are reliable carbon sinks that continue to take up carbon over centuries with benefits for biodiversity and other ecosystem services, although the rate varies greatly with tree species and age and is strongly influenced by soils and climate. Sequestration rates decline over time, but old woodlands are substantial and important carbon stores. Although woodland management may be important for a range of reasons, it is not essential to maintain carbon sequestration. Native woodland managed with a minimum intervention approach can be an effective climate change mitigation measure. Timber production can have benefits for climate change mitigation where wood products store carbon for the long-term, or replace more fossil fuel intensive materials and fuels; and can be produced in ways that support biodiversity, such as using native tree species and management of rides and forest edges. However, non-native species of tree generally support lower levels of biodiversity and plantations on peatlands have led both to the loss of biodiversity and carbon. Hedgerows, orchards and other trees outside woodland can also sequester and store carbon as well as providing other benefits within an agricultural and biodiversity context" (Gregg *et al*. 2021).

To mitigate climate change, the large amount of woodland planting required will inevitably involve the transitioning of agricultural land into woodland. Increasing woodland cover from 13% to 17% (by 2050) will require behavioural change from farmers and land managers (Ralph 2020). In order to best incentivise and support this scale of change, improved understanding of the perceptions, motivations and behaviours of land owners and managers is required, along with a clearer assessment of additional opportunities, costs, and benefits resulting from

woodland expansion. Previous research into farmers' attitudes to forestry, however, have suggested that farmers are often reluctant to increase woodland cover on their farms due to perceptions that good agricultural land should be used for food production purposes (Lawrence *et al.* 2010). There are also socio-cultural factors related to land-ownership, succession, concerns over permanent conversion, changing landscape character, and loss of sense of place, all of which could pose barriers to current policy proposals. Evidence on farmer attitudes to woodland planting and forest expansion, the focus of this review, will be analysed, highlighting any significant gaps in relation to the development of a broader 'wood culture', which might support behavioural change, and across different farming contexts (e.g. type of farm, land tenure, location).

The aim of this project is to explore and consolidate current evidence on the socio-cultural opportunities and barriers associated with land owner and land manager decision making with regard to tree planting in agricultural systems. Of particular focus will be those insights which could help in co-designing, with the farming community, more effective interventions, policies and incentives, aimed at securing long term land use change that provides for enhanced ecosystem values, as well as positive improvements in social welfare at both local and national levels. Identification of gaps in knowledge and understanding will be a significant outcome of the research, and enable recommendations to be made for future targeted policy and research in those areas.

2. EVIDENCE REVIEW METHODOLOGY

2.1 Methodology to identify and extract the data

The literature review focuses on farmers' behaviour with regard to woodland creation and tree planting outside woodland (e.g. hedges, agroforestry, agroforestry) including natural regeneration and rewilding. The review draws on recent peer reviewed literature, government research publications and other grey literature, primarily published since 2010 and relevant to the English farming context, to summarise existing research at a national level, and, where relevant, draw on existing case studies at sub-national and regional level. Where appropriate, insights on possible barriers and opportunities to tree planting were drawn from further afield. We used a flexible and robust methodology drawing on items and techniques adopted from the Rapid Evidence Assessment (REA) and Quick Scoping Review (QSR) methods (Collins *et al*. 2015). The methodology is described below.

The aim of the assessment was to review evidence that helps to answer the following questions developed by Natural England:

1. What are the relevant range of behavioural changes (or behavioural outcomes) and what is the scale of change needed?
2. What are the barriers and motivations that will help or hinder establishment of those behavioural changes?
3. What is the best existing land manager segmentation model to use when specifically addressing increasing tree cover?
4. What are the key considerations for each segment, describing both the key barriers and motivations anticipated for this group?
5. What are the potential behaviour journeys or 'entry points' to the transition?

6. Where should resources be focused for the targeted removal of existing barriers and the provision of appropriate and targeted incentives?
7. Where should resources be focused for effective communication, engagement and promotion to encourage long term land use change to increase tree cover, with consideration for future primary research?

These primary questions, specifically in relation to the target audience of farmers, agricultural land owners and agricultural land managers who could incorporate increased tree cover into their business models, underpinned the protocol for the literature review. The literature search and review were conducted through a four-stage process, designed to provide answers to the seven research questions of interest and also provide recommendations for improving the evidence base. The search and review process are illustrated in Figure 1 and described in more detail below.

Stage 1: consisted of an initial wide-ranging search exploring the literature both from the perspective of experiences and examples of forest expansion over different scales and timeframes, and identifying social, economic, environmental, and cultural factors affecting and influencing different forms of tree cover expansion (e.g. agro-forestry, natural regeneration, etc.), and where necessary drawing on the wider framework of land use and management change to understand the factors at work. **(Research Questions 1 and 2)**

Stage 2: explored the literature gathered in Stage 1 through a COM-B approach (capability, opportunity, motivation underlying behaviour) in order to draw out factors affecting capability, opportunity, and motivation for engaging in woodland expansion. **(Research Questions 2 and 4)**

Stage 3: built on Stage 2 to analyse the literature in order to draw out reasons for differences and similarities in terms of the effectiveness of tree cover expansion policy mechanisms under different physical and socio-cultural contexts. This stage enhanced understanding of the effectiveness of different behavioural drivers under varying conditions in relation to stakeholder types and land manager segmentation. **(Research Questions 2, 3, and 4)**

Stage 4: involved an assessment of the evidence collected from the literature search in terms of its quality, reliability, and validity for underpinning policy design and implementation. Stage 4 identified the gaps, drew out the implications for policy design and made recommendations for policy and practice in relation to increasing tree cover on farm land. This stage also identified the roles of key stakeholders associated with forest expansion, indicating scope for targeted dissemination and alternative pathways to influencing attitudes and behavioural change. **(Research Questions 5, 6 and 7)**

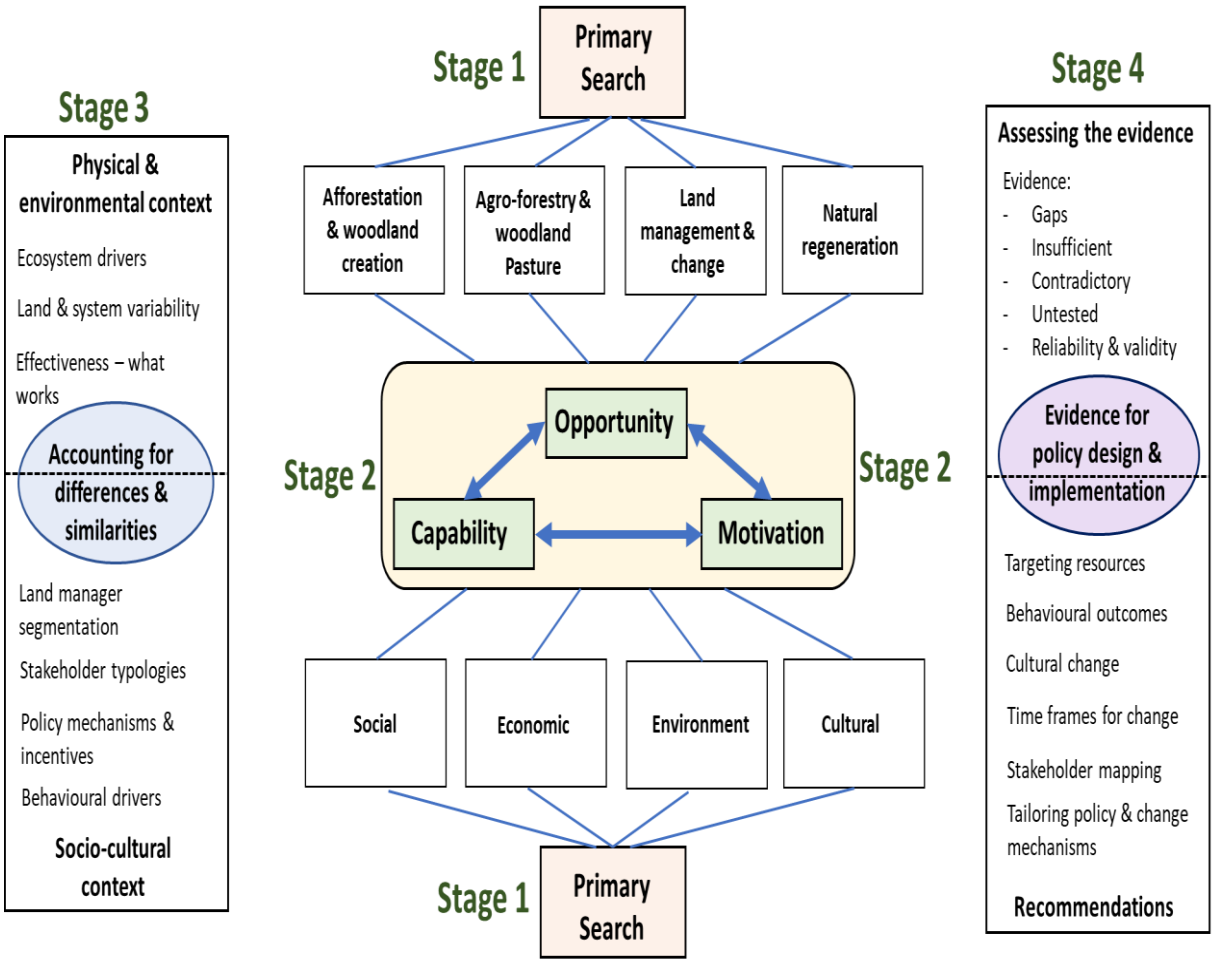

Figure 1. Overall design of the literature review

Searches were conducted using Web of Science and Google Scholar. Experience has shown that combining these two search engines enhances the capacity for identifying a wide selection of the relevant literature (academic as well as the 'grey' literature). Keywords and search strings were identified and refined in an iterative process. The search terms (Appendix 1) included words related to the research questions and the target audience. The search time-frame covered literature from 2010 to the present date (although where literature refers to earlier significant pieces of research, these were assessed for their potential relevance and, where deemed valuable, were explored for additional insight). The geographical reference for this work focussed on national (including sub-national and regional) and potentially informative international studies in a developed world context. Where reports from developed world countries indicated valuable insights on behaviour in relation to policy incentives, these items were examined, taking into account the cultural context and system factors that account for success or failure. Examples included Ireland, where forest expansion across farmland to help meet carbon targets is facing significant challenges (Upton *et al.* 2014, Duesberg & Dhubháin 2019), and France where the forested area has increased by 7% in the past 30 years although management varies from abandonment to strict state control (Sergent 2014, Frei *et al.* 2020) as well as other European countries and selected works from North America. In total 1480 documents were returned in the searches and after several rounds of screening, 104

documents were coded for the analysis (Appendix 2). The documents are mostly from the last 10 years, but are for the majority not England focussed (Appendix 2). It's important to also raise here the issue that there is a time lag between research activity and publication, and that current research evidence in this fast moving area will be becoming available over the coming years. Because of the shift in government emphasis and the acknowledgement of both the climate and biodiversity crises, it is possible that environmental concerns including the need for more trees is being seen in a more positive light by landowners including farmers, than had been the case until very recently. A decision tree for accepting or rejecting papers is provided in Appendix 3.

The key words used to explore the research questions directly were also be moderated and extended to reflect other literatures (e.g. climate change, land abandonment, agricultural production and commodities market drivers) and behavioural change processes, such as knowledge exchange, communication, social norms and framing (see Figure 1). Much of the literature on farmer behaviour change now recognises that the social systems within which individuals operate is important for understanding decision-making behaviour (e.g. Duesberg & Dhubháin, 2019) (Stage 1 of the research design). Therefore, literature on the influence of social networks on farmer decision making in the context of tree planting and broader environmental enhancement was also reviewed.

2.2 Coding, analysis and interpretation of the data

The final set of 104 documents was then coded in Nvivo using a coding framework guided by the research questions. The COM-B model (was used as an analytical framework (Appendix 1) to guide the analysis and interpretation of the data. The importance of the COM-B in this case helps focus the analysis on the barriers and opportunities with regard to underlying determinants of behaviour. In particular, this approach allowed the drawing out inferences as to where interventions should focus to facilitate a change in behaviour. The underlying factors are split into 3 broad groups: capability, opportunity and motivation (detailed below) which acting together determine the behaviour then exhibited. It is accepted that many grant schemes do not achieve their aims despite generous incentives leading to the acknowledgement that other factors are at play. Framing the analysis within the COM-B framework allows these multiple factors determining behaviour to be teased out. This central analysis was supplemented by a secondary analysis to improve understanding of factors accounting for differences and similarities, in particular where similar policy mechanisms have been shown to have different outcomes (Stage 3). Standard relevant factors for the analysis which can relate to either the individual or the enabling environment were:

Capability: the land manager's economic, psychological and physical capacity to plant trees, including knowledge, skills and awareness;

Opportunity: social and physical external factors that facilitate or impede the planting of trees, including support networks, advice, social norms, societal influence, farm type, tenure, geographical location, time and resources;

Motivation: reflective and automatic, internal factors that energize or direct the land manager's behaviour, including self-identity, perceived behavioural control (beliefs about ease or difficulty of performing the behaviour), and response efficacy (belief that actions will make a difference).

The codes (or nodes as they are termed in Nvivo) used are provided in Appendix 1 with additional explanations in Appendix 4.

The evidence was integrated in a final narrative synthesis stage (Stage 4 in Figure 1) summarising the methods and findings of the literature review and the insight in respect of the seven research questions. The report includes recommendations, and an associated set of key considerations for each potential segmentation group, describing both the key barriers and motivations typical for each group (in relation to tree planting), as well as recommendations for actions to overcome barriers, facilitate opportunities, and for future research work.

The strength of the evidence.

The strength of evidence was evaluated through two rankings: a relevance score and a robustness score (Appendix 5). Each source of evidence was scored (1 to 3, low to high) in relation to the quality of the methods, the peer review process, size and/or sampling approach, data analysis, the relevance of the work to the questions and geographical focus of the review, and justified conclusions. Relevance was also considered in relation to the number of times each document was coded.

Relevance scores (Appendix 5) tended to range from 1-2 (average 1.6) in their potential for providing evidence relating to the main research topics and focus. The highest relevance ranking of 3 was awarded to evidence that assessed initiatives and funding towards, and experience of and potential for, farm-based afforestation in the UK and socio-cultural and socio-economic aspects of farmer's involvement in these. Only 10 studies in total received a relevance score of 3. Sources with only marginal relevance to research topics were scored low (1) (52 in total).

Robustness scores (Appendix 5) were frequently in the mid-rank (2) with the average score for all studies 2.08. The studies with low robustness scores tended to be from the grey literature with unspecified sample sizes or case studies. 27 papers scored the highest score (3) and 20 the lowest (1). Scoring for peer reviewed sources linked to the relevance and range of methods used. Higher robustness scores were given when studies employed a larger sample size compared to a lower score for the smallest qualitative or quantitative studies with few participants. 79% of the sources were peer reviewed literature. Within the grey literature larger scores reflected the scope of study and reliability of the methods, whilst lower scores were associated with a focus on generalised recommendations and advice. 21% of the sources reviewed fell into the category of grey literature.

The combined scores (adding together the relevance and robustness ranking) of 2-6 give an interesting picture of strength of existing evidence (Appendix 5). Overall, the combined scores commonly ranged between 3-4, (average 3.7). These scores perhaps reflect some trends in the evidence. For instance, some very relevant studies and reports exist, but they can tend to have smaller sample sizes or single case studies, employ hypothetical or modelling research designs, or not significantly differentiate farmers from other land-owners in their findings and discussion. Elsewhere, robust evidence frequently only touched marginally on the topics or target population (farmers) of this review.

The geographical focus of reviewed sources was also recorded in order to assess how much of the data and discussion centres on England (Appendix 2). 16% of reviewed sources were England specific. A further 42% focused on two or more countries in the UK or explored evidence from Ireland. 21% looked at European case studies, sometimes including evidence from the UK and a further 22% focused beyond the UK, Ireland and Europe.

3. RESULTS

The evidence from the literature review is presented to address each of the research questions (RQ).

3.1. RQ1 - What are the relevant range of behavioural changes (or behavioural outcomes) and what is the scale of change needed?

3.1.1. What are the specific practices potentially associated with 'farming carbon'?

Our literature review found research on specific practices such as agroforestry systems (including silvoarable and silvopastoral), hedgerows, natural regeneration and rewilding. Although farmers are undertaking a range of these behaviours as part of existing agri-environmental schemes, 'farming carbon' is rarely the goal of tree planting / woodland creation; in most cases it occurs as an additional benefit. Measuring carbon in relation to the different practices is rarely carried out.

Agroforestry has potential to increase farm tree cover, although this would require wide changes in current practices.

Evidence is limited for England with reliance on research from Europe more broadly, nonetheless some useful insight can be gained on likely issues surrounding increasing areas under agroforestry.

Agroforestry (defined as agriculture incorporating the cultivation of trees) in the UK is divided into two main practices, namely silvoarable agroforestry and silvopastoral agroforestry. The first is characterised by evenly spaced tree rows with an arable crop in the alley between, while the second is where trees are introduced to forage-based production systems in widely spaced, uneven intervals. Agroforestry is associated with improving the environmental value of agriculture, wildlife habitats, animal health and welfare, and landscape aesthetics, but with increasing labour, complexity of work, higher management costs and administrative burden (de Jalón 2018). Agroforestry is considered more difficult compared to conventional agriculture, the main problem being the work needed to start an agroforestry farm and/or renew an abandoned area, which needs high economic resources and is time demanding (Rois-Diaz *et al*. 2018). Some farmers consider that agroforestry needs more time dedication, that there is more work to be done and they lack the necessary time and human resources. This confirms that agroforestry is a complex system that requires specific technical skills and advice (Rois-Diaz *et al*. 2018). Therefore, although agroforestry systems offer many advantages, including in terms of system sustainability, some farmers are critical and risk-averse with regard to adopting these practices (Nerlich *et al*. 2013). Another point that needs considering is the economic valuation of agroforestry which may not include externalities and non-financial benefits especially when these benefits are outside the farm (Marais *et al*. 2019).

Agroforestry also has potential but the current perception is that it is not compatible with large farm machinery.

Good quality, but limited, evidence exists for expanding agroforestry in England, with much of the evidence relying on a single paper, as outlined here.

Graves *et al*. (2017) evaluated farmers' views on the benefits, constraints, and opportunities for agroforestry systems (defined as systems for growing crops and cultivation of trees) in Bedfordshire, England. Most of the investigated farmers felt that agroforestry systems would not be profitable on their farms and that management and use of machinery is an important barrier to the adoption of agroforestry systems. For example, farm machinery is fundamental to conventional arable farming and successful agroforestry systems would need to be designed accordingly by implementing intercrop widths which are multiples of common widths of sprayers, combine harvesters and seed drills (Graves *et al*. 2017). Therefore, the benefits of agroforestry systems would tend to be environmental or social rather than financial. However, this assumes the current status quo with regard to machinery size; with the advances in agri-technology, automation and smart agriculture it is likely that machinery size will decrease in the future. There were also concerns about increased crop production costs attributed to the trees reducing light availability in the intercrop area. Shading by trees, if planted randomly rather than in a repeated manner, could also cause differential ripening which would make harvesting problematic. Damage to machinery caused by collisions between, for example, combine harvesters and the trees could be expensive. The area at the base of trees would lead to additional costs, partly because of weed and pest invasion; although these areas might also serve as natural reserves for bio-control agents. Finally, root encroachment into drains would impede field drainage which would be expensive to remedy (Graves *et al*. 2017).

Hedgerows and trees in buffer strips could be a solution to enhancing tree cover, but can be seen as losing land area to cultivation.

This issue has received little attention to date and more targeted study in this area would be useful in understanding the potential for trees in hedgerows or buffer strips to play a part in increasing tree cover in England.

Trees and hedgerows (defined as a mix of wild shrubs and occasional trees bordering a field) for buffer strips alongside water courses, fruit production in shrubs and shelter-belts are estimated to account for around 1% of UK agricultural land (Climate Change Committee, 2020). While farmers often believe that the simple act of taking land out of production is sufficient for providing environmental benefits, in reality active management is required.

Natural regeneration and rewilding may be part of the solution, but benefits are often focussed around biodiversity.

Again, there is a rather limited evidence base on which to draw conclusions, with one of the studies cited published by an organisation whose remit is to increase rewilding.

Compared to planting trees, natural regeneration (the process of restocking woodland by trees developing from seeds that fall and germinate in situ) and rewilding (restoring land to a more natural uncultivated state) is associated with advantages such as supporting greater

complexity and diversity of habitats, with increased woodland resilience thanks to locally adapted seeds; and better carbon storage thanks to reduced soil carbon loss (POST 2021, Merckx & Pereira 2015). Natural diverse forests and woodlands containing a range of habitat types are better able to sequester carbon dioxide during their growth phase, enhance biodiversity, and adapt to a changing climate. At the same time, imported tree diseases and management costs could be reduced (Rewilding Britain 2020). However, natural regeneration cannot be considered in isolation, but in a wider discussion about integrated land use change that supports both resilient ecosystems and communities (Rewilding Britain 2020). Here it is worth noting that assisted regeneration may be required to help longer lived plants move with climate change – trees adapted to the current climate will not necessarily be adapted to the climate in 20 or 30 years' time.

Evidence around rewilding and regeneration captured in this review tended to come either from sources campaigning on its behalf or is based around the benefits for biodiversity rather than how to achieve it by changing behaviour of landowners. Evidence emerging from activities in Cumbria's 'Natural Ennerdale' initiative however provides interesting evidence of how farmers can feel in relation to natural regeneration projects (Convery & Dutson 2012). It suggests the emergence of competing cultural narratives of what constitute correct and incorrect land management practices, and that changes in our valuations of landscapes can leave farmers feeling excluded and disenfranchised (Convery & Dutson 2012). This case study is discussed further in section 2.

3.1.2. What are the social and geographical contexts where those practices currently exist in the farmed environment?

Practices can differ according to a variety of factors, which consist mainly of social contexts, such as socio-economic factors that can significantly drive the behaviour of land managers, and geographical contexts that drive practices according to ecological and physical factors.

Social contexts influence farmer decision making and reflect peers, the wider community and traditions.

The evidence that social contexts influence farmer decisions is quite strong, with a significant number of sources; although not all are wholly focussed on woodland creation *per se*.
From a social context, the practices described in the previous section are linked to personal and family attitudes and characteristics, and to social norms. These are triggered by a multitude of underlying factors that can play both ways – either to facilitate change or inhibit change. The analysed literature (Dandy 2012, Ruseva *et al*. 2015, Ryan & O'Donoghue 2016, Graves *et al*. 2017) suggests that the factors potentially affecting behaviour are:

- Land owner attributes: age, education, family context, prior tree-planting experience, farmer image, knowledge and information, desire to farm, risk attitudes;
- Environmental factors: biodiversity, landscape, aesthetics, soil conservation, permanent nature of forestry;
- Economic factors: diversification, timber production, subsidies, tenure productivity, costs, management, technical assistance.

Moreover, behaviour change is most likely to occur at particular times and under certain circumstances, such as ownership change / inheritance, in response to crises or threats (e.g. disease outbreak, flooding), or through the spread of innovation (Dandy 2012).

Among the social factors associated with positive behaviour change were tradition and past experience with woodland. Small private woodland owners sometimes saw themselves as custodians, driven by the heritage value of woodland, landscape beauty and aesthetics, and had a desire to conserve wildlife (Eves *et al*. 2015). Owners can find personal pleasure from trees as they enhance the countryside and the landscape (Watkins 1996). In a wider European context, some evidence suggests farmers can believe livestock thrive better in a more 'natural' environment, and animals need less medication when they have access to shelter (Rois-Diaz *et al*. 2018).

Also, tree planting activities of peers may be positively related to decisions to plant trees (Ruseva *et al*. 2015) as there is evidence that farmers are more likely to participate in woodland expansion schemes if woodland exists on neighbouring farms through proximal social influences (Scambler 1989). Having the possibility of observing examples and discussing others' experience generates learning opportunities, eventually starting to acquire the skills and expertise to implement and manage woodland (POST 2021). In a wider context, some land managers are interested in understanding the best approaches for maintaining sustainability of their woodlands in the face of climate change, pests and diseases, or for ensuring economic stability (O'Brien *et al*. 2018). Additionally, group plantings of neighbouring fields combined with image-building campaigns can encourage afforestation by farmers (Duesberg *et al*. 2014).

Trust and good communication between institutions and farmers can improve the efficacy of and enrollment in agri-environment schemes that include tree planting or management (Mills *et al*. 2016). The benefits of trust include lower transaction costs (Dwyer *et al*. 2007). Trust also underpins farmer collaboration (van Dijk *et al*. 2016) and hence farmers' willingness to work collectively at a landscape scale to repair fragmented ecosystems and create a nature recovery network (Lyon *et al*. 2020). However, in Scotland it was found that farms most likely to enter such schemes are larger, with more employees, owner occupied and containing existing woodland (Hopkins *et al*. 2017).

There are also social contexts which are associated with negative behaviour change. One of these is the age of landowners. In general, older farmers are less favourable towards woodland creation, since the time-lag involved means that benefits are unlikely to be realised in their lifetime (Graves *et al*. 2017). However, older owners are more likely to sell their land for woodland planting as they approach retirement (Lawrence & Edwards 2013). There is some evidence that those with heirs are more favourable towards woodland (Scambler 1989) as they believe that planting a woodland would be a good asset for the family in the future (Duesberg *et al*. 2014). For others, winding down production as farmers' reach retirement may also be an opportunity for tree planting as discussed in section 3.2.

Economic considerations, including incentives, play a role in decisions taken.

Significant evidence exists regarding the role of economic considerations in deciding to create woodland, however much of this is also context specific making generalisations sometimes difficult to reach. Furthermore, the context of much of the research is not farmer specific though often includes farmers, making farmer specific conclusions tricky at times. Additional discussion on grants and incentives in the context of recommendations can be found later in the report.

The management of woodland can also be associated with negative behaviour change. Often, the reason for removing trees is to facilitate management, because trees can constitute an obstacle making the use of tractors or machines more difficult. Moreover, some farmers may consider trees as a source of diseases or attracting birds that eat the seeds or crops (Rois-Diaz *et al*. 2018).

If timber is the only source of income, the several decades required to achieve a return on investment from establishment and management costs can inhibit a move into timber production for profit. Depending on the price of timber, woodland creation can be considered uneconomic by land owners and managers. Woodland creation also has an opportunity cost associated with the income foregone from other possible uses of that land, as land can be more valuable if used for agriculture or development (POST 2021). The literature indicates that farmers that have higher forest incomes, are more likely to have an off-farm job and less productive soils. Therefore, their willingness to implement afforestation is possibly a diversification strategy to optimise both their land and their time resources (Ryan & O'Donoghue 2016).

Government grants for carbon sequestration and other ecosystem services are widely perceived as necessary to incentivise woodland creation by mitigating the early costs of investment and management. However, the effectiveness of agri-environmental schemes and subsidies for woodland is uncertain and offering only a grant incentive might not be sufficient to encourage farmers to plant trees (Duesberg *et al*. 2014, Lawrence & Dandy 2014, Quiroga *et al*. 2018, Ambrose-Oji *et al*. 2018b). Those most in favour of woodland subsidies are woodland owners with larger woodland holdings (Quiroga *et al*. 2018), but non-industrial and family woodland owners and those with smaller holdings showed poor affinity for grants and subsidies. Participation in programmes and incentive schemes is relatively but consistently viewed as low across different country contexts (Quiroga *et al*. 2018, Ambrose-Oji *et al*. 2018a,b). One reason is that interventions such as hedgerow management and planting trees are often long-established behaviours, and not directly motivated by participating in a scheme. As a result, financial rewards may validate existing behaviour rather than promoting new ones (Coyne *et al*. 2021).

Another reason for low scheme participation is that woodland owners are commonly concerned about the potential loss of control over their property, particularly when linked to grants for public access (Urquhart, 2006; Urquhart *et al*. 2010), and can result in an inflexible and restrictive land management regime (Lawrence & Dandy 2014). This significantly reduces the attractiveness and perceived benefits of grants and schemes (Lawrence *et al*. 2010, Mills *et al*. 2017, Ambrose-Oji *et al*. 2018a,b, Quiroga *et al*. 2018, Sarvašová *et al*. 2018).

If public recreation is a desired outcome for woodland creation, then the amount of compensation needed to incentivise farmers will likely need to be greater than that required to achieve other outcomes, such as biodiversity and groundwater protection. This is because farmers may anticipate or experience problems related to public recreational access (e.g. illegal vehicular access, visitors accessing prohibited areas, litter and vandalism) (Urquhart *et al*. 2010). Access results in too much disturbance from the perspective of some farmers, which leads to experiences of disutility from recreation (Broch *et al*. 2013).

Strategies to improve scheme uptake can consist of avoiding complex scheme structures and complicated application processes, facilitating land managers' understanding of schemes and providing support during the application process (Lawrence & Dandy 2014, Eves *et al*. 2015,

Hemery *et al*. 2018, Ambrose-Oji *et al*. 2018a). Therefore, improved communication and engagement between government and the farming community is needed (Arnott *et al*. 2019).

A study in North America highlighted that subsidized seedlings can make a difference in the reforestation choices of forest owners, effectively lower the financial cost of tree-planting. Reforestation requires significant upfront capital for site preparation and planting, and the availability of subsidy programmes can reduce the cost of investment (Ruseva *et al*. 2015).

A final social driver of behaviour change is risks and the risk attitude of landowners. Forestry is associated with risks such as fire, storms (wind blow), pests and diseases, which can cause extensive damage. Without the support of a well-developed insurance market, farmers or potential investors may be reluctant to consider forestry as an option (Zhang & Stenger 2014, Ryan & O'Donoghue 2016). Moreover, risk attitude is a strong influencing factor on farmers' behaviour in adapting and adopting new practices. Given the volatility of the industry both in respect to income and climate, many farmers already have a low tolerance to increased risk (Dessart *et al*. 2019). Those that are more risk averse are later to adopt new management practices (Lyon *et al*. 2020). Attitudes to risk and their impact with farmer decision making are discussed further in section 2.

Geographical contexts are also important in determining the likely uptake of tree planting.

Some evidence points to possible generalisations, but it should be emphasised that there is actually very limited information and research on the geographical contexts highlighted in this section, especially regarding landscape effects.

The most likely farming areas for substantial tree planting would be those deemed less productive or marginal, because farmers would not want to reduce the income from their best land. For example, one farmer interviewed for the study of Graves *et al*. (2017) said that agroforestry has 'limited application in the eastern part of England' because of concerns related to land value, landscape, biodiversity and flexibility.

In many marginal areas, intensive agriculture is not possible due to limiting factors, such as poor soils and slope morphology. In these conditions, agroforestry may be a valuable alternative for preventing depopulation in rural areas (as seen in Southern Europe), while improving soil fertility, increasing biomass production and providing a low but sustainable source of income (Rois-Diaz *et al*. 2018).

The position of specific parcels of land can be a key factor influencing a land manager's decision about what use it is put to. For example, blocks of woodland located away from roads can have increased costs of biomass extraction, but if the objective of the land manager is to improve biodiversity, the distance to roads is less critical as a decision factor (Dandy 2012).However, tree planting should be avoided on peat bogs (release of carbon) and other priority habitats such as species-rich grassland (loss of biodiversity) (Wildlife Trust 2020a, 2020b).

3.1.3. What does the evidence suggest by way of the scale of behaviour change to scale up those practices on farmland to contribute to Net Zero targets?

A substantial area of England would need to be planted with trees to make a worthwhile contribution to Net Zero.

The scale of the task is not in question, more contentious is possibly where the planting should occur, which may lead to different viewpoints depending on the objectives of different organisations.

The study of Reed *et al*. (2009) suggests that in order for woodland to contribute to UK Net Zero targets, the upscaling should be of about 23,000 ha of additional woodland annually for 40 years. The Climate Change Committee (2020) suggests scaling up tree planting rates to 30,000 hectares a year by 2025, rising to 50,000 hectares annually by 2035. This would increase woodland cover from 13% of UK land area to around 18% by 2050. Organizations such as Rewilding Britain (2020) argue that the 25 Year Environment Plan (Defra 2018) to increase woodland cover in England from 10% to 12% by 2060 and the England Trees Action Plan 2021-2024 Strategy (Defra 2021) to increase tree planting to 30,000 ha a year by 2025 are insufficient to meet Net Zero targets. They propose the need to double the UK woodland cover from the current 13% to 26% by 2030.

A recent mapping assessment by Friends of the Earth (2020) to identify areas that would be suitable for planting trees in England concludes that there is potential to double England's tree cover, largely in line with Rewilding Britain (2020). They estimate that there is the potential for planting for 1.4 million ha of poor-quality Grade 4 agricultural land, avoiding planting trees on Grade 1-3 farmland, peat bogs and other Priority Habitats. In addition, they estimate the potential for a further 280,000 ha of agroforestry, giving a total of almost 1.7 million ha, which would take England's woodland cover to 23%.

In terms of the current contribution that farm woodland makes to total UK woodland cover, the area of farm woodland recorded in the June Agricultural Census (Forest Research, 2020) altered from 0.8 million hectares in 2010 to 1.0 million hectares in 2019. These figures include estimates for farm woodland outside of that supported by grant schemes, and it is important to note that figures represent a change in the amount of farm land reported as woodland, but not necessarily actual change in wooded area (Forest Research, 2020: 41).

In 2019 just over half of all farm woodland was in Scotland in 2019 (51%) with a further 11% in Wales and 2% in Northern Ireland (Forest Research, 2020: 41). Data from the June Agricultural Census from 1981 to 2019 confirm that by far the biggest increases to farm woodland took place in Scotland during this period (Forest Research, 2020: 42). In 2019, 37% of the UK's farm woodlands were located in England (Forest Research, 2020: 41).

In 2020 the total area of agricultural land on farms in England was 8,928,000 hectares (Defra, 2020). 385,000 hectares of 'Other land on agricultural holdings' was reported as woodland in 2020, an increase from 295,300 ha in 2010 (Defra, 2020) (Table 1 below).

Table 1. Area of farm woodland (thousand hectares) in England, 2010-2020 (Defra, 2020).

Year	**England** (thousand hectares)
2010	295
2011	305
2012	308
2013	325
2014	331
2015	348
2016	370
2017	369
2018	372
2019	379
2020	385

There are questions remaining about how the increase in woodland should be achieved, including the possible role of natural regeneration.

The evidence with regard to a possible role for natural regeneration is relatively sparse and this would appear to be a significant science gap in addition to the lack of understanding of how farmers and other landowners perceive natural regeneration and rewilding.

An upscaling of woodland creation raises the question of how the additional woodland area should be created. One way for upscaling is tree planting, but if the ambition is to create diverse, climate-resilient forests and woodlands, natural regeneration can also play an important role (Rewilding Britain 2020). Natural England's (Gregg *et al*. 2021) review of potential carbon sequestration of UK habitats found that colonisation and natural regeneration of woodland offers potential advantages for climate change adaptation and mitigation, although more evidence is needed to test and quantify this.

Finally, the literature reviewed revealed that high quality advice and training in woodland and forestry practice, and support for land managers is essential for upscaling (Hyland *et al*. 2015, Rois-Diaz *et al*. 2018).

A step-change is needed in incentive schemes to move beyond supporting existing farmer behaviour to encourage wider participation of farmers in tree planting to meet treescape expansion targets.

The evidence around woodland creation grants and incentive uptake in England is relatively well studied and conclusions around some of the barriers (e.g. complexity, value of incentive) are well understood. However, there has been less research on the complex and interrelated factors such as attitudes, perceptions and social influences on how they determine behaviour.

Although grants and other financial incentives have a role, they may have only driven a relatively small behaviour change in a proportion of farmers and uptake of woodland planting grant schemes by farmers has been low (Hopkins *et al*. 2017, Howley *et al*. 2015); in part linked to grant eligibility (e.g. parcel size). For instance, the Woodfuel Strategy for England concluded that 'Owners of unmanaged woodland *[many of whom are farmers]* have not responded to traditional levers such as grant aid' (FCE 2007, p7). In such instances, incentives alone can be seen to have had a limited impact on the land management decisions and behaviours of land owners (Dandy 2012, Klosowski *et al*. 2001, Neumann *et al*. 2007, Lawrence *et al*. 2010). One issue with reviewing the evidence is that it can be hard to disentangle grants aimed at woodland creation from grants aimed at woodland management (Ambrose-Oji *et al*. 2018a,b). It is also noted that it can be difficult to know if it is the financial incentive *per se* that achieved the requested outcome in terms of tree planting or the availability of advice, often delivered alongside grants (Ambrose-Oji *et al*. 2018).

The evidence on the appeal of grants to incentivise landowners, and more specifically farmers, into tree planting appears to be mixed (Lawrence & Dandy 2014). Despite some evidence to the contrary, incentives can be perceived as too low to appeal by potential woodland creators (POST 2021, Urquhart *et al*. 2010, Eves *et al*. 2015). Research in 2014 (Lawrence & Dandy 2014), linked low uptake with land-manager perceptions of the low profitability of forestry, despite incentives. However, when sizable incentives are on the table, uptake of woodland creation programmes can remain low (Dandy 2012). Indeed, some existing woodland owners have suggested that grants are irrelevant to them (Lawrence *et al*. 2010; Lawrence & Dandy 2014). Such evidence may suggest that concerns around profitability are only one factor in determining low uptake (Lawrence & Dandy 2014). A similar pattern has been noted amongst Irish farmers, where even when forestry returns are higher than those of many livestock farms, there is limited switch to forestry (Duesberg *et al*. 2014, Vidyaratne *et al*. 2012).

Eves *et al*. (2015) suggest that grant aid schemes aiming to deliver woodland creation can be viewed by the target audience as ranging from 'ineffective' to 'a key factor' in decision making depending on the predisposition of the land owner to plant trees. Increasing grant size would therefore appeal to some, but not all potential woodland creators (Eves *et al*. 2015). The authors argue that farmer's motivations and attitudes toward woodland creation need to be better understood, rather than assuming they will plant trees at the 'right price'. The question arises as to whether grants are changing behaviour or whether the landowner, including farmers, would have made the same decision in the absence of grants (Lawrence *et al*. 2010, Dayer *et al*. 2014, Lyon *et al*. 2020, O'Brien *et al*. 2018, Rois-Diaz *et al*. 2018).

Because profit making is not always the ultimate goal of woodland creation for land-managers, financial incentives are not necessarily leading to woodland creation by land owners not already considering the action (Eves *et al*. 2015). Grants may however enable land management behaviours to take place that are already a good fit with or expand on existing values and aims, such as farmers tree planting to improve farm aesthetics, especially for farms with less finance available (Yasue *et al*. 2019, Watkins 1996).

If the aim of a grant scheme is to change behaviour rather than observable environmental changes, the evidence is limited, but one study of private land-manager decision making in the UK pointed to no significant change in attitudes or behaviour (Dandy 2012). The low uptake of woodland creation grants by farmers correlates with a 6-fold difference in farmers described as non-increasers versus those identified as future increasers (Hopkins *et al*. 2017). Several studies suggest a proportion of farmers may be disinterested in tree planting, whatever the incentive (Lawrence *et al*. 2010, Watkins 1996). For example, in Wales, 35% of non-grant receiving landowners indicated that they would not plant trees, even if a grant was available (Wavehill Consulting 2009) and only 16% of Scottish farmers who had not planted trees indicated, unprompted, that grants might influence them to do so (Mindspace 2010). This has also been noted for short rotation willow (Warren *et al*. 2016).

Further details on barriers are presented in the next section (3.2), especially those related to attitudes, traditions and social norms. It has been reported that attitudes and understanding of forestry can outweigh financial incentives in decisions on woodland creation (Dandy 2012, Lawrence & Dandy 2014). Eves *et al*. (2015) also notes that financial incentives infrequently lead to change and that behaviour (e.g. tree planting) is strongly influenced by values and beliefs. The historic low uptake of woodland creation grant schemes suggests a need for a move away from a business-as-usual approach to incentivising tree planting, if treescape expansion is to be realised on the scale needed. From the literature review, the key reasons for low uptake of grant schemes are summarised and explained further below:

- Aims of grant do not align with farmer objectives (Lawrence & Marzano 2014)
- Bureaucracy and complexity of grant process (Dandy 2012, Church and Ravenscroft 2008, Cunningham 2009, Dandy 2009, Urquhart *et al*. 2010, Wavehill Consulting 2009, Moseley *et al*. 2014, POST 2021)
- Grant payments are insufficient and do not provide adequate support or advice (Eves *et al*. 2015, POST 2021) or do not compensate for the high opportunity of woodland creation (Silcock & Manley 2008)
- Low awareness of grant incentives
- Land tenure arrangements do not encourage long-term investment in land use and management
- Reluctance to lose Single Payment (Silcock & Manley 2008)
- Restrictions on tree density and species composition can limit integration of trees into farm landscapes (POST 2021).

Aims of grant do not align with farmer objectives: Historically, grants tend to be taken up when the objectives of the grant scheme are aligned with the farmers' objectives (Lawrence & Marzano 2014). Consequently, farmers receiving woodland grants were more likely to have undertaken tree planting anyway (Lawrence & Marzano, 2014). Indeed, in an older study, Watkins (1984) found that just under half of landowners surveyed indicated that they would have planted, even without a grant. A similar point is made by Coyne *et al*. (2021) who suggest that planting trees is often a long-established behaviour that is not directly motivated by participating in a scheme. This is supported by Thomas *et al*. (2015) and Urquhart *et al*. (2011) who argue that the presence of existing woods on farms in Scotland and England, respectively, is a predictor of future intention to plant and therefore, familiarity with woodlands increases favourable attitudes towards planting. Similarly, Ruseva *et al*. (2015) found that landowners who had previous tree-planting experience were four times as likely to have

intentions to plant trees in the next five years compared with those with no prior planting experience.

In addition, a number of studies suggest that profit making is not the primary motivation for tree planting behaviour (Eves *et al*. 2015, Lawrence & Dandy 2014), thus grants are unlikely to be effective in changing behaviour or specifically leading to woodland creation by land owners not already considering the action (Eves *et al*. 2015).

Although grant uptake has generally been low, the historic Farm Woodland Premium scheme (FWPS) achieved a good level of uptake, in part linked to regular interactions with advisors (Heffernan *et al*. 2011). This particular grant scheme was strongly focussed on biodiversity benefits rather than timber production, with a focus on native broadleaves (Heffernan *et al*. 2011). Biodiversity is a key aim of many stakeholders who do engage in woodland creation (Eves *et al*. 2015), therefore the FWPS's objectives were likely closely aligned to those farmers who engaged with the scheme.

These findings suggest that current grant schemes may validate existing behaviour rather than promoting new ones. Therefore, a balance is needed between attractive financial incentives and approaches aimed at changing attitudes. Flexibility and the inclusion of elements of choice within grants allow for a better match with the farmer's worldview, making the grant more attractive and enhancing the potential for longer term behaviour change (Coyne *et al*. 2021). This match between decision-making behaviour and policy tools is key in determining uptake (Duesberg *et al*. 2014, Arnott *et al*. 2019, Lawrence & Dandy 2014, Urquhart *et al*. 2012, Eves *et al*. 2015, Warren *et al*. 2016). It is also important that schemes are tailored to the local conditions and farming approaches (Mills *et al*. 2018). It's also been suggested that grants may change behaviour over the short term but not affect attitudes which is required for long term self-sustaining change (Lyon *et al*. 2020, van Dijk *et al*. 2016). This has been observed for AES more generally (Mills *et al*. 2018). Some grants were also overly prescriptive in what could be planted and often include stipulations about minimum area (POST 2021).

Bureaucracy and complexity of grant process: One of the reasons for low (historic) uptake is that grants were seen as overly bureaucratic in relation the application process especially but also the inflexibility of associated requirements (Ambrose-Oji *et al*. 2018a,b, CCC 2020, Lawrence & Dandy 2014, Lawrence *et al*. 2010, O'Brien *et al*. 2018, Quiroga *et al*. 2018, Royal Forestry Society 2020, Thomas *et al*. 2015), but this is changing (Lawrence *et al*. 2014).

Low awareness of grant incentives: Watkins suggested in 1996 that farmers' lack of knowledge of afforestation grants was a constraint to the creation of farm woods. An Irish study, found that depth of knowledge of woodland creation schemes, rather than lack of awareness, can influence intention to plant (Duesberg *et al*. 2014). Of farmers who said they were aware of the Irish farm woodland creation scheme but didn't want to plant, a significant number (16%) changed their mind when given further details (Duesberg *et al*. 2014). The authors suggest that generalised awareness might not be sufficient and more targeted information campaigns might move a 'passive pool' of farmers towards intention to plant (Duesberg *et al*. 2014). Contrastingly, as previously mentioned Heffernan *et al*. (2011), argue that lack of enrolment to the English Farm Woodland Premium Scheme was not due to a lack of awareness, but an active decision based on farmers' perceptions that they lacked appropriate knowledge and skills.

Grant payments are insufficient and do not provide adequate support: Despite some evidence to the contrary, incentives can be perceived as too low to appeal to a broad range

of woodland creators (POST 2021, Urquhart *et al*. 2010, Eves *et al*. 2015). For example, Rouillard *et al*. (2015) in a study of farmers in 2 catchments in England and Scotland, found that land managers would only consider tree planting across the broader landscape to manage flood risk if financial support was provided (22 out of 30 interviews) because it could represent a significant change in their business model.

Alongside this, grants in the UK can neglect incorporating sufficient advisory services compared to the grant deployment (Lawrence & Dandy 2014, Hemery *et al*. 2018) and lack of provision of advice for woodland creation can be a reason for farmers not applying for grants (Heffernan *et al*. 2011). This includes accessing the information about the availability of funds (Ambrose-Oji *et al*. 2012, Ambrose-Oji *et al*. 2018a, Lawrence & Dandy 2014), with some hearing about grants via word of mouth. Clarity in terminology could assist here in making grants more accessible (Moseley *et al*. 2014). However, it's also been reported that lack of awareness may simply be a lack of interest on the part of the landowner (Ambrose-Oji *et al*. 2018a). Strongly linked to the provision of advice is the need for the advisors to have built trust with the farming community (Ambrose-Oji *et al*. 2018a). This was evidenced in the Glastir scheme where much of the administration was done remotely resulting in limited contact with advisors and arguably contributing to the lower than expected uptake (Ambrose-Oji *et al*. 2018a). When several agencies are involved in grant delivery, this can be confusing in terms of where to go for advice (Heffernan *et al*. 2011).

A question that arises with regard to grant payments is whether they should be focussed on actions undertaken or outcomes (Hanley *et al*. 2012); e.g. in the case of woodland initial planting versus longer term establishment. A potential benefit in terms of grants or government finance is that stipulations could be included for activities after the end of the financing period – this has been reported as a benefit when considering rewilding activities (Root-Bernstein *et al*. 2018).

Ruseva *et al*. (2015) suggest that large landowners (in the United States) are less likely to plant trees than smaller land owners, as they balance the opportunity for short-term benefits (through agriculture) with longer-term benefits (through forestry). However, large landowners are likely to be more responsive than small landowners to policy tools such as grants, due to their experience of other government financial support (Ruseva *et al*. 2015, Quiroga *et al*. 2018, Janota & Broussard 2008). While small landholders may have an intrinsic motivation to undertake tree planting, and thus, be less responsive to financial incentives, they may be motivated by capacity and incentive policy tools, such as subsidized seedlings (Ruseva *et al*. 2015). Similarly, Ambrose-Oji (2018b) found that low participation in woodland creation schemes in the UK is especially evident for farmers with smaller holdings and family owners. However, evidence for involvement in AES in the UK, as a proxy for woodland creation, concludes that larger, freehold and successful farms are not always the most likely to join grants (Eves *et al*. 2015). Alongside farm size, Arnott *et al*. (2019) found that AES take up in Wales, including woodland, was highest in areas with low-input farming and low farm income in uplands.

Reluctance to lose Single Payment: Farm subsidies are often the only reason why farming less-productive land remains economically attractive to land-owners. As such, Merckx and Pereira (2015) suggest to disconnect subsidies for marginal land from farming activities, which will reduce land prices and reduce competition for land with other societal players, bringing opportunities for ecosystem restoration, including tree planting. Given the goal of moving away

from the Basic Payment Scheme in the UK, this has the potential to remove this barrier to grant uptake.

3.2. RQ2 - What are the barriers and motivations that will help or hinder establishment of those behavioural changes?

3.2.1. Are certain contexts more amenable to behaviour change?

The answers to this question are grouped under the two key underlying factors (capability, and opportunity) determining behaviour; motivation is treated separately as psychological rather than physical context.

CAPABILITY

Tenancy can be a barrier to long term decisions especially tree planting.

Land tenure can influence willingness or opportunities to plant trees, with tenanted farms less likely to engage in woodland planting. 30–40% of UK farms are tenanted, with an average tenancy of 3-7 years (POST 2021). Landlord permission is often required for, or tenancy agreement clauses may prevent, tree planting (Lawrence *et al*. 2010). Tenant farmers may also be dis-incentivised from creating woodland as they are unlikely to see any return on their investment (POST 2021). In their study of farmers in Scotland, Hopkins *et al*. (2017) found that tenants were significantly the least likely to have planted trees in the past than other kinds of occupier. Land tenancy results in long-term decisions being avoided by the farmer, especially when future benefits might revert to the landowner (CCC 2020, Dandy 2012, Heffernan *et al*. 2011, POST 2021). In tenure arrangements there are two stakeholders who must reach agreement in land management decisions, and Dandy (2012) points out that tenant farmers may also inhibit the decisions of land owners to change land use, such as creating woodland.

Age influences intention to plant.

Scottish research (Hopkins *et al*. 2017) suggests that younger farmers, already involved in forestry or non-agricultural practices, who are newer entrants to farming and/or have a relatively high level of education should be a target group for encouraging tree planting through grants. Farmers under 45 were significantly more likely to intend to plant than older farmers. Research reviewing farmers' uptake of agroforestry practices from case study evidence across Europe suggests that education is the 'main' factor informing decision making, alongside family tradition (Rois-Diaz *et al*. 2010). Elsewhere it suggests that younger farmers are more likely to take up new agroforestry practice, with retirees least likely to embrace change and that farm ownership influences tree planting choices, with tenants least likely to tree plant (Rois-Diaz *et al*. 2010).

Elves *et al*. (2015) suggest that the correlation between age and farmers' attitudes to the environment is a key consideration for policy targeting woodland management or creation interventions. They argue that there is a generational divide which is creating a shifting baseline, with attitudes changing according to age. Further, they suggest that younger farmers'

have a stronger sense of 'social responsibility' informing their decision making (Eves *et al*. 2015).

Evidence from an Irish study on farms replacing or supplementing livestock income with income from farm afforestation found that the majority of farmers were choosing not to afforest and that, in line with most of the evidence on farmer age and tree planting behaviour and intention, most of these were older farmers (Ryan & O'Donoghue, 2016). In contrast to some younger farmers in the study, this age group overlooked financial gain because of 'negative cultural attitudes' (Ryan & O'Donoghue, 2016). The authors suggest that more 'positively', a smaller subset of younger farmers (likely to have larger farms and sometimes off-farm income) were minded to diversify if forest income would exceed agricultural income. The authors note that although tending to be younger, these farmers cannot really be characterised as a homogenous group, other than the lifestyle decisions they are making around fostering 'land and time resources' (Ryan & O'Donoghue, 2016). Whilst Ryan & O'Donoghue (2016) associate the reluctance of older age groups to afforest with cultural attitudes, Hayden *et al*. (2016) suggest it is tied to the 'time-lag' of benefits and their realisation outside of older farmers' lifetime, and a reluctance to limit flexibility of land-use for their successors. Several other studies agree that the timescale of benefits is a problem for many farmers, but particularly older ones who will not realise benefits in their lifespan (Watkins 1996, Lawrence *et al*. 2010).

There are a few findings that are outliers in evidencing the relation of farmer age to tree planting behaviours and suggest that sometimes tree planting can be seen as a way to scale back farming for those approaching retirement. Within Ryan and O'Donoghue's Irish study, a number of older farmers who did choose farm tree planting appeared to do so as part of a deintensification strategy for winding down production (Ryan & O'Donoghue 2016). Their decision to plant trees appeared to be part of wider lifestyle decisions and changes they were making in relation to their advancing years (Ryan & O'Donoghue 2016). Hayden *et al*.'s (2016) Scottish focused review also evidences the influence of lifestyle choices relating to age, arguing that whilst older farmers are least minded to plant trees, they are also most likely to sell land for tree planting as they approach retirement. An Irish survey of farmers and forest owners (incl. farmers) in 2010 found older age groups more likely to plant than younger ones *and* more likely to plant a larger area (Vidyaratne *et al*. 2010). This research also suggests inheritance is a factor in deciding to plant trees, but not in how big an area to plant. A Scottish study focusing on the Lockerbie area also found that older farmers were more willing to consider planting short rotation willow coppice than younger groups (Warren *et al*. 2016). The authors acknowledge that this runs counter to much of the evidence on tree planting and suggests again that it is related to lifestyle decision making related to advancing age (Warren *et al*. 2016). They cite a number of studies focused on willow coppice that also find older demographics more willing to consider it and argue that this may be because it is being considered as part of a strategy to 'reduce daily involvement in farming' (Warren *et al*. 2016). The authors recognise that establishing relationships between farmer demographics and willingness to plant is complex, but argue that 'targeted advocacy' for willow planting towards this older age group could be useful (Warren *et al*. 2016). Willow coppicing is potentially seen as easier to reverse and having shorter timescales than woodland planting, possibly partly explaining these findings.

The recognition that growing older and associated lifestyle changes can impact decision making around tree planting is important in attempts to understand farmers' willingness to

plant trees (Wilson *et al*. 2013). The same farmer may have a different perspective on tree planting depending on where they are in their life course (Wilson *et al*. 2013). The fact that family members may become more influential in decision making as farmers age can also complicate attempts to categorise (Wilson *et al*. 2013). This movement through dispositions towards tree planting with age may be reflected in evidence from Hopkins *et al*. (2017) that suggests that the length of time involved with a smallholding or farm was also associated with intention to plant, with newer entrants most likely to tree plant.

> '…future increasers were somewhat more likely than non-increasers to be relatively recently involved …. 12% of future increasers had less than five years' association with the business/holding, and 10% had been involved for five to ten years: respective figures for non-increasers were 5% and 6% (and 7% and 11% for the past increasers)' (Hopkins *et al*. 2017:125).

Alternatively, the willingness of newer owners to plant trees could be evidence of a trend revealed in a study of UK landowners; that change in land management is often associated with change in ownership or inheritance (Dandy 2012).

Education influences intention to plant.

In a 2013 study looking at intentions to plant amongst a large sample of Scottish farmers (n = 1,735), education level was most strongly associated with a plan to plant trees in the future (Hopkins *et al*. 2017).

> 'Just over a third (36%) of future increasers had a university level education, compared with 18% of non-increasers and 31% of past increasers; furthermore, the proportion of future increasers with only a school level education (28%) was smaller than the respective figure of past increasers (33%) and far lower than that of non-increasers (49%)' (Hopkins *et al*. 2017:125).

Irish research suggests that theoretically, decision making skills around profitability and farm afforestation could be a barrier for some, those with less agricultural education are potentially less able to compare returns of tree planting with those of their existing agricultural practices.

> 'When looking at education levels there is a difference between drystock and dairy and tillage farmers: fewer drystock farmers have availed of agricultural training in the past when compared to dairy and tillage farmers (Table 8). While this indicates that potentially there could be a lack of decision-making skills, this would only be a barrier to further farm tree planting for a small proportion of the farming community' (Duesberg *et al*. 2014:200).

A US-wide survey exploring factors impacting private forest owners' attitudes towards management for carbon sequestration and trading found education level to be the only demographic variable that was statistically significant in attitudes towards it (Thompson & Hanson 2012). Those with higher levels of education were more likely to be positive about such approaches (Thompson & Hanson 2012). The authors suggest that logically this could be correlated with higher income enabling freer decision making, however they note that income itself was not correlated with attitudes (Thompson & Hanson 2012). They suggest instead that rather than reflecting resources, higher education levels may in some way facilitate 'egalitarian or biocentric motives' (Thompson & Hanson 2012). In another US study, the only demographic factors impacting 'private landowner' enrolment into a carbon sequestration scheme were gender and education (Ambrose-Oji *et al*. 2018a). US research

exploring policy incentives for encouraging private landowners to create woodland finds that intention to plant in the future is twice as likely amongst college-educated respondents and that more recent ownership (under five years) is positively associated with intention to plant trees (Ruseva *et al*. 2015).

In a broader paper (McElwee & Bosworth 2010) exploring the characteristics associated with diversification, including into 'environmental goods', amongst farmers, higher levels of education, professional qualification or degree, and having worked outside of agriculture were associated with diversification. This resonates with findings that suggest intention to plant more trees can be higher amongst farmers with higher education levels and non-agricultural diversification experience. The authors also find that younger farmers are more willing to diversify (under 55) and more willing to take on diversification that might create additional work (McElwee & Bosworth 2010).

Some evidence suggests that farmers with previous experience of woodland creation, environmental schemes or other forms of diversification are more likely to be considering further tree planting.

Hopkins *et al*. (2017) Scottish survey of farmers' attitudes towards afforestation identify a range of experiential learning associated with willingness to plant trees in the future and found that those who have already engaged with forestry or taking part in non-agricultural diversification were more likely to be intending to plant trees in the future. An intention to increase planting was also associated with previous enrolment in environmental schemes (Hopkins *et al*. 2017). The authors suggest that these farmers may be characterised as more 'active' and 'diversified' farm managers (Hopkins *et al*. 2017). Those intending to plant in the future were over 6 times as likely to have forestry on their farm already (Hopkins *et al*. 2017). They were 3 times as likely to be involved with tourism and recreation as diversification activities and 5 times as likely to be processing and selling farm produce. They were also twice as likely to be involved in generating renewable energy (Hopkins *et al*. 2017). Those who had planted in the past or were intending to plant in the future were much more likely to be currently involved with an agri-environment scheme (or have been involved with one in the past, or intend to be involved with one) (Hopkins *et al*. 2017). Future planters were also 3 times as likely to be converting to or certified as organic producers (Hopkins *et al*. 2017). Farm management activity (measured through increase in a range of activities over last five years) was highest amongst those who had already planted in the past (33 %), followed by those who intended to plant in the future (31%) and was lowest (15%) for those with no intention to plant (Hopkins *et al*. 2017). Intention to plant was also associated with uptake of technological innovation, with future planters and past planters both more likely to have applied new technology in the recent past (Hopkins *et al*. 2017).

Ruseva *et al*. (2015) suggests that private landowners, within their sample in the midwest of America, with prior tree planting experience are four times more likely to intend to plant trees in the future compared to those not previously involved in tree planting. The authors also argue that a positive correlation between larger land holdings and intention to plant could reflect the likelihood their owners have past experiences of agri-environment schemes (in comparison to owners of smaller parcels) and are therefore perhaps more sensitive to 'policy tools' (Ruseva *et al*. 2015).

Thomas *et al*. (2015), reviewing the potential for afforestation in Scotland, argue that the presence of existing woods on farms is a predictor of future intention to plant and therefore familiarity with woodlands increases favourable attitudes towards planting. This relationship they argue is supported by evidence that existing woodland on neighbouring farms can also be associated with farmers' willingness to plant in the future.

In Ryan and O'Donoghue's (2016) Irish study evidencing a cohort of older farmers choosing afforestation as part of a deintensification strategy for winding down production this group tended to be already receiving part of their income from agri-environment schemes and receiving higher payments on average than younger farmers (Ryan & O'Donoghue 2016).

Some evidence finds the converse, that previous engagement with agri-environment schemes is either not correlated with future intentions to plant or negatively associated with them. A German study, for instance, found that farmers' attitudes towards incentivisation of afforestation didn't appear to correlate strongly to previous engagement in nature conservation measures via agri-environment schemes, confounding the authors' expectations (Brouwer *et al*. 2015). Elsewhere, research focused on case studies of farmer experiences of agri-environmental schemes in England found farmers sometimes reluctant to engage in incentivised hedgerow planting if their experiences of previous funded planting were negative, particularly where management requirements were a poor fit for the local context, both practical and cultural (Emery & Franks 2012).

Some evidence that a lack of farmer skills could potentially be a barrier to farm based tree planting.

An assessment of the English Farm Woodland Premium Scheme and its ability to promote and sustain environmental improvements in agricultural landscapes (Heffernan *et al*. 2011) hypothesises that farmers' lack of familiarity with woodland management skills may make them 'innately' uncomfortable pursuing forestry (Heffernan *et al*. 2011). Farmers deciding not to apply for the scheme complained that there was little advice on how to transition to forestry on agricultural land (Heffernan *et al*. 2011). At the same time participants on the scheme made little use of woodland training available to them (Heffernan *et al*. 2011).

A recent POSTNOTE on woodland creation (POST 2021) also suggests from its review that farmers lack specific skills for afforestation, alongside appropriate technology and tools and that there is a need to 'upskill' farmers through advice and guidance. Agricultural farmers may wish to continue utilising their existing skill sets in any move towards agroforestry, according to evidence from Bedford, England where most wished to integrate their existing choice of crops into any silvoarable system (Graves *et al*. 2017).

In a paper looking more widely at farm diversification, McElwee and Bosworth (2010) argue that farmers sometimes lack understanding of and the ability to confidently move within diversified markets and opportunities, because they are not embedded in the social networks surrounding those markets and lack social ties to them. In this sense farmers could be seen to lack skills in 'external awareness', alongside any lack of aptitude and ability (McElwee & Bosworth 2010).

The role of 'knowledge' is key in constraining or enabling woodland management, creation or expansion amongst farmers.

Farmer's belief in their capability to successfully implement actions and change is an important factor in decision making (Ambrose-Oji *et al*. 2018a). Research in lowland Scotland found that 'most' farmers' interested in woodland perceived themselves as lacking woodland management knowledge and that these perceptions underlay their desire to sell their woodlands (Lawrence & Dandy 2014). The authors describe this as an 'apparent knowledge deficit' (Lawrence & Dandy 2014). In Fife, farmers were disinclined to try short rotation forestry due to 'a lack of available information' (Lawrence *et al*. 2010). Within another Scottish study, a key barrier to farmers engaging with short rotation willow coppice was a perception that they lack appropriate expertise and therefore couldn't take informed decisions (Warren *et al*. 2016). An Irish study (Vidyaratne *et al*. 2010) also identifies a specific 'knowledge gap', in terms of farmers' awareness of timber's economic returns and the wider value of woodlands, as a disincentive to the creation of farm woods.

Elsewhere, research suggests that alongside the size of holding, length of ownership and membership of woodland organisations and social networks can all impact landowners' 'woodland related knowledge' (Lawrence *et al*. 2010, Lawrence & Dandy 2014). Lawrence *et al*. (2010:59) argue that evidence that these are key influences upon knowledge gain

> 'presents a considerable opportunity for stakeholders seeking changes in woodland management and increases in new planting'.

Lawrence *et al*. (2010) identify however, what they describe as the 'farming/woodland split' in circulation and gain of woodland focused knowledge resources. Citing evidence from Scotland they suggest that woodland management knowledge for example seems to be outside of farmers' frame of reference for required land management expertise (Lawrence *et al*. 2010).

A knowledge deficit may not be a barrier to woodland creation/expansion/management if farmers have the connections and contacts to employ skilled forestry professionals (Lawrence *et al*. 2010). However, existing managers have identified a lack of these contractors as a hindrance to expansion (POST 2021). In addition, reliance on buying in knowledge to establish woodland may be part of a 'passive/outsider' or 'disinterested' mindset to woodland management that Sotirov *et al*. (2015) diagnose as characterising some European farmers entered into afforestation schemes, an outlook that can limit further action. Further, Lawrence *et al*. 2010, argue a lack of knowledge will 'be a greater disincentive to new woodland planters' who lack the networks and connections to engage forestry professionals. Evidence from Northern Ireland suggests farmers may also be less likely to participate in formal woodland focused networks such as membership of forestry organisations and may be reluctant to join them (Lawrence *et al*. 2010 citing Blackstock and Binggeli 2000), because of perceived self-identity as farmers.

Dandy's (2012) review of landowner decisions also argues that networks are key to farmer's knowledge resources, and a lack of social networks is a potential barrier to decision making as farmers can't gain advice or guidance from this source. This is critical when professional advice is limited or absent. The author identifies social networks as playing a key role in woodland management decisions and landscape scale decision making (Dandy 2012).

In a study of European forestry owners (Deuffic *et al*. 2018) the authors illustrate how knowledge disseminated from 'formal' sources may be compared with and operationalised in decision making in relation to knowledge, concepts and understandings from 'informal'

knowledge sources such as peers, family and the media, as well as that gained through experiential learning. The information and knowledge owners/managers find most relevant depends on their context and forestry objectives and can limit acceptance of change (Deuffic *et al*. 2018). Ambrose Oji *et al*. (2018a,b) find that landowner/manager behaviour in relation to ideas of managing woodlands for 'resilience' is similarly aligned with their own 'knowledge, information' and interpretation of key 'concepts' and how these relate to their specific context. Sumane *et al*. (2018) agree that informal networks and peer knowledge, alongside the evidence of farmers' own experience and experimentation are key knowledge sources for farmers. Whilst Rois-Diaz *et al*. (2018) argue that technical advice and guidance from professionals in extension services can be respected, integrated and have most influence on farmers' decision making when future scenarios are uncertain, Sumane *et al*. (2018) argue that farmers tend to fall back on these informal knowledges in such situations. The authors suggest that informal, peer and localised knowledge resources can increase farmers' 'confidence and capacity to act' and agree with Deuffic *et al*. (2018) that sometimes these can provide material with which to resist other, perhaps more formal knowledge (Sumane *et al*. 2018). In a case-study exploring English farmers' attitudes to agroforestry, it was found for example, that their established knowledge or local context and practices made silvoarable management systems appear inappropriate and not fitting with their current practices (Graces *et al*. 2017:80).

> 'One stated, "Why change the separation of crops and trees which is practical?" Another said that, "fields are the factory floor of the farm and trees in fields are obstacles"…One said that it was "not the right idea for this part of the country" and another that it had "limited application in the eastern part of England".'

A fairly recent review of European case studies found that farmers had varied and frequently imprecise concepts of agroforestry: 'Some farmers defined it as growing trees, others related the definition with the promotion of trees in agriculture, while others thought that it is about integrating woodlands with crops (i.e. apple rows in crops), planted forest with arable field like corn or wheat, or grazed forest. Other farmers referred only to particular practices that were familiar for them: trees planted in strips, plantation for biofuels, or as short rotation coppice. Actually, in many cases, agroforestry was a concept that had never been heard, especially by conventional farmers' (Rois-Diaz *et al*. 2018). This study found that whilst some loosely recognised the concept as referring broadly to some kind of blending of trees with livestock or crops, other farmers actually practising agroforestry were unaware of the formal concept and specific term (Rois-Diaz *et al*. 2018). The authors argue that such findings evidence the need for communication and training campaigns directed at growing understanding of agroforestry amongst farmers, but also policy makers and advisors (Rois-Diaz *et al*. 2018). Within the same review, findings suggest that frequently more informal learning (and inspiration) from successful examples of agroforestry and its advantages is an important source of knowledge gain for farmers (Rois-Diaz *et al*. 2018). Examples ranged from colleagues and peers to internet pages (Rois-Diaz *et al*. 2018). Rois-Diaz *et al*. (2018) argue that successful examples of farmer-led projects are more credible to other farmers and that peer to peer learning both piques interest and transfers knowledge effectively. Ultimately, the authors advocate for active support for development of linkages between all other stakeholders and farmers in order to encourage the growth of networks that can facilitate formal and informal knowledge circulation and exchange (Rois-Diaz *et al*. 2018).

Research on the value of farmers' local knowledge also promotes the worth of 'multi-actor knowledge networks' and informal learning opportunities for knowledge gain on sustainable change (Sumane *et al*. 2018). The authors argue that such networks, and networking within

them, can democratise knowledge, resulting in effective knowledge exchange where farmers are 'active partners' in learning, generation of new, innovative understandings and practice, and the sharing of these (Sumane *et al*. 2018). Such networks can help 'translate' 'foreign' knowledge into local context and knowledge resources (Sumane *et al*. 2018). Peer to peer and multi-actor networks may be particularly important for dealing with complex areas requiring relatively rapid behaviour changes and solutions that are responsive to and embedded within local contexts (Sumane *et al*. 2018). Ambrose Oji *et al*. (2018b), also argue that peer and multi-stakeholder networks play a key role in building confidence and trust in change. The authors suggest that it is not necessarily a question of what knowledge is available, but how it is constructed and consumed that is significant (Ambrose Oji *et al*. 2018b). Relatively little emerged in the literature reviewed concerning farmers' knowledge of climate change and intention to participate in tree planting as a nature-based solution. Hyland *et al*. (2015) suggested that welsh farmers' lack of knowledge of climate change and perceptions of it as a relatively low risk to society (in comparison to water quality, food and energy security) create a barrier to their adoption of practices addressing it. O'Brien *et al*. (2018) found knowledge of concepts of ecosystem services or payment for these services (PES) amongst land-managers was limited although they recognised that the woodland they manage provides a variety of 'goods' to society.

OPPORTUNITY

The size of the farm or land under management is a determinant in some cases, but not in all.

The evidence of the influence of the size of farm or land under management is mixed, but does suggest relationships exist, though the findings are not always consistent.

A number of studies find that size of holding can be significant in determining whether land managers convert part of it into woodland, especially if the goal is income from timber production (Dandy 2012, O'Brien *et al*. 2018, Thomas *et al*. 2015).

Hopkins *et al*. (2017: 125) find that in Scotland, larger farms are consistently more likely to have planted trees in the past, but don't reveal a correlation between farm size and intention to plant in the future. However, the authors find a link between labour and intention to plant, with farms that employ more staff typically more likely to intend to plant. This evidence suggests that the relationship between size of landholding and intention to plant may be complicated by other issues related to capability, in this case physical and knowledge resources. Several Irish studies suggest a consistent relationship between larger farm size and future intention to plant (Duesberg *et al*. 2014, Ryan & O'Donoghue 2016, Watkins *et al*. 1996). McElwee and Bosworth (2010) suggest more broadly that larger farms facilitate the potential for diversification, including tree planting.

For smaller farms the need to maximise agricultural output from the available land to keep the farm viable can be a barrier to tree planting (Mills *et al*. 2013, Vidyaratne *et al*. 2012). The minimal area of tree planting for timber income can be too extensive for small farms (Duesberg *et al*. 2014). For smaller areas, the priorities of land managers may be on managing trees for shelter and biodiversity, rather than for timber or recreation (Lawrence *et al*. 2010). Messaging on management or planting might increase effectiveness by multiple targeting of key issues appropriate to different farm sizes (e.g. profit; timber; wildlife).

Focussing on England, Emery and Franks (2012) found little evidence of any relationship between structural variables including farm size and decision to plant trees, concluding that generalising along structural lines is difficult. Similarly, Ruseva *et al*. (2015), exploring the intention to plant trees amongst private landowners in the US, found that smaller land owners are more likely to tree plant than those with larger parcels. The authors suggest this is because the use values of smaller parcels tend towards multi-purpose recreation, conservation and aesthetic purposes. A caveat here is that small landholdings may operate in different cultural circumstances in the US. The authors also hypothesise that larger land holdings are more likely to have been previously engaged with agri-environment schemes and, therefore, more likely to be sensitive to the potential of incentivised afforestation (Ruseva *et al*. 2015). This suggested correlation between size of land holding and likelihood of previous engagements with AES again suggests that the relationship between size of land under management and intention to plant is complicated by other issues related to capability, in this case knowledge.

Fragmentation of land parcels is reported as a barrier to investment in forestry in European focused research, but again the evidence here is specific to its geographic and cultural context (Quiroga *et al*. 2018).

Perceptions of soil or land quality emerge as a barrier to tree planting, especially when the farmer views food production as the reason they farm; evidence appears to suggest some farmers favour marginal land for conversion.

Rois-Diaz *et al*. (2018), suggest that European farmers are commonly reluctant to turn soil perceived as 'rich' over to agroforestry, as they anticipate lower net farm margins. Elsewhere, evidence suggests that farmers can perceive land as 'too good for forestry' (Vidyaratne *et al*. 2012 citing Ni Dhubhain & Gardiner 1994). The significance of these perceptions around 'correct' land use could also be rooted in a desire to be seen as doing the right thing, or 'good' farming, by other farmers, a socio-cultural influence that can challenge attempts to foster tree planting within this community (Lawrence *et al*. 2010).

European Farmers are more likely to turn over marginal land they perceive to be difficult or unprofitable to farm, to agroforestry and woodland creation (Hanley *et al*. 2012, Rois-Diaz *et al*. 2018). Evidence in the UK and Ireland finds that farmers view tree planting as an 'inappropriate' use of productive, profitable land, but that tree planting might be an option for the less productive land (Confor undated, Dandy 2012, Duesberg *et al*. 2014, Graves *et al*. 2017, Rois-Diaz *et al*. 2018, Ryan & O'Donoghue 2016, Thomas *et al*. 2015). Where land is not currently considered cost effective to manage, conversion to woodland or energy crops may be viewed more favourably (Rouillard *et al*. 2015, Smith *et al*. 2011). The use value of marginal land may however be contested socially if it forms part of areas of outstanding natural beauty or national parks.

Research exploring incentivisation of tree planting in Germany and the Netherlands (Brouwer *et al.* 2015) finds that farmers' perceptions that their land is too fertile for forestry plays a significant role in deterring them from participating in schemes, (particularly in the Netherlands). The authors argue that incentivisation could perhaps cross such boundaries by linking compensation to measures of soil quality and productivity of land (Brouwer *et al.* 2015). The Royal Forestry Society's 'Woodland Creation Opportunities and Barriers' Survey in 2020 found that of those surveyed who had recently created woodland (last two years): '37% were

created on pasture, 26% on arable and the balance on a mix of arable and pasture. The proportion of arable land is higher than expected' (Royal Forestry Society 2020.

As a whole it was difficult to identify evidence as to whether particular farming systems were more likely to convert to or incorporate tree planting, than others. Thomas *et al.* (2015), predict in the Scottish context that woodland creation is more likely on sheep pasture, rather than arable land, as it is easier to integrate with existing land use and has lower opportunity costs. In case study research in Bedfordshire, exploring arable farmers' attitudes to integrated tree crop systems, respondents frequently felt that tree planting was incompatible with arable production, trees adversely impacting crops and vice-versa (Graves *et al*. 2017).

The relationship between tree planting and intensity of production can vary and may influence farmer decision making around tree planting.

There is evidence from a single study undertaken in Ireland that the relationship between tree planting and intensity of livestock production can vary, in research that also segments the characteristics of farmers trying to balance woodland creation with stock production (Ryan & O'Donoghue 2016: 108-9). Following tree planting (in Ireland) some farms (one-third) did not alter livestock density (usually the largest and most intensive livestock farms, with highest income and density). These are characterised as having an "intensive/optimisation" mindset (Ryan & O'Donoghue 2016: 109). 25% of farmers increased stocking density. These farms tend to be the smallest and more likely to have off site income. Forest income on these farms may be generated on spare, marginal land without reducing agricultural land area. These farms are characterised as having a "diversification" mind-set (Ibid). The majority reduced density (44%) and tended to be smaller farms with previously high stocking rates, managed by older farmers who the authors suggest are winding down (Ryan & O' Donoghue 2016). They were more likely to participate in agri-environment schemes and receive higher payments than the other groups. These farmers are characterised as having a "de-intensification" mind-set (Ryan & O'Donoghue 2016). The authors suggest that in sum, these patterns demonstrate that afforestation is a decision made in relation to lifestyle choices, as well as intensity of production (Ryan & O'Donoghue 2016).

3.2.2. Woodland creation constitutes a long term / permanent land change. What is the evidence related to barriers and motivators for this? What is the evidence related to participation in incentive schemes and compensation schemes?

Here, it is also useful to group this evidence in relation to capability, opportunity and also motivation, which together determine the behaviour outcome.

CAPABILITY

The long-term nature of tree planting appears to be a barrier, especially in terms of loss of agency and uncertainty about possibility to revert to alternative land use.
Family, succession and legacy may impact decision making.

The issue of succession as an element in farmer's consideration of tree planting as a long-term decision emerges in a number of studies reviewed. Vidyaratne *et al*. (2010) suggest inheritance is a factor in Irish Farmer's tree planting decisions, though not on the scale of committing to a plantation. Fears over loss of control or agency though committing to tree

planting may thus be linked not only to the length of commitment tree planting requires, but also concerns over the degree of control inheritors will have. US research looking at farmer's entry into conservation easements, finds similar issues of succession create barriers to in perpetuity agreements, with potential entrants reluctant to prevent flexibility of land-use for their inheritors (Miller *et al*. 2010). These farmers were also reluctant to give up familiar and favoured land practices (Miller *et al*. 2010).

Family may be an important context for farmer decision making, including land management and woodland creation. Discussing plans with family has been evidenced as an important part of decision processes for farmers (Graves *et al*. 2017, Lawrence *et al*. 2010, McElwee & Smith 2012). In Irish research, family was found to be instrumental in deciding the use of land not central to the farming business (Duesberg *et al*. 2014) and Dandy (2012) argues that family interest in forms of land-management not significant to the primary decision maker can be influential.

In other evidence, family context was evidenced as a possible barrier to innovation through reinforcement of tradition, family heritage, continuity and legacy (Dandy 2012, Mills *et al*. 2013). Tradition and family pressure can at times reinforce what is perceived to be best practice (Dandy 2012); decisions more likely to be made when they fit in with the culture of family and friends. However, it can sometimes be a catalyst to environmental improvement and protection, such as tree planting for the enjoyment of family, and hedgerow creation and maintenance undertaken to help create a sustainable legacy for future generations (Lawrence *et al*. 2010, Ruseva *et al*. 2015, Coyne *et al*. 2021).

Legacy was a consideration in how land is to used and whether changes are made in a range of studies (Deuffic *et al*. 2018, Miller *et al*. 2010, Rouillard *et al*. 2015, Thomas *et al*. 2015, Vidayaratne *et al*. 2012), including farmer's pride in the past work carried out by family members (Holstead *et al*. 2017). By contrast, Hopkins *et al*. (2017) Scottish survey of farmers' attitudes towards tree planting found that intention to plant trees was not correlated with factors associated with family such as whether the farm was inherited, intent to continue in farming, or succession. This mixed evidence suggests a need to better understand how and when family context, succession and legacy influence intentions to plant, as the evidence reviewed suggests a significant influence with the potential to both drive and inhibit change.

OPPORTUNITY

For those who would plant trees for timber rather than other goals there's also the issue of financial risk involved and that income is delayed and inconsistent. A barrier would appear to be that some farmers view forestry as unprofitable, even when it's more profitable than their current farming business.

European farmers' intentions to plant trees and adopt agroforestry may have been limited by perceptions that it is unprofitable and that planting incentives are worth less than the returns of conventional agriculture (Rois-Diaz *et al*. 2018). The view that woodland and trees are not profitable has been evidenced amongst English farmers (Urquhart *et al*. 2010). Graves *et al*. (2017) case study in Bedfordshire reported that farmers perceived agroforestry systems as not profitable for their farming business. One exception may be poultry and eggs in agroforestry systems in the UK, where access to woodland for chickens adds a premium to the product (de Jalon *et al*. 2018). Regional economics of forestry and land prices can mean land is more valuable used for agriculture or development, as noted above (POST 2021).

Compared to agriculture, forestry economics can appear much more unpredictable especially in relation to the length of time before timber can be harvested (Ryan & O'Donoghue 2016, Thomas *et al*. 2015). Coyne *et al* (2021) argue more broadly that non-take up of AES grants can be linked to insufficient financial incentive and the loss of income from taking land out of production is not compensated (Coyne *et al*. 2021). This is linked to the loss of annual income from agricultural production and it's replacement by future income. Confor, the trade association for forestry industry in the UK, argues that a key potential for grants is to target any financial risk linked to long term investment (Confor undated). Further research on how farmers view financial risk, profitability, grant income and future income from tree planting and woodland creation (e.g. timber) as compensating lost annual income from agricultural production is required.

In Ireland, full time farmers are most likely not to plant because of lack of incentives, whereas part-time farmers are most likely not to plant for lifestyle reasons (Duesberg *et al*. 2014). Similarly, Hopkins *et al*. (2017) reported that those farms most dependent on agricultural income were least likely to express an interest in expanding or creating woodland, as they perceive the need to maximise agricultural production from their land to stay viable. One issue in England may be that farm tenancy affects the potential receipt of economic benefits from woodland creation (Heffernan *et al*. 2011). Larger farms and estates may view forestry and timber production as a source of income although as discussed earlier, the relationship between size of holding and intention to plant is sometimes mixed (Lawrence *et al*. 2010, Quiroga *et al*. 2018, Watkins 1996). In the case of farmers who have planted trees or hedgerows whilst contracted under AES agreements, a small English case study by Coyne *et al* (2021) found these were already established behaviours, not necessarily influenced by financial incentive.

The wider literature exploring woodland creation and ownership by land-managers suggests that perceptions of poor profitability can be a dis-incentive to both, but also that profit is perhaps not always the main driver of management and tree planting (Dandy 2012; Eves, 2015: 14; Lawrence *et al*. 2010). Dandy (2012) notes that non-timber products and services are often of greater interest to small woodland owners than timber and so these owners do not necessarily respond to economic factors. There are more specialised activities linked to perceptions of profitability from woodland such as pheasant shooting and possibly tourism, but these did not emerge strongly in the evidence reviewed as drivers for farmers to tree plant. This does not mean they are not important (Urquhart *et al* 2010), but evidence was scarce within the confines of this review.

Decision making around grants, profits, risk and other financial incentives are influenced by a range of social and cultural factors.

Some land managers may also be concerned with a loss of control and agency via the regulation and bureaucracy associated with woodland focused grants and less likely to engage (Dandy 2012). McElwee and Bosworth (2010) point out that considering farmers as a homogenous group is a mistake that hinders policy; the needs and attitudes of small farm owners underlie decisions to plant woodland or not. Motivations often overlooked are those linked to social or psychological factors (Mills *et al*. 2018). Low grant take-up may in part be attributed to low perceived financial value, but in addition cultural views and traditions can be important (Moseley 2014). Not only is the level of financial support on offer important but also

how complex the process of receiving the grant (Ambrose-Oji 2019, Coyne *et al*. 2021, Dandy 2012).

The influence of such factors may underlie what Eves *et al* (2015:47) evaluate as the 'conflicting' evidence on 'levers' that influence land managers attitudes to incentivised tree planting; with some research indicating reluctance to create woodland however large the financial incentive, whilst other studies suggest increases in grant amounts to be the central tool of raising take-up.

The long-term regulation of financial incentives can be perceived to limit freedom after changing land use.

Dandy (2012) argues that for landowners considering planting trees, grant regulations (including felling licences, replanting requirements and restrictions to reconversion) can amplify perceptions that it is a 'one-way street' (Lawrence *et al*. 2010) to woodland creation involving long-term loss of control over land management. This is suggested to be a key barrier to tree planting, and for those unfamiliar with tree husbandry can be exacerbated by a sense of increased risk and inability to respond to such risks flexibly (Dandy 2012). One solution suggested to increase farmers' willingness to plant trees is to not impose felling licences on this group (Lawrence *et al*. 2010).

Duesberg *et al*. (2014) found that the length and inflexibility of a commitment to afforestation was the second largest barrier Irish farmers cited as preventing them from considering tree planting. The authors argued that possibly loss of profit is associated with this barrier, because crops/livestock can't be altered in relation to markets, but they note that farmers who described inflexibility as an issue didn't identify profit loss as a disincentive. Instead, they suggested, farmers appeared to be expecting agricultural returns to increase, year-on-year, and this opinion may have influenced a wish to remain flexible.

Watkins (1996) also identified a specific 'form of irreversibility' or the loss of 'hope value', where the potential to realise a large return on agricultural land given planning permission is removed. Here selling land for potential future development is perceived as providing the biggest possible financial gain, and in effect is a form of land banking. Duesberg *et al*. (2014) argue that information campaigns exploring the future for woodland products could help address perceptions around profit loss, and point to the fact that some past planters suggested they had been motivated to afforest by the idea of a 'long-term asset' (Duesberg *et al*. 2014). The authors also identify that farmers may feel they will lose the ability to carry out land management processes and practices they enjoy, for the long-term, as a possible component of this barrier (Duesberg *et al*. 2014).

The perceived irreversibility and inflexibility of tree planting, including for energy crops, is consistently identified as a factor influencing decision making in the UK and Ireland (Vidyaratne *et al*. 2010, Warren *et al*. 2016). Farmers can also be concerned that the long timescale means that grant support may alter and reduce whilst they are committed (Watkins 1996). Similarly, European farmers may be reluctant to adopt agroforestry practices if they are perceived as tying up land-use for the long-term (Rois-Diaz *et al*. 2018).

An additional issue here is around access and loss of control in determining who can access the land, which influences grant uptake when these are linked to public access and potential damage or disturbance (Watkins 1996, Lawrence & Dandy 2014, Lawrence *et al*. 2010) and also the potential issue of public liability (Lawrence *et al*. 2010).

Perceptions about the degree to which tree planting can be integrated with existing and 'productive' practice could be a barrier or enabler.

Wider research on farmer engagement with agri-environment suggests that 'environmental enrichment measures' including tree planting were more likely to be taken up if they were a good and flexible fit with existing practices (Coyne *et al*. 2021). Coyne *et al*. (2021) argue this can enable farmers to feel they retain control over their behaviours, alongside easing effort of delivery of AES.

A lack of awareness of the degree to which agroforestry practices can integrate tree planting with productivity is cited as a barrier to farmers adopting it in the UK, where farmers may perceive agroforestry practices as removing land from production and reject it on this basis. (Rois-Diaz *et al*. 2018).

MOTIVATION

A substantial proportion (sometimes a majority) could decide not to plant trees in response to grants even when grants and other guarantees are set higher than the income generated by farming. Here the issue of self-identity is important (e.g. 'I'm a farmer not a forester').

In Scotland, research has revealed negative views from farmers with regard to tree planting, based on the deeply held belief that farmland is for food production not trees (Warren *et al*. 2016, Ambrose-Oji 2019). This issue, of farmers finding tree planting an unattractive prospect despite the potential income from forestry being larger than that from farming has also been reported in Ireland (Ryan & O'Donoghue 2016). Irish evidence similarly suggests a frequent reason for not planting trees is that the land should produce food and this preference may be present 'even if it is making less profit than forestry' (Duesberg *et al*. 2014).

The embeddedness of norms and values around particular crops and approaches to food production within farmer's social-cultural identity and wider farming culture is a repeated theme within the UK focused literature (Eves *et al*. 2015, Duesberg *et al*. 2014, Lawrence *et al*. 2010, Valatin *et al*. 2016, Warren *et al*. 2016, Watkins 1996). These values and ideals may be communicated and shared across generations, such as sheep farming, resulting in strong emotions against changing the landscape by planting trees (Iversen 2018).They are significant components of the Good Farmer identity, farmers able to signal to their peers and local community their skill and aptitude through their correct maintenance of a productive landscape (Lawrence *et al*. 2010, Warren *et al*. 2016). Warren *et al*. (2016) suggest Scottish farmers can be resistant to energy crop planting for example, because the crop is unfamiliar, does not yet carry a clear cultural value associated with farming, and therefore doesn't comfortably fit with or communicate the farmer's self-identity.

This production-oriented view can be persistent and boosted by the issue of food security around the world: farmers may find it morally questionable to take land out of production when many have struggled in the past to cultivate the land (Watkins 1996) and people are starving elsewhere (Mills *et al*. 2013). Similarly, they may deem food security a more significant risk, than a more generalised concept of climate change, as research across Wales described in 2015 (Hyland 2015).

Additionally, there may be a perception that there would be little job satisfaction in forestry compared to farming, which can be a lifestyle choice (Duesberg *et al*. 2014). This understanding may be rooted in a perception by farmers that for forestry, trees are planted and then left to grow with little management action in between, and certainly without the clear annual crop life-cycle elements. Farmers may perceive little opportunity to carry out preferred and 'good' farming practices (Warren *et al*. 2016).

Van Dijk *et al*. (2016) studying Dutch farmers conclude that self-identity is the dominant factor behind farmer's decisions to carry out unsubsidised agri-environmental actions and imply that financial compensation can only have marginal impact in altering motivations. Voluntary activities that don't rely on financial incentives are argued by contrast to help influence intrinsic motivation - I'm the 'kind of person who does this' - and incorporate new behaviours and ideals into their concept of self (van Dijk *et al*. 2016). Hyland *et al*. 2015 suggest that social learning (observing and learning from others modeling change) could play a key role in shifting 'productivist' concepts of the good farmer towards inclusion of pro-environmental values and norms, impacting intrinsic motivations and reorienting attitudes, goals and practices (Hyland *et al*. 2015). Facilitation of farmers planting trees or allowing regeneration could require changes in perception of what a good farmer is. The evidence suggests that decision making processes incorporate whole life considerations, values and ideals, and are not limited to business related factors (Warren *et al*. 2016). This has implications for where to target funds to shift how farmers perceive themselves and demonstrate the value of their activity to peers and community.

3.2.3. What's the evidence related to potential perverse outcomes from the behaviour change? For example, preventing, managing and mitigating woodland establishment or trees being planted where there are negative impacts on biodiversity.

Evidence exists that trees were sometimes planted in inappropriate areas leading to either a loss of biodiversity, specific species or release of stored soil carbon.

There is evidence that to date some financial incentives for tree planting have generated poor environmental returns because trees were planted in the wrong place, for example on 'poor' soil but species rich habitat (Wildlife Trust 2020a), on peatland (Wildlife Trust 2020b), or in open riparian habitat home to specialised species (SEPA 2009). Arnott (2019) reports that in Wales Glastir woodland planting resulted in the unintended loss of species-rich semi-natural grassland. There appear to be concerns currently, within the forestry industry, that forestry advisors may overlook the biodiversity or carbon storage potential of grasslands and other ecosystem types leading to inappropriate conversions to woodland (Royal Forestry Society 2020).

Arnott (2019) also notes that woodland creation often results in small areas, unconnected to other woodland fragments and resulting in increasing areas of woodland under the edge effect. This issue of fragmented habitat types, including woodland, is a concern where outcome aims are biodiversity driven (Hanley *et al*. 2012, Heffernan *et al*. 2011). Grants may have requirements for a minimal total area to be converted to woodland, but frequently this does not include a stipulation for the minimal size of each fragment (Heffernan *et al*. 2011) leading to the creation of very fragmented woodland with limited biodiversity value. It also favours larger farms for eligibility of grant take-up.

Woodland creation grants may result in ecological uniformity (Heffernan *et al*. 2011), where similar species are planted over wide areas, limiting biodiversity. There may also be conflicts when woodland owners view themselves as protectors of biodiversity but not necessarily the type of biodiversity that is trying to be enhanced by policy actions (Deuffic *et al*. 2018).

3.2.4. Farming is about to go through the biggest change in a generation (Brexit and ELMs). What are the behavioural factors to consider in light of asking farmers to adopt long-term practices in a context of so much uncertainty?

This question is primarily concerned with motivation, the third underlying factor determining behaviour after capability and opportunity already covered in detail above.

Attitudes and beliefs, difficult to quantify, may significantly influence choices being made.

Attitudes, beliefs and world view of farmers are important in understanding their decisions to plant trees or not, alongside the contexts that are shaping these views (Ambrose-Oji 2019). Dayer (2013) posits that attitudes are the most consistent predictor of behaviour intention or change. Underlying attitudes, the interplay of beliefs, feelings and values, developed over time have a central role in decision making, especially within long term changes such as tree planting (Dandy 2012, Eves *et al*. 2015, Iversen 2018, Mills *et al*. 2018, Mills *et al*. 2013).

Farmers can gain personal satisfaction from actions that benefit the wider environment, but also align with existing understandings and ideas (Coyne *et al*. 2021; Wilson *et al*. 2013). Choices made can be influenced by the farmer's environmental consciousness (Dandy 2012). Tree planting or natural regeneration can be a contested activity if it conflicts with farmer's underlying values and preferences, Cumbrian farmers for example are evidenced in one study to be strongly opposed to the idea of the landscape becoming 'wild' and positive about broadleaf planting in preference over pine (Iversen 2018). Different farmers (or foresters) may exhibit a broad range of attitudes with regard to the environment, despite 20 years of targeted policy (Deuffic *et al*. 2018). The breadth of attitudes exhibited by farmers with regard to the environment has enabled researchers to segment farmers with regards these (Mills *et al*. 2018), including the identification of farmer segments that may be predisposed to planting trees (Eves *et al*. 2015).

New entrants to farming may have different attitudes to those born into the farming community, and this shifting social makeup may be reflected in shifting attitudes in the sector, including towards woodland (Eves *et al*. 2015, Lawrence *et al*. 2010). With regard to small woodland owners Eves *et al*. (2015) however, found no strong link between the socio-demographic characteristics and attitudes and motivations. Attitudes anchored in tradition, may be a barrier to change, especially where farmers hold strong views with regard to the correct use of land (Eves *et al*. 2015, Graves *et al*. 2017, Lawrence & Dandy 2014, Lawrence *et al*. 2010). However, studies exploring farmer's perceptions and attitudes alongside their intentions to expand woodland can still struggle to evidence clear links between these (Hopkins *et al*. 2017).

Research in 2015 found that welsh sheep and beef farmers ranked climate change below food security, energy security and water security (Hyland *et al*. 2015) and farmers' beliefs and feelings around this issue are likely to play a role in their attitudes towards planting trees as a natural landscape solution. The same research also evidenced a belief amongst this group that farming is not a cause of climate change and doesn't contribute significantly to it (Hyland

et al. 2015). This data may now be a little dated as much as changed in terms of government and public perception and understanding of climate change risks and little data on how English farmers currently view the need to adapt to such risks emerged within the confines of this review. A better understanding of how different kinds of farmers might be influenced by their existing beliefs and perceptions around climate change, land-use and environmental conservation could help tailor approaches towards encouraging tree planting (Moseley 2014).

Social networks, the behavioural norms they carry, the potential to build trust within them and public attitudes also affect decision making.

As farmers make decisions within the context of wider social norms it is also important to understand wider rural cultural attitudes (such as values and motivations associated with the 'good farmer', productivist ideal) and how these attitudes impact farmer decision making with regard to woodland creation (Mosely *et al*. 2014). Peer social networks and the behavioural norms within them are influential on land-manger and farmer decision making (Ambrose-Oji *et al*. 2018, Dandy 2012). Dandy (2012) and Warren *et al*. (2016) note that social networks can lead to significant resistance to change; but on the other hand may be conduits for innovations. Networks allow regular exchange of ideas (O'Brien *et al*. 2018). Farmers may be members of a number of social networks, both formal and informal, and so can be influenced by a range of ideas. Within networks, personal and professional social ties can have an impact on decision outcomes and membership of a social network can reinforce land managers belief in their current attitudes and actions (Dandy 2012, Dayer 2013, O'Brien *et al*. 2018).

Some evidence suggests farmers can be positively disposed towards sharing ideas and acting collaboratively (Coyne *et al*. 2021), despite the issue of risk raised earlier. Cooperation can consolidate social bonds, but also run the risk of disputes down the line if cooperative actions fail to deliver as expected (Emery & Franks 2012). A lack of social networks can inhibit decision making by limiting exposure to ideas, knowledge or advice (Dandy 2012, O'Brien *et al*. 2018). In cases where farmers wish to maintain strong independence, they may avoid professional type networks and focus on family and informal networks (Deuffic *et al*. 2018, Lawrence *et al*. 2010).

Networks provide the opportunity to build social capital and trust, fundamental within decision making processes (Fisher 2013, Ambrose-Oji *et al*. 2018b); and key within an informant (e.g. specialist adviser) and recipient (farmer) relationship. Where advisors have established trust over time (Fisher 2013) they may be more successful at exchanging knowledge; greater availability of and contact with advisors facilitating successful delivery of advice (Lutter *et al*. 2018). Moseley *et al*. (2014) also argue that knowledge exchange is significant in designing engagement with farmers. They argue there is a need to 'think like a farmer', rather than a forester or policymaker and gain an understanding of farmers' perceptions of land assets in order to promote transition to woodland creation. Building of social capital, both with advisors and peers, has been evidenced as facilitating change within the farming community (Lyon *et al*. 2020, Ruseva *et al*. 2015, van Dijk *et al*. 2016, Kueper *et al*. 2013); limited participation hindering it (McElwee & Smith 2012, Tidey *et al*. 2010).

Having a link to the wider local community and building local social networks and trust within them can also facilitate change (Short *et al*. 2019, Thomas *et al*. 2015, Root-Bernstein *et al*. 2018). Obtaining consensus within the wider community for bigger changes may also be a requirement for supporting farmers to alter behaviour (Iversen 2018) and multi-actor knowledge networks can be powerful mechanisms to promote behaviour change in farmers (Sumane *et al*. 2018, Lutter *et al*. 2018).

An exploration of woodland creation in Cumbria, found long standing approaches to eliciting change used by official bodies (farm inspections, AES) may have fueled distrust between farmers and regulatory bodies, with farmers feeling unheard, misunderstood and perceiving a clear division between 'us' and 'them' (Iversen 2018). The researcher attempted to distinguish themselves from 'them' by spending time building trust and connection with local farmers (Iversen 2018: 243-4).

Lawrence and Dandy (2014) note the importance of family members in networks and their influence on decision making in relation to tree planting. Social factors such as public attitudes influence land-management decisions (Dandy 2012), including appropriate tree species to use and whether tree felling occurs. Public opinion influences decisions which may impact the landscape, wildlife or the environment (Deuffic *et al*. 2018). Where society places a higher value on biodiversity, broadleaf tree planting is less dense allowing for a range of habitat types to exist (CCC 2020). Farmers might undertake certain activities if it would improve public perceptions of farming (Holstead *et al*. 2017), including within the local community (Hopkins *et al*. 2017, Mills *et al*. 2018).

Fears of loss of control/agency, especially for long term commitment linked to tree planting, influences decision making.

As suggested above loss of control/agency could be linked to the length of commitment landowners make in entering forestry and the regulation they face if using grants, that tie up land use for the long-term (felling-licences, permission to fell, time restrictions on reconversion) (Lawrence *et al*. 2010, Dandy, 2012, Lawrence & Dandy 2014). In more general explorations of AES, farmers have been found to resist regulation that limits their independence and control, an aspect of this their ability to make rapid and timely adaptations to changing, local, circumstances (Emery & Franks, 2012, Mills *et al*. 2013, Riley *et al*. 2018). Existing owners of woodland can also be wary of entering into long-term management agreements perhaps for some of the same reasons (Urquhart *et al*. 2010, Urquhart *et al*. 2012, Valatin *et al*. 2014, O'Brien *et al*. 2018) alongside a more generalised sense of loss of autonomy and 'ownership' (Urquhart *et al*. 2012).

Farmers' may be more willing to engage with changes to practice if they are fairly closely associated with actions they already take and enable them to enjoy a sense of behavioural control (Coyne *et al*. 2021). On the other hand, agri-environmental behaviours may also be inspired by personal emotional and ethical standpoints and enable those undertaking them to retain a sense of control over environment (Coyne *et al*. 2021). Interestingly, historically, land managers have regularly handed over some control over decision making to other forestry professionals in the case of woodland creation/management (Dandy 2012). Some European farmers undertaking afforestation as part of AES have also been characterised as tending to cede control of planting to forestry contractors and thereafter act as passive or disinterested owners (Sotirov *et al*. 2015).

Evidence from existing woodland owners suggests that land-managers may fear funding schemes that require increased public access, concerned about issues of control and agency in relation to liability, privacy, property rights, achievement of conservation aims, theft and vandalism, and costs (Lawrence *et al*. 2010, Lawrence & Dandy 2014). One suggestion is that tree planting schemes need to reassure planters in regard to these issues and could

provide financial and legal assistance in relation to any crime. Land-manager and community concern over loss of control could feature in rewilding or natural regeneration schemes that chose to operate less through intervention, but through surrender of management (Root-Bernstein *et al*. 2018).

Farmers make their decision in a wide context and social norms play a key part in their decision making; the views of their peers, neighbours and the wider public are critical in understanding how farmers reach a decision (Moseley *et al*. 2014).

Risk aversion, both financial but also reputational, may hinder big changes to farming practice.

Barriers associated with risk aversion can emerge in response to regulation of incentivised tree planting (felling licences, replanting requirements, reconversion time limits) and perceptions that planters will no longer have the freedom to independently make land management decisions that respond to risk (Lawrence *et al*. 2010, Dandy 2012). This long term uncertainty and risk aversion can be a significant constraint on tree planting (Watkins 1996).

As described above land managers may fear woodland planting may entail public access requirements that will bring risks to their rights, increase their responsibilities, conflict with their aims and increase their costs (Lawrence *et al*. 2010, Lawrence & Dandy 2014).

Farmers contemplating planting may also be averse to the risk of losing peer respect for their 'correct' or 'good' land use: 'Using the land for its appropriate productive purpose is an important value and can undermine attempts to encourage tree planting' (Lawrence *et al*. 2010).

Changing agricultural practices, e.g. to agroforestry, can lead farmers to worry about risks from lower yields in terms of farm finances (Nerlich *et al*. 2013, CCC 2020). Financial risks linked to the long time requirement for timber production and the volatility of the markets are also farmer concerns (POST 2021, Ryan & O'Donoghue 2016). The perception of risk rather than risk itself is the greatest barrier especially with regard to financial income from tree planting (Dandy 2012). Risk *per se* is not a barrier if it is properly managed (Ryan & O'Donoghue 2016), but for this the right knowledge and advice are required; this explains why the level of perceived risk is linked to how familiar the farmer is with the activity (Dandy 2012, Eves *et al*. 2015).

Cooperative actions between farmers, e.g. in planting trees across boundaries, also suffer from risk perception of how other farmers might behave, such as changing their minds on an agreement (Emery & Franks 2012). A final risk worth mentioning is when grants or assistance are linked to outcomes rather than actions, where other environmental factors could affect the outcome, be that biodiversity, carbon sequestration, or other environmental goals (Hanley *et al*. 2012, Lyon *et al*. 2020). The size of the farm also impacts risk perception with smaller farms being more risk averse to changes than larger ones (Lyon *et al*. 2020). Grants themselves are also a source of risk when it is unclear how long they will be available for. This is particularly crucial for long-term decisions such as tree planting (Lawrence *et al*. 2010).

Response-efficacy (the belief action will lead to desired change, such as woodland establishment) could be a hidden factor in decision making.

Motivation and attitude might not fully explain how behaviours change in existing woodland owners/managers and it has been suggested that belief in the efficacy of a change can be an additional explanatory factor (Ambrose-Oji *et al*. 2018b, Lutter *et al*. 2018, Mills *et al*. 2013). Ambrose-Oji *et al*. (2018b), suggest that whilst many are keen to 'do the right thing', this is diluted by fears of taking the wrong action and that concerns that recommended action is poor advice can be a barrier within decision making. Elsewhere, Ambrose-Oji *et al*. (2018), argue that 'practice, social learning' and discussion within peer and multi-stakeholder networks can play a key role in building assurance and belief. This links to questions of knowledge, where it is not what knowledge is available, but how it is generated and consumed that is significant (Ambrose-Oji *et al*. 2018).

Case study (Iveserson 2018) research of Cumbrian farmers' attitudes to woodland creation found that respondents distrusted claims around the environmental and societal benefits of woodlands, and commonly believed woodland creation unlikely to have much of an influence in these areas, including upon climate change.

The quality of advice and trust in messengers play a determining role in whether advice is acted on.

This need to know that changes will lead to desired outcomes leads on to the issue of advice and trust within it. Small scale farmers may prefer to gain advice through face-to-face and peer interactions, site visits, and local capacity building and facilitation (Ambrose-Oji 2018b, Lawrence *et al*. 2010, Lutter *et al*. 2018, Lyon *et al*. 2020). Training programs aimed at facilitating outcomes have been evidenced as beneficial (Arnott *et al*. 2019), and may be delivered by NGOs (Rewilding Britain 2020). With professional advisors, the efficiency of communication with farmers can depend on trust and personal relationships (Dandy 2012, O'Brien *et al*. 2018), and can be facilitated by being integrated within social networks (Tidey *et al*. 2010). Some researchers have also argued that farmers could be supported to improve their decision-making skills in relation to diversification of activity and specifically woodland creation (Duesberg *et al*. 2014). Where new techniques or methods, such as tree husbandry, are required, advice can be critical (Graves *et al*. 2017).

Decisions may be taken that minimise perceived risk and stick to the status quo where advice is absent (Holstead *et al*. 2017), or contradicts values (Thomas *et al*. 2015). In research exploring landmangers attitudes towards woodland creation and management free advice was particularly appreciated (Lawrence *et al*. 2010); especially when it was 'practical' (Lutter *et al*. 2018). Office-based advice was not perceived to be as useful (Lawrence *et al*. 2010). The advice that landmangers receive or don't receive has been evidenced as highly influential in decision making, in a forestry context (Lawrence *et al*. 2010).

Landmanagers may gain advice on woodland creation and management from a wide range of actors and sources, and it can be of varying quality (Lawrence *et al*. 2010). Lobley *et al*. (2012) exploring the potential for afforestation in England suggest that newer entrants into land management tend to either have a clear plan formulated in relation to professional advice or alternatively are guided by local practice and pre-existing management regimes. Newer entrants should therefore, the authors suggest, be a key target of woodland creation advice (2012: 31):

> ‘possibly through the agencies of professionals involved in the process, including land agents and solicitors, to raise awareness of the financial and non-financial benefits of woodland planting and to provide advice to potential planters’.

Advice delivered via multiple delivery channels has been argued to be the most efficient way of getting messages across too hard to reach land managers, which farmers could be characterised as in this context (Lyon *et al*. 2020): mailings, farm magazines, face-to-face interactions, online, etc; trusted collaborators can also greatly assist in transmitting knowledge (e.g. suppliers, farming clubs, NFU). Advice via multiple sources would potentially go some way to deal with the heterogeneity in farmer’s motivations and preferences (Mills *et al*. 2018). Moseley *et al*. argued in 2014 that the advisory system accessible to farmers was ‘dominated’ by agents and agricultural advisors with a restricted understanding of forestry and little interest in promoting it. With changing perceptions and regulatory frameworks in regard to climate change and nature-based solutions this situation may well have altered, but the literature reviewed did not capture evidence of any developing shift. It is important to consider the issue of the appropriateness and reliability of expert knowledge and trust in this knowledge by farmers (Fisher 2013). This becomes even more critical when dealing with areas of future uncertainty, such as future pests and diseases of trees, and impacts of climate change (Lawrence & Marzano 2014, Dandy 2012, Hyland *et al*. 2015). Evidence of the degree to which farmer’s advice and guidance networks have incorporated tree planting and woodland creation as appropriate, effective and significant activity and successfully shared this message is likely to be clarified in the coming years as data being collected now emerges.

3.3. RQ3. What is the best existing land manager segmentation model to use when specifically addressing increasing tree cover?

3.3.1. What are the appropriate segmentation models (or combination of segmentation models) to use when considering woodland creation, tree planting, and management.

This section undertakes a review of existing segmentation models in relation to woodland management and creation and makes recommendations regarding suitability of current models to support policy design for woodland expansion. The development of typologies is a well-used approach to improving understanding of the characteristics of target groups within a population. Typology studies have experienced a recent renaissance through segmentation models linking cluster analysis with surveys and other sources of data.

This section will explore segmentation modelling in relation to achieving behavioural change among land managers, which is not straightforward and has its critics as well as supporters. The literature describes a wide range of farmer/land manager typologies and segmentation models exploring various issues such as response to climate change (Barnes *et al*. 2012), the potential for take-up of agri-environment schemes, and farmer motivations stretching back at least to the 1970s (Gasson 1973); but in relation to forestry, until very recently, most of the focus has been on woodland management rather than planting and creation (Lawrence *et al*. 2010, Ambrose-Oji 2019).

Critique of segmentation modelling

Segmentation models have both strengths and weaknesses. On the one hand they can enhance understanding of a target population, on the other the evidence for clustering is often weak.

Segmentation is identified as a useful tool for improving policy design through improved understanding of different 'types' within a target population, which can identify factors driving motivation and behaviour, as well as providing guidance for how to improve communications and engagement. Policy implementation is enhanced through improved understanding of the complexities of the target group, especially where there is limited experience of potential impact (e.g. as a result of policy change or new approaches), when behaviour within a target group can be highly variable, and/or there is a need to access hard-to-reach groups (Lyon, *et al*. 2020). One reason segmentation modelling has developed is the limited utility of single (or limited) descriptor typologies (e.g. woodland owner/non-woodland owner; farmer/non-farmer) which do not capture the variability within types (Eves *et al*. Volume 2, 2014; Urquhart & Courtney 2011), and the modelling data collection process itself can also provide opportunity to gain deeper insights into characteristics of the target population and sub-groupings.

Segmentation models, however, have been critiqued in a number of ways, in particular relating to their limited applicability, especially when narrowly focused, or based on small sample size. Understanding the purpose of a proposed segmentation exercise is a significant factor in development of a model that will generate a useful typology. The approach taken to identify 'types' within a target group, and the type of data collected, will depend on how the information is to be used. For example, a typology developed to understand woodland management behaviour of a target group may not be applicable in trying to predict behavioural change from

provision of new incentives aimed at woodland creation. On the other hand, where understanding of potential behavioural change is limited, such as in the case of woodland creation, analysis of behaviour from similar forms of activity, can be useful (e.g. the utilisation of segmentation models focused on farmer engagement with agri-environment schemes as a proxy for understanding potential farmer response to woodland planting incentive schemes).

Stronger critique is based on the perceived 'weakness' of typologies developed through segmentation modelling in relation to the complexities of identified groups within a target population, and the variability of response to policy incentives. Eves *et al*. (2013) have noted the similarity of 'types' generated by segmentation models in relation to woodland management and others have highlighted the variability within 'types' owing to the complex interactions of variables affecting an individual's decision making, such as tenure, and the desire to deliver multiple goals (Deuffic, 2018; Dandy, 2012; Emery *et al*. 2012). An additional weakness has been noted in relation to the types of respondent surveyed or incorporated into segmentation models (Eves *et al*. 2015). In many studies these tend to be private individuals rather than the wide range of organisations which might own large amounts of woodland for investment or other management purposes.

Figure 2 provides an overview of the issues around segmentation arising from the literature on woodland management and creation. A segmentation model is developed from analysis of a sample of the target population. Modelling is driven by the proposed utilisation or purpose for undertaking the analysis and will determine the questions asked and the type of information collected influencing the model outcomes. Modelling is usually undertaken in order to increase understanding of the target population to enable improved policy design and intervention mechanisms and may also provide information on factors driving behaviour, and how to communicate and engage with different 'types' within the target group. A key objective is often an improved ability to predict behavioural change as a result of policy intervention.

Segmentation models have demonstrated that predicting behavioural change is difficult, and often the evidence for clustering is weak.

Studies have demonstrated similarities in individuals across segments as well as high variability within clusters. This occurs as clustering techniques analyse and group individuals on a limited number of factors, whereas in reality similar characteristics can occur among individuals whatever grouping is utilised to create the clusters, i.e. people are complex and there is a high level of variability within 'types'. When it comes to exploring motivations and behavioural change through clustering the problems are compounded as multiple reasons can account for behaviour, as well as local context, which cannot all be captured through statistical procedures. Incorporating theories of behavioural change into segmentation modelling can improve the utility of models (e.g. linking business objectives, environmental attitudes, and motivational factors), enabling deeper understanding of the level of change or intervention that will potentially result in action) but the issue of interaction between factors (capability, opportunity, motivation) and context remains.

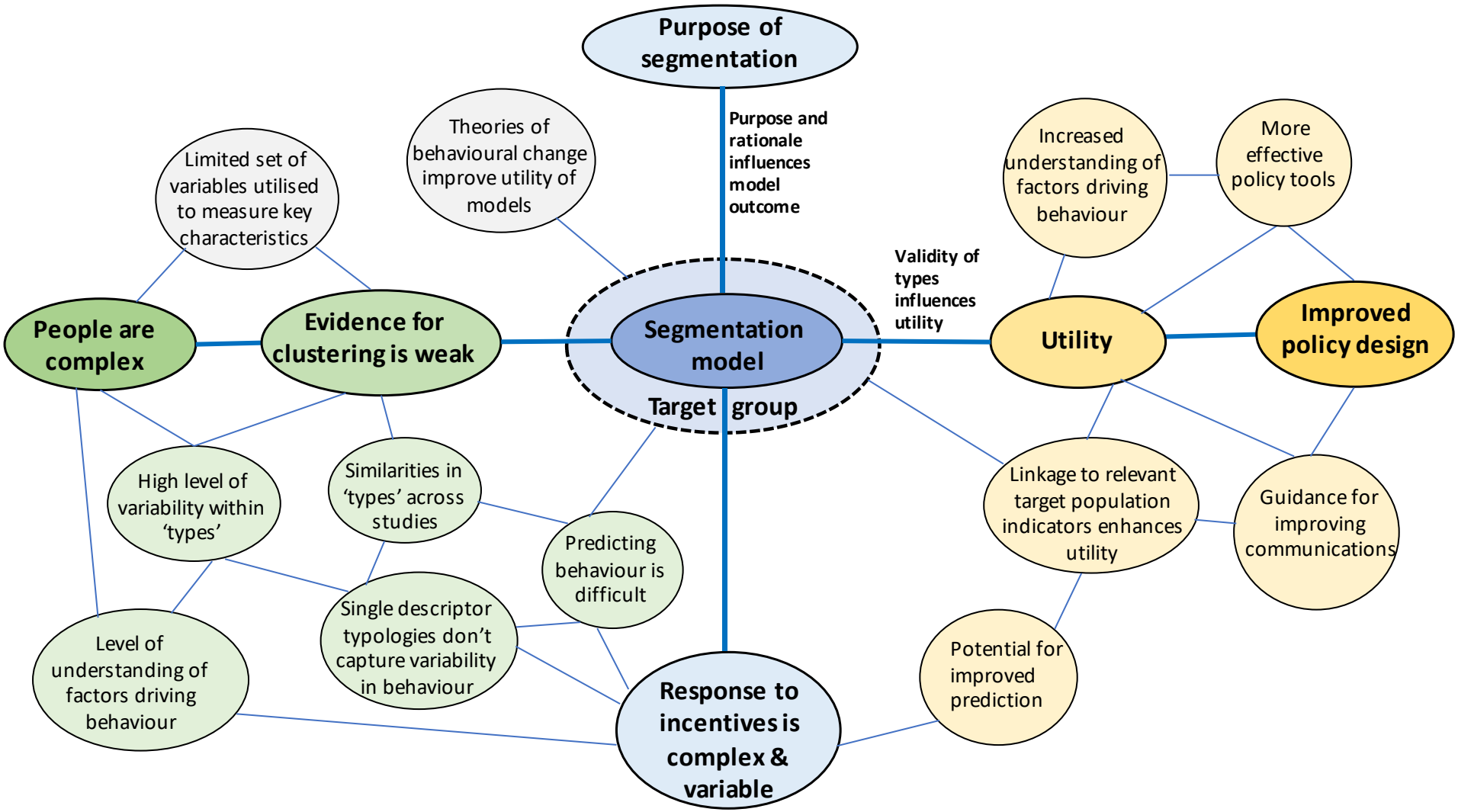

Figure 2. Concept diagram of segmentation modelling drawn from the review of literature.

Segmentation modelling for woodland creation

The literature review found few segmentation models exploring woodland creation.

The issue of which segmentation model is 'best' for application to woodland creation is complex, as it depends on the purpose of the segmentation and questions designed to elicit relevant information for a segmentation analysis are context dependent. Only a limited range of studies have explored segmentation in relation to woodland creation and there is some debate about the limited level of variability between typologies created by different researchers (Eves *et al*. 2015). There is far more literature regarding segmentation models exploring woodland management, some of which have interesting findings which might be applicable to woodland creation. Care is required, however, as application of existing models to address new situations (such as large-scale expansion) may not be effective if they have been developed for a different purpose; they may not be measuring the relevant characteristics of a target group, for example, even if the 'segments' developed seem appropriate.

An exploration of segmentation analysis in relation to woodland management (see Table 1 of Appendix 6) provides some useful insights into alternative approaches that might be applied to woodland creation. The most relevant are those studies exploring attitudes towards public goods provision and management, all of which tend to identify groups along a continuum related to conservation/wildlife management vs. business focus/profit maximisation. Each segmentation model tends to place individuals on a broad continuum (e.g. provision of public goods; attitudes towards management techniques; attitudes towards public access; reasons for woodland ownership) related to the question of interest. Usually there is a group at each end of the spectrum representing the extremes (e.g. on a business interest vs conservation continuum there may be 'Investors/timber producers' at one end and 'conservationists' at the other), a multi-functional group trying to achieve a number of goals in the middle, and two or three other groups between them with varied characteristics (e.g. size of woodland, average age; lifestyle, or management objectives). The studies focusing on public goods provision (Urquhart, 2008; Urquhart, Courtney & Slee, 2010; Urquhart & Courtney, 2011), for example, have restricted geographic coverage but are similar to other woodland management segmentation studies in that they identify investors in timber production at one end of a continuum and individuals at the other focused on management for personal enjoyment, along with 'conservationists' managing for wildlife or other public benefit. At either end of the continuum there can be groups that tend not to engage with grant support, though for different reasons (for example, linked to loss of control, succession issues, or a desire to manage the woodland for a particular purpose).

The literature for the most part reinforces the notion that woodland owners/managers demonstrate wide variability in relation to their management objectives and their reasons for ownership. Whichever way a population of woodland owners or farmers is divided up for analysis there will be those who want to manage for wildlife or biodiversity conservation, those wanting to ensure a return on investment, and others who will have a mix of goals depending on their individual situation, attitudes, and values driving ownership. In addition, some studies have revealed high levels of within group differences (for example, Eves *et al*. 2015) suggesting that while those at the extremes might have strong views that will be difficult to change, there can be a range of attitudes, experience, and potential for action within all segments).

Moseley *et al*. (2014) take a more traditional look at woodland owners (of all types) developing a typology based on categories of landowner/manager (e.g. farmer, investor, etc.). The

approach is useful in exploring the potential to increase woodland in the sense that it suggests where large scale planting might be possible, and also emphasises the importance of previous experience of woodland creation in guiding behaviour. However, it is not sufficient for a COM-B based segmentation approach as it does not take into account the underlying attitudes that drive decision making, which can be independent of the scale of land holding (Eves *et al*, 2015).

Two studies have taken a slightly different approach by focusing on identifying which groups would be more and less likely to change behaviour. In their study of afforestation potential, Hopkins *et al*. (2017) build on the notion of woodland creation experience as a guide in allocating Scottish farmers to one of three groups based on past experience and future intentions (over the period 2005-20). Those identified as 'Future increasers' were viewed as the group most likely to increase planting of trees and therefore the group to target in terms of support. The approach also suggests that 'past increasers' might be persuaded to engage in afforestation while 'non-increasers' could potentially be ignored (at least in the short term where there is limited support and resources for incentivising action). An earlier model from the woodland management perspective (Butler *et al*. (2007) took a similar approach, exploring attitudes and engagement of 8,000 woodland owners in the USA with a view to targeting extension support. The four groups created by the segmentation model identified, at the two extremes, those already exhibiting the desired behaviour ('model owners') and those that could be ignored or left alone ('write-offs') as very unlikely to be reached or to change. The middle two groups are divided into those most likely to be influenced (the 'prime prospects') and those that might be persuaded to change with additional effort ('potential defectors').

An alternative approach to segmentation, but also focused on behavioural change, was taken by Dayer *et al*. (2014) who developed three typologies to understand private woodland owner behaviour in relation to forest 'patch cutting' to enhance wildlife habitat. The authors developed two typologies based on behaviour (4 'types' exploring experience and intention of adopting patch cutting) and motivation (3 'types' based on current and planned use of the woodland) and integrated them with a 'Reasoned action' typology (4 'types' drawn from the Reasoned Action Approach: 'Doer', 'Observer', 'Neutral', and 'Rejecter'). The integrated nature of the typologies provided deeper insights into the behavioural intentions and motivations of landowners, along with those most likely to act. The study explored provision of support for targeting policy mechanisms ('tools') towards groups most likely to change behaviour.

In relation to woodland creation in the UK, the most extensive segmentation study (described below) is that by Eves *et al*. (Vol.4, 2015), which identifies 'Farmers first' (with strong beliefs that they are food producers, although a large proportion also own/manage woodland as a source of revenue) and 'willing woodland owners' (conservation minded owners) at opposite ends of a continuum. An earlier model from the woodland management perspective (Butler *et al*. (2007) explored attitudes and engagement of 8,000 woodland owners in the USA with a view to targeting extension support. The four groups created by the segmentation model identified, at the two extremes, those already exhibiting the desired behaviour ('model owners') and those that could be ignored or left alone ('write-offs') as very unlikely to be reached or to change. The middle two groups are divided into those most likely to be influenced (the 'prime prospects') and those that might be persuaded to change with additional effort ('potential defectors'). The Eves *et al*. (2015) study thus identifies two groups that to a certain extent reflect the 'model owners' and 'write-offs' identified by Butler *et al*. (2007) in the sense that one is already engaged while the other might be difficult to change due to strong underlying

beliefs and values driving behaviour. The group of models described above as focusing on the capacity for behavioural change, although addressing both management and creation, suggest a potential way to utilise existing segmentation models in a creative manner to support development of a policy framework for woodland expansion.

3.3.2. What are the segments?

Segmentation models and typologies group individuals through identifying what distinguishes one subset of the target population from another, but the resulting categories, or 'segments' depend on both judgement of the researchers and the aims of the research.

Land managers/farmers involved in woodland management have been categorised on a wide range of characteristics, including: age, income, tenure, farm/landholding size, level of experience with woodland, environmental attitudes, business objectives, motivation, as well as geographic location and current activity. Tables 1 and 2 in Appendix 6 identify segment profiles taken from a range of studies. As mentioned earlier, there are similarities across the woodland owner/management models in terms of the identified 'types', with the majority of studies identifying 'segments' focusing on timber production or more business oriented, in comparison to the more conservation minded, on a gradient, with one or more groups focused on multiple/mixed goals in between.

England examples include:

- A typology of woodland managers in England (Church & Ravenscroft 2008) exploring attitudes to public access provision developed 3 segments (dutyists, reluctants, and marketeers) based largely on different attitudes to incentives and requirements of grant provision.
- A survey of members of a small woodland owner group (Woodlands.co.uk 2011) developed segments based on the types of activity undertaken (Nature Lovers, Family foresters, Creatives, Bush crafters) of a group of small woodland owners with similar characteristics.
- Urquhart (2008) in a small study of private woodland owners identified four 'types' (Multi-functional owners, Self-interested owners, Hobby conservationists, Custodian) based on attitudes towards provision of public benefits.
- Hopkins *et al*. (2017) focused on farmer intentions to afforest, using a large sample to divide farmers into three broad categories (Future increasers, Non-increasers, Past increasers).

Targeting is important, in terms of both population and the question(s) of interest. Studies utilising small and/or geographically restricted samples may provide in-depth understanding but are likely to suffer from lack of external validity, making generalisations to larger populations problematic. Focusing on a narrow set of questions will limit utilisation of results. Segmentation studies that attempt to categorise groups based on a wide range of characteristics risk producing segments with high levels of variability among individuals in each category (Eves *et al*. 2015). Large scale surveys of characteristics with some form or cluster or multi-criteria analysis can still be affected by bias; survey samples tend to be self-selected, often those most interested in the subject under consideration will respond (Dayer *et al*. 2014), and clustering involves an element of judgement to determine the nature and validity of the groupings generated.

Eves *et al*. (2015) produced the most thorough recent segmentation study of farmer potential to create woodland in England, drawing a sample of farmers from across all regions. Separate samples were drawn to explore the potential for increasing woodland management and woodland creation. The woodland creation segmentation model is based on data collected from telephone surveys with 1,000 farmers providing a wealth of information on farm and socio-economic characteristics, woodland ownership, utilisation of agri-environment and woodland grant schemes, and factors affecting motivation such as attitudes to planting and perceived barriers. The clustering model created five segments:

- Farmers first
- Business oriented farmers
- Casual farmers
- Pragmatic planters
- Willing woodland owners

'Pragmatic planters' were identified as the group most likely to engage in woodland creation with more than three-quarters of the segment indicating potential. They were also identified as having interests in carbon sequestration, timber, woodfuel, and income generation from woodland. 'Willing woodland owners' were also identified as likely to plant with 61% of the segment indicating potential and more driven by a desire to generate environmental benefits. 'Farmers first' were the least likely to plant (two thirds indicated they were 'very unlikely' to plant), even though they tended to have the largest land holdings. The report itself notes a few limitations:

- Potentially some sample bias, as 79% of the farmers contacted would not engage;
- Some questions had to be dropped from the questionnaire due to length of phone calls, which limited the extent to which planting issues and engagement with the grant system could be explored;
- The terms 'woodland' and 'woodland creation' were not defined, which created some issues in phone interviews;
- Only 35 farmers took part in follow-up interviews due to time pressures.

In terms of the segments created by the clustering analysis the data analysis suggested that in relation to some factors measured there was considerable variation within the segments and follow-up interviews highlighted some of these differences. For example, 'Pragmatic planters' were identified as those most likely to plant woodland but follow-up interviews suggested they might be 'reluctant to give up productive or grazing land for woodland creation'; 'willing woodland owners' were also identified as reluctant to give up productive land; 'business-oriented farmer' were 'more interested in in environmental benefits than the segment model suggested'; and, 'Farmers first' showed interest in 'higher rates of grant aid'. Thus, although the model created a neat segmentation of farmers, deeper analysis suggested more variability within each segment and a more complex set of factors influencing individual farm decision making.

3.3.3. Who are the wider 'unusual suspects'/stakeholders who have an important role in the system?

Dandy (2012) identifies a wide range of factors influencing forest decision making within four broad categories of influence: economic, social, physical-environmental, and operational. Decision makers are identified as including landowners, farmers, land agents, and community representatives, which are involved in different ways in each individual decision situation, and

themselves are affected by the four categories of influence noted above. Table 2 identifies a range of stakeholders with the potential to influence forest decision making.

The rationale for owning forested land, and the management objectives will also clearly impact the influences to which decision makers will be exposed (Lawrence and Dandy, 2014; UK Parliament, 2021). Timber production will involve engagement with timber industry agents and foresters, for example, whereas a focus on game management or biodiversity will bring decision makers into contact with wildlife trusts and sport shooting organisations. Management purpose will thus affect the mix or organisations and individuals that influence forest planting and management decisions.

The importance of knowledge exchange has been reported where, for many woodland owners/managers, it appears to be of more importance than grant support (Lawrence and Dandy, 2014; Hemery *et al*. 2018). Trusted advisors, although not 'unusual' will therefore be a key ingredient in future forest expansion. The scale of forest expansion, however, may lead to requirements for new forms of knowledge exchange (KE) potentially requiring 'unusual' forms of advisory relationship in order to get at the harder-to-reach segments of interest in order to persuade and support behavioural change.

Table 2 Stakeholders with the potential to influence forest decision making.

Area of influence	Involvement	Types of stakeholder
Provision of knowledge and advice	Those engaged in knowledge exchange; advisory bodies; knowledge providers; specialists; new forms of KE support.	Consultants; forester; farm advisors; land agents; contractors; arboriculturists Wide range of bodies depending on management objectives [e.g. forest indust woodfuel industry; Forestry Commission; RSPB; NFU; FWAG; Wildlife Trusts; Environment Agency (flood control)
Social norms	Values and beliefs are influenced by social and community norms.	Relatives, friends, neighbours, local community; peer group (e.g. other farmers); society/consumers
Economic/financial	Grant schemes; availability of loans; tax relief; investment opportunities; advice on rates of return from alternative production objectives; insurance.	Grant allocating bodies; estate owners; land agents; banks; insurers. Inland revenue; pension and trust funds; institutional investors; corporate investment ('green credentials'); renewable energy companies (biomass); wood processing industry (woodchip)
Regulation	Sets the context in which management occurs - can be enabling or constraining	Regulatory bodies controlling management (e.g. Felling licences) and grant schemes
Operations	Suitability of land for planting; production objectives	Forest advisors; forest industry; contractors; nurseries.
Ownership	Patterns of tenure and ownership	Church Commissioners; Oxbridge Colleges; Corporate social investors; pension and investment funds; Local communities

An area where more 'unusual' stakeholders might be identified is in terms of ownership. Oxbridge colleges, for example, have long invested in forest ownership and management and there is a growing interest in ethical investing and corporate social responsibility leading to purchase and planting of woodland to meet carbon sequestration and other corporate social

responsibility goals. More 'unusual' stakeholders would be investment fund managers and corporate landowners, or others interested in generating long term revenues as part of an investment portfolio.

3.4. RQ4. Issues related to the utilisation of segmentation models

3.4.1. Segments or groups that are (and are not) incorporating woodland creation and tree planting into their business models?

It is difficult to identify, from segmentation models, the current levels of activity in terms of woodland creation and tree planting that are incorporated into business models. Most of the segmentation models examined in the review are more than six years old and comprise a wide range of land owner and manager types, apart from the Eves *et al*. (2015) segmentation of farmers. Without primary research it is impossible to provide an accurate picture of current activity. This section therefore summarises some of the woodland creation activity that can be ascertained from the literature in general terms, but does not include all segments that have been identified.

<u>Productivist farmers and woodland owners</u>

Farmers with strong views on the food production role of agriculture and focused on generating revenue ('productivist') are not incorporating forestry or woodland creation into their businesses. Ambrose-Oji (2019) noted several factors account for this including the following:

- Incompatibility of agricultural grants and forestry incentives
- Bureaucracy associated with applications and management
- Strong views on the traditional role of farming (i.e. food production not trees) and no perceived public benefits from woodland

<u>Conservation minded farmers and woodland owners</u>

Hyland *et al*. (2015) noted that livestock farmers identified as 'environmentalists' (younger than average with a large proportion having a university degree), despite having a high awareness of climate change had a low sense of perceived risk to their business suggesting they might be less inclined to adapt their behaviour. Those identified as 'countryside stewards' were identified as being less inclined towards productivism and more likely to alter behaviour to improve the environment more widely.

With regard to segment type, some of those that identify as conservation and environmental minded are most open to tree planting; behaviour might depend on whether the farmers view themselves as custodians of the current farming system and landscape aesthetic or custodians of the wider environment. Land-owners classified as Eco-centric Managers or Multifunctional Managers are most likely to value the ecosystem, environment and social benefits of their woodlands (Ambrose-Oji *et al*. 2018). The 'Willing woodland owners' are another group where tree planting and woodland creation is strongly linked to conservation and enhancing the environment (Ambrose-Oji *et al*. 2018). Urquhart *et al*. (2010) found that many woodland owners, including farmers, have conservation and environment motivations for woodland creation and management and farmers have often reported a sense of pride and personal satisfaction with tree planting and woodland creation, with environment benefits being a key motivator (Coyne *et al*. 2021). Farmers involved in agroforestry in England rated

health and welfare benefits in animal production as a key benefit, which links in with the more environmentally sustainable livestock rearing approach (de Jalon *et al*. 2018).

In Europe, small woodland owners will also often have non-timber and non-profits motives for woodland creation and ownership including for woodland products, recreation and biodiversity (Deuffic *et al*. 2018). However, the benefits of tree planting for the local environment, wildlife and society needs to be evident to facilitate uptake of tree planting schemes (Emery & Franks 2012). Recently, it has been reported that the three biggest motivations for woodland creation are to enhance biodiversity, sequester carbon and protect the landscape (Royal Forestry Society 2020).

Private woodland owners, including farmers, who view themselves as custodians are motivated by the heritage value and protecting the landscape for the future (Eves *et al*. 2015; Moseley 2014). In many cases farmers entering a woodland creation scheme already had woodland on their land (Urquhart *et al*. 2012). A contrary example of where custodians were opposed to tree planting is provided by Miller *et al*. (2010) referring to a farm on a valley floor with a much-appreciated open space, the aesthetics of which, it was felt, would be ruined by tree planting. Thus, tree planting is likely to be influenced by the type of landscape a custodian is aiming to protect and landscape preferences might potentially also influence farmer attitudes to tree planting, rewilding and regeneration schemes (Lawrence & Dandy 2014, Convery & Dutson 2012).

3.4.2. Why are those segments or groups not incorporating woodland creation, tree planting and management into their business models?

There are multiple reasons for why different segments are not incorporating woodland creation and tree planting into their business models, some of which depend on the rationale for owning and managing woodland, others are related to wider social or economic issues. These barriers to woodland creation are outlined in section xx of this report, but some of the key factors in relation to different segments include:

<u>Loss of control</u>
Both productivist farmers and small woodland owners managing for personal enjoyment or wildlife fear loss of control through planting trees and accepting grants (Eves *et al*. 2015). Associated barriers are a desire to avoid public access (often a requirement of grant schemes) and lack of 'spare land' for afforestation.

<u>Irreversibility of afforestation</u>
Farmers in particular are concerned over the potential impact of afforestation on agriculture, and for some (e.g. hill sheep farmers in Cumbria and other parts of the UK, dry livestock farmers in Ireland) it may mean the loss of traditional practices and life styles and the inter-generational transfer of practice and/or viable farm units.

<u>Social, structural, and cultural factors</u>
A wide array of social and cultural factors influence agriculture and conversion of farm land to forestry and woodland management more generally. Age appears to be a factor with younger farmers more open to ecological values (as exemplified by Eves *et al*.'s pragmatic planters and willing woodland owners which contained the joint youngest farmers) and more aware of climate change issues; farm tenure (a structural issue) can constrain actions that can be taken

on the ground (Dandy, 2012), and individual knowledge and belief systems make farmers and landowners more or less open to arguments regarding provision of public goods. In Ireland, for example, no farmer wants to be the one who gave up the 'family farm' or switched to forestry, however poor the agricultural returns, and for some no amount of financial incentives will alter behaviour. Even in Ireland, however, some farmers approaching retirement view afforestation of at least part of the land as a way of 'easing into retirement' (Ryan and O'Donoghue, 2016; Ryan, O'Donoghue and Hynes, 2018).

Lack of knowledge and skill might also account for failure of some farmers/woodland owners to engage in forest management and creation. 'New woodland owners' (either through inheritance or purchase) can lack management skills, and may not be sufficiently linked in to relevant networks to get support (Ambrose-Oji *et al*. 2018), and 'Casual farmers' in the Eves *et al*. (2015) segmentation state a desire for advice on woodland management and creation.

Lack of financial incentives/economic inefficiencies

Commercially focused woodland owners ('productivist') are more likely to be influenced by grant schemes than those managing for recreation or wildlife (investor owned large woodlands and financially oriented are more likely to seek grants) (Eves *et al*. 2015). Lawrence and Marzano (2014) note that 'individual investors' are viewed as a 'new' category of woodland owner, motivated by profit and drawn into ownership through the attraction of tax incentives, while small investors who purchase woodland for family recreational activities and potential to hand down to the next generation tend not to have the intention to plant or the skills.

Eves *et al*. (2015) note that in a review of international literature 'benign neglect' is the dominant management regime for 'smaller woodlands', and financial incentives do not influence all woodland owners. Lobley *et al*. (2012) on the other hand suggest that 'availability of funding' is an issue for land managers other than farmers, such as NGOs and trusts involved in woodland management and planting, while 'a lack of financial return' is of more concern for local authorities, colleges, Crown estates and investors'.

Complexity of grant application procedures have also been cited as a barrier to woodland creation (Eves *et al*. 2015). In addition, Duesberg *et al*. (2014) highlight the importance of more tailored targeting of groups through aligning policy objectives with woodland owner/manager decision making in order to influence behaviour.

Indifference

Urquhart and Courtney (2011) in a typology of woodland owners identify three types of 'consumption/protection-oriented owners' motivated by non-financial objectives such as amenity and nature conservation. The third 'type' within this broader category are 'passive' owners who are described as being indifferent towards their woodland, considering it to have little value and more of a burden than a benefit. 'Indifferent' owners are unlikely to engage in either woodland management or forest creation.

3.4.3. What are the wider systems in which these segments sit and how do the people and processes of those systems interact with the various segments and their incorporation or otherwise of woodland creation and tree planting into their business models?

Lyon *et al*. (2020) suggest that limited time and income constraints on farmers are going to cause them to focus on the issues that immediately affect their primary business activities and interests. Thus, those that are more concerned about climate change impacts and

environmental issues are likely to engage with relevant advisors, support networks and associations that encourage their activities. In contrast those focused on maximising agricultural efficiency are more likely to be linked into the relevant sectoral advisory networks and incentive schemes.

Traditionalist/Farmers first

Traditional farmers, with strong views on the role of the farmer in food production, tend to be well networked into agricultural support systems. They may also be utilising agri-environment schemes to enhance incomes and deliver wider public goods unrelated to forestry and are unlikely to be engaged with forest experts or consultants. In relation to climate change they are likely to have a negative view towards any increase in regulation that is perceived as restricting production and allocate blame to other parts of the agricultural sector, such as fertiliser production and processing (Barnes and Toma, 2012; Hyland *et al*. 2015). Lyon *et al*. (2020) indicate that smaller family farms and 'farmers-under-pressure' are less likely to be interested or involved in provision of public goods.

Timber producer/Productivist/profit oriented

Tend to be large scale woodland owners focused on timber investment for profit. Likely to be aware of grant and advisory support schemes, and utilise professional foresters/consultants for active management and to develop management plans; aware of market conditions and process and linked to industry to maximise value of outputs (Ambrose-Oji *et al*. 2018). Larger woodland likely to be planted to coniferous species. Higher awareness of climate change issues but focus is on potential for impacts on forest growth and revenue (e.g. concern over increased impact from pests/disease; market for carbon credits).

Multi-functionalist/Enterprise focused managers

This 'segment' incorporates a wide range of farmers and landowners that may have multiple goals and take a pragmatic approach to enterprise development that fits into their local context, lifestyle, and value systems. The aim is often to ensure the business as a whole is profitable so may cross-subsidise activities and balance risks. Woodland is only a part of the farm-business and this type may or may not be linked into forest advisory support systems. Awareness of climate change impacts varies. Younger farmers (with higher education levels) tend to have more awareness of potential climate change impacts. The more environmentally aware farmers are likely to understand potential impact from livestock and more likely to adopt mitigation and adaptation measures (Hyland *et al*. 2015).

Amenity/Conservation focused

Tend to be newer owners, least involved in active management, and with low forest management skills. May belong to a local woodland or wildlife association but tend to be disconnected from public or private forest expertise and advisory support (Ambrose-Oji *et al*. 2018). More likely to be connected into wildlife management and conservation networks.

3.4.4. Recommendations for segmentation modelling

Segmentation models and typologies can divide up a target population in myriad ways as decision making in relation to land and resource use are influenced by a wide range of factors. Survey-based segmentation models, however, are limited in the range of questions they can address, it is therefore important to have a clearly defined set of aims and objectives before

embarking on the approach. The critical aspects of developing typologies through segmentation modelling are:

- deciding on the objectives of the analysis
- accessing the target population
- selection of clustering techniques
- verification of the different 'types' generated
- agreeing the proposed utilisation of the outputs.

Current best practice will incorporate theories of rational action into segmentation modelling making the approach more complex, but enhance understanding of the target population behaviour and increase utility of the analytical outputs (e.g. for communicating, developing policy tools, and action on addressing barriers to change).

At this point it is worth considering whether there is a need for additional segmentation modelling and what value it might add to the current understanding of farmer and woodland owner/manager behaviour.

The review of previous research in relation to woodland management and creation has revealed the following:

- A wide array of farmer and woodland owner 'types' but with general agreement that they range from those investing in woodland to maximise timber production and or profit to those that manage woodland purely for personal enjoyment and/or nature conservation. There are also those who try to balance multiple objectives, one of which may be to generate income from woodland management, or to maintain a more diverse landscape or wildlife habitat.
- Research reveals that there are farmers who will not countenance tree planting, believing it is not the role of the farmer, and those that are more inclined to manage woodland as part of a farmed landscape and are more open to provision of public goods.
- A significant proportion of farmers and landowners are not motivated by financial incentives to plant trees for a variety of reasons, including concerns over loss of control of their land and farming activities, and the regulation and bureaucracy associated with grant schemes and applications.
- Social and cultural factors, attitudes and beliefs play a large role in decision making.
- There are multiple reasons for owning and managing woodland.
- There are 'types' of land managers/owners ready and willing to plant trees, and there are also those who may never be persuaded to plant. In between are 'types' who may be easily persuaded/incentivised to alter behaviour, and those who will take longer to persuade or may not act until they have the capability, opportunities and motivation to do so.

The Eves at al. (2015) study has provided a thorough exploration of woodland management and creation, revealing some of the key characteristics of different 'farm types' but also identifying the difficulties of creating artificial 'segments', or groupings, when multiple factors and local context influence decision making. It is not clear that another segmentation model would provide any additional useful information. In addition, a segmentation approach tends to be static, it explores farmer/land manager perceptions of the current situation. Those perceptions may be erroneous, and also provide no predictive power in relation to the potential

for change as a result of different policy scenarios, changes in attitudes and beliefs as a result of crisis, re-framing of problems, or new information. What would be more useful at this point is to use the current knowledge gained from existing segmentation models as a foundation to develop a more comprehensive framework for woodland expansion based around understanding the capabilities, opportunities and motivations that drive behavioural change among farmers, and other land managers (see section 5 Conclusions for recommendations in this regard).

3.5. RQ5. What are the potential behaviour journeys or 'entry points' to the transition?

Does the evidence suggest any behavioural insights that are relevant to development of a pipeline of prospective applicants to incentive schemes?

In the UK, the smaller scale land owners, including farmers, prefer personalised advice such as face-to-face meetings with professional advisors, peer information exchange and case study visits, and membership of local or regional networks aimed at capacity building (Ambrose-Oji 2018). The issue of trust between advisor and recipient is critical here (Lyon *et al*. 2020). Peer information exchange, where trust is more established, could be an answer to improving information dissemination (Kueper *et al*. 2013, Lawrence & Dandy 2014, Tidey *et al*. 2010). Sometimes, even farmers who have taken up a scheme may be unaware of the ultimate purpose of the scheme as reported for Glastir (Lawrence & Marzano 2014). There can be the risk that grants push farmers to be motivated by money and undermine actions that may have been taken without financial support (van Dijk *et al*. 2016).

Because woodland creation at the landscape is the ultimate goal, cooperation between farmers is likely to be critical; help with network facilitation would encourage this (Ambrose-Oji *et al*. 2018, Kueper *et al*. 2013). Social norms also play a role here in defining what a farmer should do, seeing other farmers planting trees would encourage others to so (Moseley *et al*. 2014, Mills *et al*. 2018, Thomas *et al*. 2015, Wheeler *et al*. 2018, Ruseva *et al*. 2015). Having the possibility of observing examples and discussing others' experience generates learning opportunities, eventually starting to acquire the skills and expertise to implement and manage woodland (POST 2021).

Participatory approaches in policy design have the potential to improve uptake, but there's also the risk that participants don't all have an equal voice negating some of the potential benefits (Deuffic *et al*. 2018). A way of monitoring and quantifying outcomes to validate activities and thus demonstrate the behaviour change was correct in the sense of being viewed positively by peers would be important for some farmers (Emery & Franks 2012).

A broad range of perspectives is evident within stakeholders and this includes both within stakeholder groups (e.g. farmers) and between stakeholder groups (Iversen 2018). Engaging with this broad range of perspective is critical to achieve the widest possible uptake of grants and woodland creation (Iversen 2018); consultation processes must be able to accommodate these broad range of opinions.

Intervention points can be identified where communication should be targeted to maximise the potential for behaviour change (Moseley *et al*. 2014). Nudges could be applied at these

intervention points to achieve the desired behaviour, such as woodland creation (Moseley *et al*. 2014); nudges work best when applied in a series along the potential intervention points (Valatin *et al*. 2016). Examples of approaches include the use of emotions to prompt behaviour change; encourage farmers who own woodland to become messengers to shift social norms around the image of a good farmer; tell farmers what their peers are doing well; pass information via social networks; timing interventions at critical points (Moseley *et al*. 2014). It would be important to target nudges to different segments to maximise effectiveness (Valatin *et al*. 2016).

3.6. RQ6. Where should resources be focused for the targeted removal of existing barriers and the provision of appropriate and targeted incentives?

The heterogeneity of the farming community means that no single action or intervention will engage farmers and land managers in creating and managing their local woodlands. Instead, a mix of interventions is required which align with the different beliefs, values and attitudes of farmers. In this context, it is useful to examine the intervention functions described in the Behavioural Change Wheel (Figure 3) to explore potential interventions to overcome barriers to and engage farmers in tree planting and woodland creation.

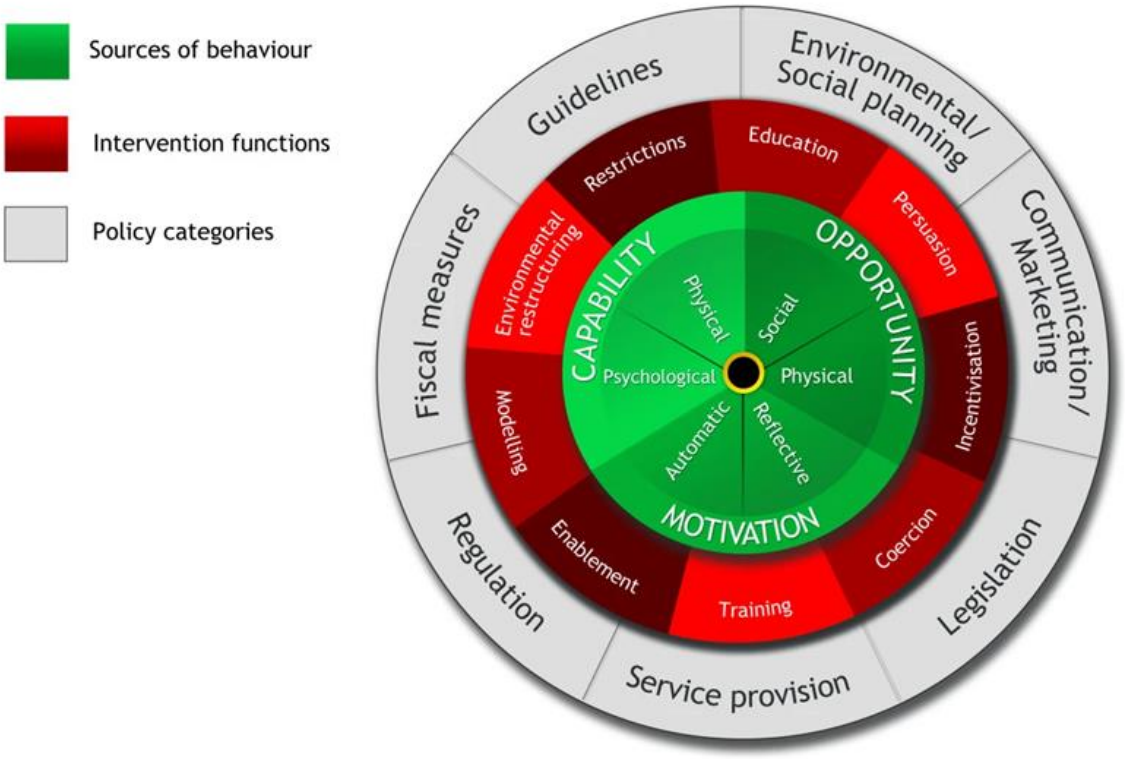

Figure 3. The Behavioural Change Wheel incorporating the COM-B Model.
Source: Michie *et al*. 2011. © 2011 Springer Nature, reproduced under license CC BY 2.0.

3.6.1. Incentivisation – financial reward

Incentivisation for woodland creation and tree planting relates to receiving a financial reward through a grant scheme. According to Dandy (2012), there are three ways in which economic incentives might influence land manager's decisions and behaviour. Firstly, grants and other

incentives can mitigate the early costs of investment and management, as also outlined in Ruseva *et al*. 2015. Secondly, financial incentives are considered 'compensation' for land-managers who have lost income through not practising more profitable land-uses. Thirdly, a view held primarily by land-managers themselves, sees economic incentives as important for managing risk and uncertainty. Paying for economic services, such as carbon sequestration may be a fourth approach, but very limited evidence on this exists.

Government grants are widely perceived as necessary to incentivise woodland creation. Woodland creation requires significant upfront capital for site preparation and planting (although perhaps less so for very small-scale planting), and the availability of subsidy programmes can reduce the cost of investment (Ruseva *et al*. 2015, POST 2021). However, according to Ambrose-Oji *et al*. (2018) there is no general consensus regarding the effectiveness of grants, subsidies, cost sharing models or alternative support packages, whether looking at specific types of landowner, particular types of schemes, or specific country contexts and some of the evidence is contradictory (Lawrence & Dandy 2014, Quiroga *et al*. 2018, Eves *et al*. 2015). That being said, there are some general insights that can be gained from the literature review.

Firstly, there should be **sufficient grant to reduce financial risk of a long-term investment**. Woodland creation also has an opportunity cost associated with the income foregone from other possible uses of that land, particularly if it is good agricultural land (POST 2021). Graves *et al*. (2017) argue that a small number of farmers might take up agroforestry due to factors of 'self-interest' such as stewardship or farmer image, but wider scale uptake will require financial incentives. A common reason for non-take up of grants is that the financial incentive is insufficient and the loss of income from taking land out of production is not compensated (Coyne *et al*. 2021). Indeed, Bateman *et al*. (1996) conclude that farmers would consider tree planting on agricultural land, if the price was right – however, in their study the level of compensation needed to influence a shift in behaviour was high. The average profit under agricultural production was £125/acre, but the mean stated willingness to accept compensation was £250/acre (note: this study was undertaken 25 years' ago). However, other economic studies suggest that forestry returns are likely to be higher than farming on poor or medium quality land, such as those typically used for beef and sheep farming (Duesberg *et al*. 2014, Breen *et al*. 2010, Collier *et al*. 2013).

Secondly, not only is the level of financial support on offer important but also how complex the process is in receiving the grant (Ambrose-Oji 2019, Coyne *et al*. 2021, Dandy 2012). A number of authors highlighted issues with the perception of land managers of the bureaucracy and complexity of previous grants schemes (Lawrence *et al*. 2010, Moseley & Valatin 2014, Dandy 2012). Moseley *et al*. (2014), suggest that it is very well understood that the bureaucracy around grant applications hinders woodland creation, although one scheme in Wales was identified by farmers as straightforward (Wavehill Consulting 2009). For any future woodland creation schemes it is recommended by Moseley *et al*. (2014) that the **design of information and application forms are kept simple** and even consider pre-populating application forms. Further strategies to improve scheme uptake can consist of avoiding complex scheme structures and complicated access points, combining farming and forestry options for different grant payments in the same administrative procedure, facilitating land managers' understanding of schemes and the management of the application process (Ambrose- Oji 2016, Ambrose- Oji & Tidey, 2017, Lawrence & Dandy 2014, Eves *et al*. 2015, Hemery *et al*. 2018, Ambrose-Oji *et al*. 2018).

Thirdly, **policy tools that match the decision-making behaviour of the target audience are more likely to facilitate change** (Duesberg *et al*. 2014). This includes structural payment formats, with Moseley & Valatin (2014) suggesting that for some landowners or land managers lump sums are preferred but for others, smaller, regular payments, such as the annual payment for previous woodland schemes which mirrors the pattern from agriculture, are preferred. Aligned to this, **co-creation of policy options** by farmers could help in limiting these sorts of issues (Lyon *et al*. 2020), as well as alleviating farmers' feelings of not being listened to (Emery & Franks 2012).

Rewilding Britain (2020) suggests that incentive schemes, such as Environmental Land Management Scheme (ELMS), should explicitly support and incentivise natural woodland regeneration and nature-enriching land uses that sustain rural livelihoods. These payments can be structured to reflect carbon sequestration and biodiversity enhancement value in different restored ecosystems including woodland. They argue for the need to ensure that ELMS provides funding for the natural regeneration of woodlands as well as the integration of native tree species into farming systems via agroforestry, woodlots, woodland pasture, low impact silviculture etc.

In addition to grant incentives, other financial mechanisms may have a role to play in incentivising farmers to plant trees, such as carbon trading schemes, tax relief and insurance. According to the Climate Change Committee (2020), the key mechanism for woodland creation and some agroforestry schemes should be **auctioned contracts** (e.g. similar to those offered for renewable electricity) or a **carbon trading scheme**. They recommend that public funding should be used for the non-carbon benefits of woodland creation (e.g. alleviating flood risk, recreation) or planting trees on farms where it would not occur through private initiatives. The report also suggests that a current knowledge gap is understanding the factors that might prompt farmers to engage with private versus public schemes or how the characteristics of private schemes influence farmer behaviours and the adoption of interventions that might deliver public goods, and also encourage private beneficiaries to buy into the initiatives (e.g. they often involve a high upfront cost to investors, with rewards not fully recouped for many years).

Tax concessions and relief is another form of incentive that has been widely applied to land-management, and forestry in particular, with significant impacts. However, as Dandy (2012) outlines, such tax relief has to be carefully designed to avoid inappropriate tree planting as occurred in the 1980s with investors (often corporations), rather than existing land managers, planting trees to reduce their tax burden – a policy that led to conversion of peatland and the release of large amounts of stored carbon. The Climate Change Committee (2020) highlights the importance of reviewing the tax treatment of woodlands, if necessary, making amendments to ensure there is no disadvantage to farmers from changing their use of land to forestry. Ryan and O'Donoghue (2016) described an example of tax relief proposed by Teasac in Ireland that linked a reduction in the tax payable by expanding dairy farmers on the increase in value of their herd if it was offset by woodland creation (either on their own land or another farmer's land). For the expansion to be carbon neutral, research suggests that one hectare of forest would need to be planted for every five additional livestock units (the grazing equivalent of one dairy cow) (Lanigan & Richards 2014).

A final social driver of behaviour change is the financial risk of woodland creation. Forestry is associated with risks such as fire and storms (wind blow) which can cause extensive damage. It is suggested that without the support of a well-developed **insurance market**, farmers or

potential investors may be reluctant to consider woodland creation (Zhang & Stenger 2014, Ryan & O'Donoghue 2016).

3.6.2. Persuasion

Persuasion relates to the use of communication to induce positive or negative feelings to stimulate woodland creation or tree planting. The review identified a number of persuasive actions that can be undertaken to overcome barriers to woodland creation and tree planting. Whilst larger-scale woodland owners and managers and forest management companies have little difficulty accessing forest and woodland grants, Ambrose-Oji *et al*. (2012) suggest that farmers and other non-traditional woodland managers are more difficult to engage. Duesberg *et al*. (2014) argue that more targeted information campaigns might be required to move a 'passive pool' of farmers towards intention to plant. Likewise, Dandy (2012) suggests that grants themselves can act as an awareness-raising tool, acting as a trigger to encourage farmers - through publicity - to seek further information and contact a woodland adviser or grant-giving body.

Ambrose-Oji *et al*. (2012) identify different ways of engaging farmers in grant schemes which include:

- better use of existing and established communication pathways to reach farmers and small woodland owners. This might, for example, include farming media or communication from partner organisations, such as farming unions.
- continuing to ensure that promotional and explanatory material is paper-based as well as on-line, paper documents may still be more accessible than electronic forms of information and have the advantage of being readily passed on between farmers and landowners.
- ensuring presentation and marketing of woodland grant schemes is focused on the business and land management needs and concerns of the target group (e.g. clearly explaining the need for woodland creation and management, how this fits in with farm planning)
- adjusting language and terminology to make forestry and woodland management more understandable to new entrants and non-specialist land managers (e.g. O'Brien *et al*. (2018) suggest that terms such as natural capital, ecosystem services can be confusing, ambiguous and unclear).

In relation to the third point, several authors suggested that woodland creation and practices, such as agroforestry, should be promoted as an activity that complements and benefits farming and can be integrated into existing farm systems (Hopkins *et al*. 2017, Dandy 2012, Valatin *et al*. 2016, Rois-Diaz *et al*. 2018). It is known that environmental activities, such as tree planting, are more likely to be adopted if it is shown that there is a good and flexible fit with existing practices (Coyne *et al*. 2021).

With this in mind, framing can be used to match different farmers' beliefs, attitudes and values and motivational influences to tailored presentation material (Moseley & Valatin, 2014). Framing messages can be developed that highlight the particular public good benefits of trees, such as, carbon sequestration, flood remediation, soil organic matter improvement, biodiversity, and animal welfare, or could be focused on personal benefits, or both. Duesberg *et al*. (2014), for example, suggests that in the case of the Irish farm tree planting scheme, an image-building campaign, aimed at highlighting the multiple benefits of tree planting and the positive environmental benefits to the local environment, could be combined with an

information campaign about the monetary benefits of the scheme, which would activate the pool of potential planters. Examples of different message framings are outlined below, although there is no clear evidence of the effectiveness of these different framings.

Economic benefit messaging – The framing could be focused on the economic benefits gained from woodland creation, which might, for example, emphasise the short-term cash surpluses on grants or short-terms benefits from the production of woodfuel (Moseley *et al*. 2014). Tree planting could also be presented as complementing lifestyle choices, such as part of a deintensification strategy for winding down production.

Biodiversity benefits - Urquhart *et al*. (2010) found that many woodland owners, including farmers, have conservation and environment motivations for woodland creation and management. Farmers often reported a sense of pride and personal satisfaction with tree planting and woodland creation, with environmental benefits being a key motivator (Coyne *et al*. 2021). Image-building campaigns can be directed at these farmers by emphasising the nature conservation and wildlife benefits of tree planting (Duesberg *et al*. 2014). Such messages that frame woodland creation as benefitting biodiversity could be promoted by environmental organisations to which farmers are members of, such as FWAG, RPSB, Wildlife Trusts, Woodland Trust etc.

Local community benefits - Moseley & Valatin (2014) suggest that the best way to promote woodland creation to some farmers could be to highlight the local benefits of such action. Therefore, in some cases message framing might focus upon the farmer's contribution to reducing flood risks to neighbours downstream, or reducing soil erosion, or positively contributing to local biodiversity.

Animal welfare benefits - Farmers involved in agroforestry in England rated health and welfare benefits in animal production as a key benefit (de Jalon *et al*. 2018). Therefore, messaging can highlight the animal health and welfare benefits of tree planting to promote agroforestry to livestock farmers.

Carbon sequestration benefits - A number of studies suggest downplaying the benefits of woodland creation for climate change mitigation (Moseley & Valatin 2014) as the global benefits will not necessarily resonate with farmers. Hyland *et al*. (2015) argue that farmers' lack knowledge about the contribution of agriculture to greenhouse gas emissions and perceive climate change as a relatively low risk to society (in comparison to water quality, food and energy security) creating a barrier to their adoption of practices to address it. The level of farmers' perception of risk was similar to that of the general publics' perception. Similarly, Lawrence & Marzano (2014) suggest that woodland owners and managers in Wales are motivated less by conviction and concern about climate change, and more by the values they hold towards woodland management. This was partly explained by a lack of confidence in climate change predictions which tended to be generalised rather than place-specific predictions of change. However, it is worth noting that these studies are over five years old and that perceptions about the risks of climate change and the climate change mitigation narrative within farming community has developed, particularly with the recent introduction of NFU's Net Zero GHG emissions target indicator for agriculture (NFU 2021) and a supermarket's pledge that all their farm suppliers will be net zero by 2030 (Farmers Guardian 2021).

The general consensus is that any message framing should be positive (Moseley *et al*. 2014, Mills *et al*. 2018). The focus should be on how woodland creation provides positive benefits

rather than the negative consequences if woodland is not created. According to Moseley *et al*. (2014), positive images and words should be associated with woodland creation, (e.g. protects us from flooding, and helps to cool our planet/environment).

3.6.3. Education and Training

The evidence suggests that **offering only incentives might not be sufficient to encourage farmers to plant trees** (Duesberg *et al*. 2014, Lawrence & Dandy 2014, Quiroga *et al*. 2018, Ambrose-Oji *et al*. 2018). Farmers often lack the knowledge and the skills to undertake woodland creation and tree planting, and ongoing management (e.g. Brouwer *et al*. 2015, Heffernan *et al*. 2011), so grants need to be bundled with information, advice and opportunities for training in order to be effective and attractive to farmers.

Interventions on education and training relate to increasing knowledge or understanding of woodland creation and tree planting and imparting skills. O'Brien *et al*. (2018) makes a useful distinction between learning and training. Training is most often associated with developing specific skills, such as. the use of a chainsaw, pest management, woodland management planning, applying certification schemes, and the identification of tree species and birds. By contrast, learning is often associated with conceptual and practical thinking about silvicultural and management approaches.

Increased knowledge of income potential/profitability of woodland: A number of studies suggest that European farmers intentions to plant trees and adopt agroforestry may have been limited by perceptions that it is unprofitable and that planting incentives are worth less than the returns of conventional agriculture (Rois-Diaz *et al*. 2018, Urquhart *et al*. 2010, Graves *et al*. (2017). In particular, there is a perception that forestry, especially on smaller scales, is uneconomic (Dandy 2012, Heffernan *et al*. 2011). Graves *et al*. (2017) point to one exception, poultry and egg production in agroforestry systems in the UK, where access to woodland for the chickens adds a premium to the product (De Jalon *et al*. 2018). Duesberg *et al*. (2014), argue that information campaigns exploring the future for woodland products could help address perceptions around profit loss.

Support for advice and training provision: It is widely accepted that encouraging woodland creation and tree planting with the farming community requires more than the provision of information (Ambrose-Oji *et al*. 2018). A recent review found that farmers lack specific skills for woodland creation, alongside appropriate technology and tools and that there is a need to 'upskill' farmers through advice and guidance (POST 2021) with advice and information exchange being crucial for enabling change to occur (Hyland *et al*. 2015 Rois-Diaz *et al*. 2018). Advice relies on clear communication and the building of trust between farmers and advisors (Arnott *et al*. 2019, Kueper *et al*. 2013, Lyon *et al*. 2020, Moseley *et al*. 2014). A lack of trust and communication can limit engagement (Ambrose-Oji *et al*. 2018, Arnott *et al*. 2019, Emery & Frank 2012).

For farmers with little knowledge of woodland creation, practical advice from trusted sources of information is important (Hyland *et al*. 2015), as is the use of established communication channels (Ambrose-Oji *et al*. 2012). The importance of the messenger and that the messenger is trusted can not be overstated (Moseley 2014). Lawrence *et al*. (2015) recommend the targeting of woodland creation advice via land owning and farming organisations, sporting organisations and land agents. However, according to Moseley & Valatin (2014), the

agricultural advisory system is dominated by agricultural advisors and agents who may have a limited understanding of forestry or interest in promoting it. In a document providing recommendations for promoting agroforestry in England (Soil Association & Woodland Trust, no date) one recommendation is the need to "develop, fund and train a new generation of farm and forestry advisors that break the divide between forestry and agricultural advice and expertise". In addition, Lobley *et al*. (2012) suggest that there may be an opportunity to engage with new landowners, particularly at the point of land purchase, possibly through land agents and solicitors, to raise awareness of the financial and non-financial benefits of woodland planting and to provide advice to potential planters.

As stated above, communication needs to be targeted at the audience and in particular needs to address their concerns and use terminology that is easily understood (Ambrose-Oji *et al*. 2012, Hyland *et al*. 2015). Similarly, the framing is important in creating a bond with the audience (Hyland *et al*. 2015, Moseley *et al*. 2014) but it therefore follows that communications framed in different ways appealing to particular segments of the farming community would be required (Lawrence & Marzano 2014, Lyon *et al*. 2020, Mills *et al*. 2018). In addition, delivering the information via a wide range of channels and organisations and means would be beneficial in reaching the widest possible target audience (Lawrence *et al*. 2010, Lyon *et al*. 2020), as well as the use of physical (paper) formats in some instances, as these can be useful in facilitating communication and passing on information between farmers (Ambrose-Oji *et al*. 2012). The communication tools chosen should also encompass a varied selection of options to reach all segments of the farming community (Lawrence *et al*. 2010, Lyon *et al*. 2020, Wilson *et al*. 2013).

Developing networks/communities of practice: The review has revealed that farmers are less likely to participate in formal woodland-focused networks, such as membership of forestry organisations, resulting in a lack of knowledge, advice, guidance and connections to engage forestry professionals (Lawrence *et al*. 2010, Dandy 2012). Dandy suggests that social networks play a central role in woodland management decisions but farmer networks where peer-to-peer learning about woodland creation and tree planting are scarce. According to Dandy (2012) what is required is a strong engagement by the forestry community with existing farmer social networks, undertaking considerable knowledge-exchange activities, particularly via channels characterised by high levels of farmer trust. This point is echoed by Rois-Diaz *et al*. (2018) in relation to agroforestry, who advocate for active support for the development of linkages between all other stakeholders and farmers in order to encourage the growth of networks that can facilitate formal and informal knowledge circulation and exchange.

Investing in networks and structures that facilitate social and cultural exchanges would promote peer to peer exchanges and possible cooperation at larger scales (Arnott *et al*. 2019, Lyon *et al*. 2020, Moseley *et al*. 2014, Racinska *et al*. 2015, Rois-Diaz *et al*. 2018, Yasue *et al*. 2019). Networks incorporating specialists where they are viewed as equals to non-specialists (i.e. the farmers) could be a useful way to facilitate exchange of ideas (Kueper *et al*. 2013). Tackling perceptions, such as the issue of public access, could remove some of the reticence in woodland creation by farmers (Broch *et al*. 2013). There is also the need to tackle the self-image of farmers and the concept of what a good farmer should do; shifting this perception of what a wellrun farm looks like would seem to be a key priority (Duesberg *et al*. 2014, Graves *et al*. 2017). Increasing communication and engagement in these areas to facilitate change in perception of woodland creation and potentially facilitate cooperation between farmers would likely lead to beneficial outcomes in terms of attitude changes (Emery and franks 2012; Eves *et al*. 2015; Hopkins *et al*. 2017).

A focus on enabling or incentivising cooperation between neighbouring farmers may also be beneficial (Duesberg *et al*. 2014). Development of demonstration farms with woodland would be useful in showing more reticent farmers how woodland can integrate and provide wider

benefits to the farm environment (Hopkins *et al*. 2017). Hands-on learning opportunities would help in increasing familiarity with tree husbandry and requirements for successful woodland creation (Kueper *et al*. 2013, Lyon *et al*. 2020).

Understanding of woodland creation and tree planting is a continual learning process that builds through practice, social learning and discussion with peers and networks (Ambrose-Oji *et al*. 2018). Dandy's (2012) review of landowner decision-making argues that networks are key to farmer's knowledge resources. A lack of social networks is a potential barrier to decision making as farmers are unable to gain advice or guidance from this source.

Moseley and Valatin (2014) recommend that conversations about woodland creation with peers, family and others should be encouraged as these types of collective discussions aid familiarisation with issues and process. Family involvement in collective discussions is particularly important as tree planting is a long-term commitment that can affect the farm business, family heritage and family legacy (Duesberg *et al*. 2014, Dandy 2012, Graves *et al*. 2017, Lawrence *et al*. 2010, McElwee & Smith 2012, Ruseva *et al*. 2015).

Peer discussions could also be aided through virtual communications via social media and other online platforms. Moseley and Valatin (2014) also recommend encouragement and facilitation of opportunities for group discussions about woodland planting at land management events, such as game fairs, which ideally should be led by peers. A series of country-wide farmer workshops on woodland creation run by trusted sources can also be important in enabling debate and discussion in situ (Ambrose-Oji *et al*. 2018). Such events were successfully used to promote soil health practices amongst the farming community and are being used in various Facilitation Fund farmer projects (McDonald 2017).

3.6.4. Modelling (Demonstration)

Modelling is defined as providing an example of woodland creation and tree planting for people to aspire to or imitate. It is recognised that farmers are influenced to change behaviour through seeing real-life examples of the activity. Related to learning through peer networks, farm walks and on-farm demonstrations are also useful in showing how a new technology or management scheme can work for them in practice (Khanal *et al*. 2019, Rose *et al*. 2018). According to Hopkins *et al*. (2015) local demonstration woodlands have been suggested by a number of studies as a useful approach to encourage woodland expansion (Wood Fuel Task Force 2008, Convery *et al*. 2012, Valatin *et al*. 2016, Rois-Diaz *et al*. 2018, Kueper *et al*. 2013). When establishing a network of demonstrations, Lyons *et al*. (2020) warns that a conscious effort must be made to show a variety of farms. It is important that farmers and land managers are not only shown demonstrations on large, well-managed, progressive farms, as smaller or under-pressure farmers will find it hard to relate to what is demonstrated, which may increase their feelings of exclusion and inferiority.

Graves *et al*. (2017) argue that there is currently a lack of agroforestry demonstrations, partly because of the long-term nature of silvoarable agroforestry which makes it difficult for an individual farmer to trial, due to the long-term commitment of land, labour and capital. Lawrence *et al*. (2014) suggest that the public forest sector could take the lead on such demonstrations, being large enough to absorb risks by trying out alternative species or silvicultural systems. The private sector could also be supported in undertaking on-farm

demonstrations through initiatives, such as Innovative Farmers which might, for example, support on-farm research into innovative agroforestry practices.

3.6.5. Restrictions

Restrictions are defined as using rules to increase the opportunity to create woodland or plant trees (or to increase woodland creation and tree planting by reducing the opportunity to engage in completing behaviours e.g., growing crops on marginal lands).

Dandy (2012) states that the regulatory system can have a strong impact on farmers' decisions to change lang management. It is possible that ongoing regulatory commitments or structures may be a constraint on options for change, and increased engagement with regulation may lead to the subsequent loss of control over decisions. Furthermore, land managers may become familiar with a particular suite of regulations, and they may fear that changing land use will require having to learn and negotiate a new suite, with the associated need to expend time and effort.

It is argued that some grant regulations, such as felling licences, replanting requirements and restrictions to reconversion can amplify the landowners' perceptions that woodland creation involves long-term loss of control over land management. This is suggested to be a key barrier to woodland creation, and for those unfamiliar with woodland can be exacerbated by a sense of increased risk and inability to respond to such risks flexibly (Dandy 2012). One recommendation to increase farmers' willingness to plant trees is to not impose felling licences on this group (Lawrence *et al*. 2010). There is evidence that controls, such as felling licences, which restrict the conversion of woodland back to agricultural land, can result in a perceived 'loss of flexibility'. However, regulation also has an important role in ensuring that grants do not lead to trees being planted leading to undesired outcomes, as highlighted earlier (peatlands, species rich habitats).

A policy brief by ELO and WWF on growing trees on farmland states that the legal definitions of agricultural vs. forest land in official registers (which may be affected by the size of the parcel or the tree cover) should be revised where having more trees on farmland creates a loss of land value or disproportionate restrictions to management.

Farmers fear that changing land use so that they are not actively farming their land, either through activities to reduce flood risk or woodland creation may risk losing their agricultural subsidies (Rouillard *et al*. 2015). Reassurances that these activities will not result in loss of subsidies as they are gradually reduced under the existing agricultural policy, will go some way to allaying these fears.

Additionally, the laws governing farmland leases between owners and tenants should include a framework delimiting the roles and responsibilities of each actor as regards growing trees on leased land. Contractual arrangements that may constrain uptake amongst farms that are tenanted or designated as common land, or part of a private sector payment for ecosystem services scheme, also need to be addressed (Rouillard *et al*. 2015, Climate Change Committee 2020).

3.6.6. Environmental re-structuring

Environmental re-structuring refers to changing the physical or social context in which woodland creation or re-planting operates.

Influencing social norms: Ruseva *et al*. (2015) argue that for some farmers financial incentives are less likely to influence motivations to plant trees compared to informal social influence mechanisms. Social norms are one such influencing mechanism and are defined as having two perceptual references: perception of what is commonly done in a given situation (descriptive norm) and the perception of what is commonly approved of (injunctive norm).

There is some limited evidence from the review that descriptive norms can influence tree planting behaviours. For example, Ruseva *et al*. (2015) suggest that the woodland creation activities of peers were positively related to motivations to plant trees. Providing opportunities for farmers to discuss tree planting experiences with other farmers and observing woodland creation examples can therefore help make these practices more acceptable. Furthermore, communicating to landowners or land managers about the 'pro-social' behaviour of their neighbours and peers who are planting woodland can activate descriptive norms (Moseley, 2014).

An injunctive norm is seen when a link is made to social approval of the desired behaviour. It is very similar to subjective norms. Tree planting is more likely if it is perceived it would be viewed positively by the local community (Hopkins *et al*. 2017). Whilst few of the studies reviewed confirmed the importance of subjective norms in woodland creation, other research has shown that 'subjective norm' is a particularly important determinant of farmer behavioural intention, for example in the context of farmer decision making and soil health (Bartkowski and Bartke, 2018) and other contexts (Schaak & Mushoff 2018; Senger *et al*. 2017). Moseley *et al*. (2014) caution against promoting a narrative that farmers are against woodland planting as this reinforces perceptions about farmer behaviour and can instil a view that it is acceptable not to plant because no one else is. They recommend use of an injunctive norm, such as 'many landowners would like to plant more trees' (p. 15).

With farmers for whom custodianship of the land is part of their self-identify, Moseley and Valatin (2014) recommend promoting tree planting as their duty to enhance local biodiversity, amenity and landscape, linked to social approval. Although such framing may be counterproductive in the context of landscape stewardship, as two studies identify strong negative emotions related to altering the landscape by planting trees (Iverson 2018, Miller *et al*. 2010).

As it is known that farmers also take account of the views of others, Moseley and Valatin (2014) argue for wider interventions, beyond the farming community, that target rural attitudes on the importance of woodland creation for climate change mitigation.

Increasing market opportunities for wood products: It is argued that farmers often lack an understanding of and the ability to confidently move within diversified markets and opportunities because they are not embedded in the social networks surrounding these markets and lack the social ties (McElwee & Bosworth 2010, Dandy 2012).

However, there are opportunities to improve farmers' access to markets for woodland products. The best use of wood products for carbon sequestration is timber which locks up carbon in buildings. There is a potential market opportunity from increased demand for sustainable or ecological approaches to building projects that source local timber for their constructions (see, for example, Assemble Studio 2020). Also, Lobley (2012) suggests there

is potential for improvement in markets for woodfuel of short rotation coppice, particularly if local and regional scale heat and power stations are developed. This could be viewed as a perverse outcome in the sense the wood will be burned and return carbon to the atmosphere, but soil storing carbon under permanent crops (e.g. willow coppice) is greater than in arable systems, resulting in a net uptake of carbon assuming sensitive harvesting.

Increasing diversification market opportunities linked to recreation and tourism: There are specialised activities linked to tourism and shooting that may encourage woodland creation, although there was limited evidence in the review for these activities driving tree planting. However, there is likely to be some interest in these diversification opportunities which could be promoted amongst land managers.

Increasing natural regeneration: Rewilding Britain (2020), despite being a pressure group, has some interesting suggestions. It calls for future policy that enables land managers to leave wilder areas to allow natural regeneration. They argue that currently the UK has an uneven and uncoordinated land-use planning and regulatory process. They suggest that there are (at least) three different process/systems – agriculture that is fairly lightly regulated, woodland creation that is fairly robustly regulated by Forestry Commission or equivalents (but little Local Authority involvement) and renewable energy development that the Local Authority regulates under planning. They call for locally-led integrated Land Use Plans across the rural economy, including farming and forestry, that deliver benefits for people, nature and climate. Within this, they would like to see an increase in investment in natural regeneration from public and private financing within a supportive regulatory framework.

An issue to be aware of is that rewilding is a confusing word, used in many different ways. Strictly speaking rewilding assumes a large protection area allowing top predators to re-enter or be reintroduced, something that currently does not apply to the UK. Focussing attention on natural regeneration or minimal management might be better than using the term rewilding.

3.6.7. Enablement

Enablement refers to increasing the means/reducing the barriers to increase the capability for woodland creation and tree planting (beyond education and training) or opportunity (beyond environmental restructuring). Several studies recommended that engaging farmers in the design of woodland grant schemes will help enable woodland creation (O'Brien *et al*. 2018, Emery & Frank 2012). Farmer involvement in scheme design would accommodate the different approaches and interests on different farms. It would also allow farmers to feel a sense of ownership over the issue of woodland creation and ensure that their knowledge is incorporated into the design of the scheme.

3.6.8. Where should resources be focused for effective communication, engagement and promotion to encourage long term land use change to increase tree cover, with consideration for future primary research?

Multiple communication methods should be used to promote woodland creation and tree planting as it is more likely that the messages about the benefits of woodland creation and tree planting will be heard by as many people as possible (Lyons *et al*. 2020). Methods of communication could include:

- Direct interaction through phone, face-to-face meetings, workshops, discussion groups.
- Paper communications through mailings, agricultural magazine and press

- Online content, apps and websites
- Social media
- Television and radio.

When using these different channels, it is important that the messaging is credible, salient and legitimate and that it is also consistent across the varied channels. Use of farmer focus groups to test and validate messaging is recommended.

Cooperation and collaboration in spreading the message is recommended as this will also help keep the message consistent. Informing several different actors involved with the farming community to take forward the message will help to strengthen the message and keep consistency (see Rose *et al*. 2018). Collaborating with different groups, organisations and actors will increase the likelihood that a farmer will receive information from a source they trust (Ehlers & Graydon 2011. These collaborators will also know the most suitable way to communicate to their audiences (Ehlers & Graydon 2011).

Potential messengers, social networks, 'mavens and champions for increasing tree cover on farmland include:

- Farmers who are respected and trusted members of the farming community should be encouraged to become woodland champions to reinforce woodland planting as a social norm.
- Advisory organisations that advise farmers on agri-environment schemes should be trained and supported to encourage woodland creation and tree planting on farmers. Such organisations include FWAG, Wildlife Trusts, RSPB, Game and Wildlife Conservation Trust and private advisory consultants.
- Land agents could be supported to encourage new landowners to consider woodland creation and tree planting as a land management option for their new land.
- Facilitation Fund and farmer cluster groups could be supported to run training sessions on woodland creation and tree planting. Also, they could be encouraged to undertake collaborative tree planting schemes on adjacent blocks of land.
- Large estates could support tenants in tree planting and woodland creation. E.g. National Trust (see Lobley 2012)
- Farmer organisations that promote innovation, such as Innovation for Agriculture and Innovative Farmers could be supported to facilitate discussion groups, workshops and farm field labs.
- Farmer representative organisations, such as NFU, CLA, could be encouraged to support tree planting to meet net zero GHG emission targets for agriculture.
- Encourage discussions about forestry/agroforestry practices on online farming forums, such as the Farming Forum.
- Social media networks – development of a social media strategy, with specific hashtag to enable peer-to-peer discussion of forestry issues.

4. CONCLUSIONS

4.1. Key findings

The overall aim of this literature review was to identify the social and behavioural science evidence relevant to woodland creation (including via planting and natural regeneration), wood pasture, agroforestry and hedgerow planting / establishment in agricultural landscapes. This evidence was then used to inform recommendations for the design of interventions to encourage long term land use change to increase tree cover, and for future primary research, where evidence gaps were identified.

A wide range of reasons for owning and managing woodland, including tree planting, were identified, such as personal pleasure, biodiversity, timber production, amenity and recreation. Carbon sequestration itself was rarely cited as a motivation for woodland ownership or tree planting. As the focus on 'carbon farming' and tree planting to mitigate climate change has only recently become a national target, the paucity of literature focussed specifically on farmer behaviour in England may be due to the time lag in undertaking research and publication.

Decisions to expand tree cover on farmland are influenced by farmer attitudes, motivations, values, skills, business aims, market drivers and social pressures. However, farmers are more likely to plant trees if the objectives of tree planting schemes are closely aligned to their own objectives, either personal or business. In this regard, policy tools need to appeal to multiple 'types' of farmer, who may have different motivations for and attitudes towards tree expansion. Along with this, policy tools need to be flexible, adaptable and capable of being bundled in different ways, and farmers must be able to perceive some benefit from tree expansion on their farm (e.g. soil health, shading, adaptation to climate change, payments for ecosystem services), rather than just the global benefit of climate change mitigation.

Two current issues threaten a large-scale woodland expansion objective:

- Climate change arguments have limited influence on decision making: due to lack of understanding, but also influenced by the fact that the costs of action tend to be immediate and local, while benefits are perceived as indirect, long-term, and global.
- Forest expansion will alter the landscape, potentially limiting land use for generations: the lack of a wider 'woodland culture' will create resistance that will influence landowner/manager decision making with regard to tree planting.

A large-scale change in farmer/landowner behaviour in the short term is unrealistic without significant awareness raising, tailored policy tools, and targeting of groups that have differing views, skills, and perceived opportunities to act. **Segmentation studies** have revealed there are those ready and willing to plant woodland, as well as those who will not, and that they may occur within multiple 'segments' or 'farm types'. Forest expansion will require:

- Provision of opportunities
    - a range of policy mechanisms capable of being tailored to local contexts
    - identification of suitable land types
- Enhanced capabilities
    - Training and skills development in woodland creation and management
    - support mechanisms (advice; knowledge exchange)
- Motivation to act
    - increased planting by different categories of land and woodland owner

    - a change in awareness of climate change impacts and the range of local woodland benefits (including timber and other wood products), development of cultural values and changes in attitude.

Specifically, analysis of the segmentation models reveals the following:

- Segmentation models have limited application and their utility is dependent very much on the purpose they were designed for (the questions they were designed to address).
- A wide array of farmer and woodland owner 'types' have been developed through segmentation models, ranging from those investing in woodland to maximise timber production and or profit to those that manage woodland purely for personal enjoyment and/or nature conservation. There are also those who try and balance multiple objectives, one of which may be to generate income from woodland management, or to maintain a more diverse landscape or wildlife habitat. Research also repeatedly reveals that there are farmers who will not countenance tree planting believing it is not the role of the farmer, and those that are more inclined to manage woodland as part of a farmed landscape and for wider public benefit.
- A significant proportion of farmers and landowners are not motivated by financial incentives for a variety of reasons, including concerns over loss of control, regulation, and bureaucracy associated with grant schemes and applications.
- Social and cultural factors, attitudes and beliefs play a large role in decision making.
- There are multiple reasons for owning and managing woodland.
- Segmentation models tend to be 'backward looking' and static. While they provide understanding of farmer types, characteristics, and factors influencing behaviour they are a snapshot in time and do not provide information on how behaviour might alter within a different context, especially under crisis conditions when awareness, attitudes, and beliefs may alter rapidly.
- Existing segmentation models provide sufficient information about farmers in England on which to develop a woodland expansion framework. It is unlikely that an additional segmentation model will add useful or policy relevant information to the information on different farmer types.
- The study by Eves *et al*. (2015) provides extensive understanding of a range of farm types and characteristics in relation to woodland planting. It also reveals the limitations of segmentation models and the variability within defined farmer 'types.
- A woodland management segmentation model developed in the USA (Butler *et al*. 2007) identified four woodland owner types: those 'model owners' who already displayed desired behaviours; those that could be 'written-off' as never likely to change; and those in the middle that could be persuaded with effort. The initial target were described as 'prime prospects' - those most likely to be influenced by interventions that change behaviour.
- Linking the understanding derived from the Eves *et al*. (2015) segmentation study with ideas from the Butler *et al*. (2007) study, provides the basis for developing a 'woodland expansion framework'. The framework creates an iterative approach linking farm 'type' with improved understanding of capabilities, opportunities, and motivations, delivered through tailoring of policy tools.

4.2. Developing a more comprehensive framework for rapid tree cover expansion

Figure 4 illustrates a recommended approach utilising current knowledge on segmentation to develop a more comprehensive framework for achieving a rapid woodland expansion over the next 30 years. The framework is based on an iterative approach to targeting and engagement to change behaviour using policy tools that address needs, build capacity, create opportunities and alter motivation. The aim is a flexible package of tools that can be 'bundled' in innovative ways to meet the needs of different 'segments' of the target population. Initial effort (short term: 1 – 3 years) should focus on those who are willing to plant, gradually moving along the continuum to those least likely to plant. These (as Eves *et al*. 2015) have shown, might have quite variable characteristics in terms of farm size, business model, and motivation, which will require deep understanding of needs (in terms of capabilities), financial support and removal of barriers (opportunities), and knowledge, attitudes and beliefs (motivational drivers). A high level of engagement will be required to understand needs and develop policy tools that will generate the desired behaviour among target groups.

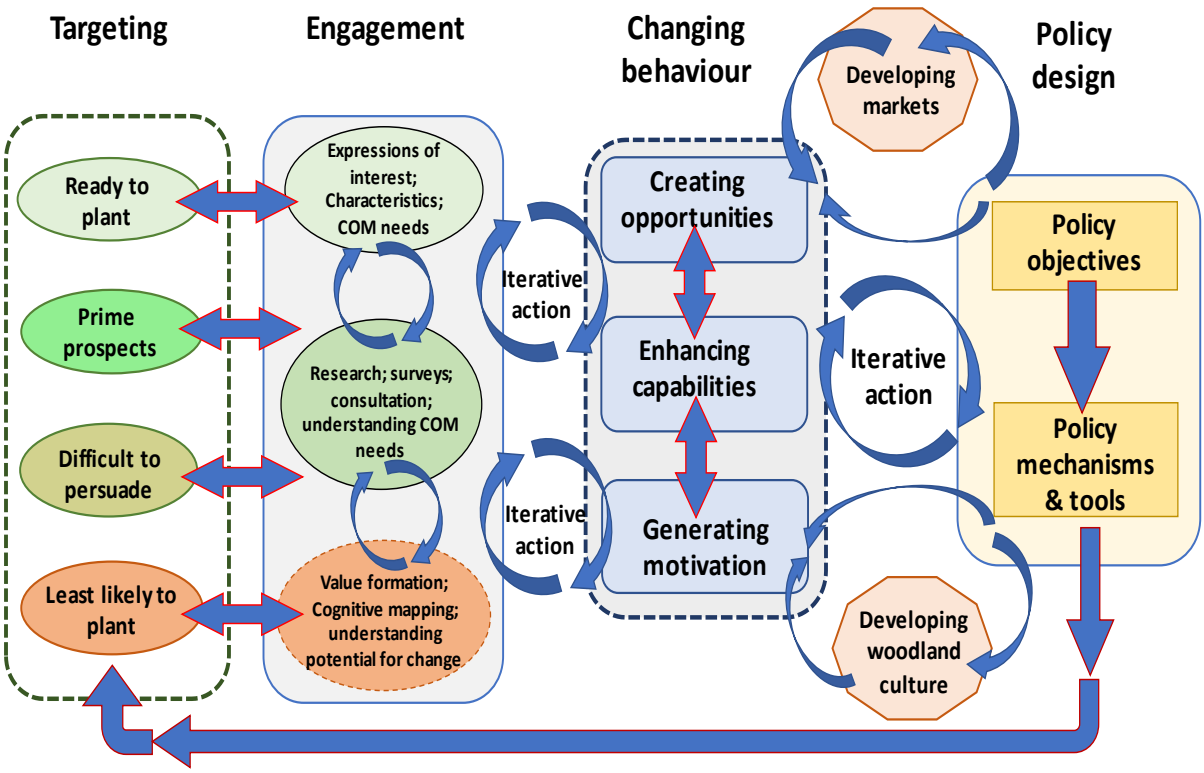

Figure 4. Engaging landowners/managers in a woodland expansion framework

In the medium to longer term (4–10 years and beyond), additional expansion will require changes in understanding, attitudes, beliefs, of those 'segments' requiring a higher level of 'persuasion' to change behaviour. The diagram suggests an iterative set of processes to develop policy mechanisms and adjusting for effectiveness as attitudes and values change over time. Medium term action would focus first on 'prime prospects' whose capability/opportunity/motivation (COM) needs are likely to be easier to achieve. In the

longer term the same iterative process would occur for those more difficult to persuade. Two longer term areas of activity would need to operate alongside land manager support: enhancing market opportunities (e.g. timber, wood fuel, biomass), and the other focused on societal values formation and establishment of a 'wood' culture, which over time would alter attitudes towards wooded landscapes, agro-forestry, and the nature of farming.

In order to realise the level of behavioural change needed for the scale of treescape expansion planned, there will need to be a change in farmers' values, cultural beliefs and social norms. This requires starting with those most likely to engage in tree planting, with a longer-term goal of shifting social norms over time to encourage a wider set of farmers to engage in expansion of farm tree cover. It also requires collaboration with stakeholders that farmers trust, who can help in normalising tree planting behaviour.

The evidence review identified a paucity of research specially focused on social and behavioural characteristics influencing woodland creation and tree planting in England, particularly when compared to the equivalent literature on farmers' agri-environmental behaviours. A programme of research is required to fill this evidence gap and recommendations are provided on research priority areas. This research is urgently required to inform the development of a long-term strategy needed to encourage the wider uptake of woodland creation or tree planting in farmed landscapes.

4.3. Recommendations

We propose three strands of recommendations, operational over different timescales (Table 3), and including both policy recommendations and recommendations for future research.

	Timescale	*Policy intervention*	*Priority evidence needs*

STRAND A **UNDERSTANDING THE CAPACITY FOR EXPANSION**	Short (1-3 years**)**	**IDENTIFY 'PRIME PROSPECTS':** ● Targeting farmers most likely to engage in tree planting, including those already engaged & those likely to plant ● Engage initial planters as champions for tree planting (e.g. through demonstration, communication, sharing best practice). ● Provide clarity on ELM to enable farmers to make informed decisions about long-term management & integrate with England's Tree Planting Programme	Social survey to identify current capacity, opportunity & motivation to increase tree cover, & barriers to planting/regeneration Needs assessment: ● How woodlands, TOW & agroforestry can align with farmer values & practice ● Capacity for planting, natural regeneration & rewilding ● Farmers' willingness to accept compensation for conversion ● Barriers to woodland creation, e.g. farm tenure, inheritance tax, land value etc. ● Advisory & training needs for farmers & their advisors Identify where change is already happening in terms of farmers planting trees (e.g. via Farmer Facilitation Funds, SUDS schemes etc.) Stakeholder analysis / social network analysis of farmers' 'tree'-related networks Developing co-design / participatory approaches for the design of policy options for treescape expansion on farmland

<u>STRAND B</u> **CREATING OPPORTUNITIES TO ATTRACT A WIDER SET OF FARMERS**	Medium (1-5 years)	**COMBINE 'STICKS, CARROTS & SERMONS':** ● Flexible & tailored bundles of regulation, economic incentives & information for application to local contexts and different farmer/land manager 'types' or segments, co-designed with farmers ● Capacity building through knowledge and information exchange ● Building in capacity for tools to adapt to changing needs & circumstances of farms over time & in response to shifting norms ● Ensure that regulatory burden does not act as a disincentive to tree planting or natural regeneration ● Develop an insurance market for tree risks	Building on the evidence collected in Phase 1, identify what bundles of strategies, tools, markets etc. can enable trees and woodlands to be realised as a long term asset to encourage farmers to engage Identify what market-based approaches might best incentivise afforestation (e.g. carbon offsetting, market for wood products) Identify any perverse outcomes that may result from increased tree planting on farmland

STRAND C **SHIFTING SOCIAL NORMS IN RELATION TO TREES ON FARMLAND**	Long (1-10 years)	**DEVELOPING A WOODLAND CULTURE:** Peer-to-peer and multi-actor learning ● Demonstrations on farms ● Social and multi-actor knowledge networks facilitated through farmers' trusted networks Education ● Embed woodland management in agricultural training/degrees ● Provide advice/training for woodland management Public awareness ● Promote public recognition of farmers engaged in tree planting/management ● Raise wider communities' awareness of importance of woodland creation for environment, carbon sequestration, biodiversity, etc.	Identify what 'nudge' mechanisms or entry points might lead to small changes that lead to bigger shifts in understanding, attitudes, beliefs over time Assess effectiveness of farmer 'tree champions' in shifting social norms & behaviour Understand how public perceptions and consumer demand influence farmers' willingness to plant trees Evaluate effectiveness of policy tools

Table 3. Overview of recommendations.

4.3.1 Strand A: Understanding the capacity for expansion

The first strand is about understanding the capacity for expansion. The literature review has identified a clear lack of evidence on which to develop workable policy tools, so further research is needed to better understand the opportunities and barriers to farm tree expansion. In terms of policy recommendations, an initial entry point would be to target farmers who are most likely to engage in tree planting such as those already engaged and those who have the potential to plant (e.g. those that align to Eves *et al*.'s (2015) Pragmatic Planters and Willing Woodland Owners, for instance). These early adopters can then be engaged as champions for trees on farmland, either through on farm demonstrations, communication within social networks and sharing of best practice. Work is needed to identify existing initiatives in which farmers are engaged as tree planters (e.g. via Farmer Facilitation Funds, SUDS projects, agroforestry etc.) in order to identify best practice and potential farmer tree planting 'champions'.

In terms of evidence needs, the agricultural policy landscape is changing rapidly as the UK comes out of the Common Agricultural Policy and develops new policy based on the principle of public money for public goods. This is likely to influence farmers' capability, opportunity and motivation towards tree planting, thus new evidence is needed to benchmark current willingness to plant. A large-scale social survey of farmers would enable the collection of such data, and could be used to test the current validity of the Eves *et al*. (2015) segmentation model, adjusting it to reflect up to date perceptions and to identify barriers to engagement across different segments. Alongside this, it is important to identify the wider set of actors who have an important role in influencing farmer behaviour change – although the stakeholder landscape for farmers in terms of agricultural production is well understood, integrating trees in farmed landscapes is likely to involve different actors. Alongside this, there is also a need to identify farmers' existing social networks to identify key intermediaries, brokers and influencers, and also the gaps in farmers' social networks.

The literature review identified that policy tools that align with farmers' motivations are more likely to succeed, therefore it is important that new tools are designed in partnership with farmers and other stakeholders. This will require the development of engagement or co-design approaches that are likely to encourage participation from farmers. Here it might prove necessary to design approaches specifically for different segments; a one-size-fits all approach is unlikely to succeed in reaching the number of farmers required for the scale of tree planting needed.

Alongside this, the literature review identified research gaps such as: a need to better understand how woodlands, trees outside woodland and agroforestry can align with farmer values and practice; the capacity for planting, natural regeneration and rewilding; farmers' willingness to accept compensation for conversion; barriers to woodland creation on tenanted farms; the advisory and training needs for farmers and their advisors.

4.3.2 Strand B: Creating opportunities to attract a wider set of farmers

The second strand, running over the medium term, is about developing innovative interventions in order to create opportunities that attract a wider set of farmers to expand the trees on their farm. We know that previous grant schemes often attract the usual suspects, those who are already interested in tree planting, but wider uptake has been limited. There is a need therefore to develop mechanisms that nudge a broader cohort of farmers into tree

planting. A combination of 'sticks, carrots and sermons' will be needed to create opportunities for behaviour change on the scale needed. There needs to be flexible and tailored bundles of regulation, economic incentives and information that can be applied across different local contexts and will appeal to different farmer types or segments, with a focus not just on carbon sequestration objectives. All of this needs to be done with wider stakeholder engagement and knowledge exchange in order to enhance capacity, and there needs to be flexibility to adapt the tools to the changing needs and circumstances of farmers over time and in response to shifting norms. Policy options such as tree planting grants co-designed with stakeholders are more likely to have improved uptake, ensuring that barriers to uptake are considered during the design phase (e.g. including establishment/management costs in grants, ensuring the application process is simple, provision of support for preparation of applications, identifying how or whether the grant process can be integrated with ELMS). Care here is needed in making sure ecological and ecosystem science input to grant design is included and acted on to avoid any perverse outcomes (as observed previously).

Alongside grants, market mechanisms can enable farmers to realise some economic benefit from enhanced tree planting. These should include a combination of mechanisms to enable farmers to realise long-term financial benefits from tree planting (e.g. through initiatives such as the Woodland Carbon Guarantee), alongside increasing marketing opportunities for timber and wood products.

Information and communication will be important mechanisms for enhancing the capacity and motivation of farmers to plant trees. This will require positive message framing and tailoring messages to different farmer types/segments (that speaks to their motivations), including messages about the income potential and profitability of woodland as well as positive messages around biodiversity and environmental stewardship. Information and training on woodland creation and woodland management should be available to farmers in a format that is accessible to them, and is more likely to be positively received if delivered by trusted sources. This means that the influencers of farmer decision-making should be targeted, not just farmers. This may involve providing advice not just to farmers, but to agricultural advisors and agents, who may not currently have the required knowledge regarding tree expansion. Key to this is through engagement in farmers' social networks – for instance, through farmer woodland champions, Farmer Facilitation groups, advisors, representative organisations (NFU, CLA), innovation promoters (e.g. Innovative Farmers), land agents, estates with tenants, online farming forums and social media; as well as the events that farmers are likely to attend, such as game fairs and agricultural shows. Opportunities for knowledge sharing might be through, for example, a series of country-wide farmer workshops on woodland creation run by a trusted source and a network of woodland creation demonstrations on farms of different types and sizes, including agroforestry demonstrations.

Other mechanisms might also need to be considered to incentivise farmers to plant trees such as: allowing farm woodland to be eligible for inheritance tax relief; a reduction in the regulatory burden / penalties for those who plant (e.g. SPHNs, felling licences); underpinning orders for saplings from nurseries to stimulate home-grown production of biosecure stock and to ensure continuity in supply; development of an insurance market for woodland/tree risks, such as wildfire, wind blow, pests and diseases, health and safety, and increase rewilding and natural regeneration opportunities through locally-led integrated Land Use Plans.

4.3.3. Strand C: Shifting social norms in relation to trees on farmland

The last strand is a more longer-term goal, involving influencing farmers' cultural beliefs and attitudes in order to shift social norms in relation to trees on farmland. This will require a more longer-term strategy but is crucial for enabling wider uptake of woodland creation or incorporating trees outside of woodland into farmed landscapes. Policy interventions that can support a shift in social norms are likely to be more in terms of advisory or capacity building approaches. Evidence that is needed for changing attitudes include identifying what nudge mechanisms might lead to small changes that lead to bigger shifts in understanding, attitudes and beliefs over time, and also understanding how public perceptions influence farmers' willingness to plant trees. These will include supporting peer-to-peer and multi-actor learning, such as through a network of woodland creation and agroforestry demonstrations on farms. This model has been shown to be successful in farmer learning, and there are some examples of this in agroforestry. It will also involve social and multi-actor knowledge networks for learning, sharing ideas and influencing social norms, facilitated through farmers' trusted networks. A tool for long term change is through education – embedding woodland management and ecosystem science into agricultural training or degrees, with the provision of advice/training for woodland management to farmers more broadly.

In addition to shifting farmers' attitudes towards treescape expansion, a shift in societal expectations and perceptions of farming is needed. The pathway to this shift might include promoting public recognition of farmers engaged in tree planting or natural regeneration through media articles, awards etc. In addition, it will be important to raise wider societal awareness of the importance of woodland creation by farmers for environmental, carbon sequestration and flood protection outcomes.

There is also a need to monitor and evaluate policy tools to assess their effectiveness, and to adapt them as needed, to meet changing social norms and behaviours.

4.4. Final remarks

There are a wide range of reasons for farmers to undertake woodland creation and management, such as personal pleasure, timber production, biodiversity and amenity, although carbon is rarely cited as a motivation for woodland ownership in existing studies. This may be changing in recent years as the focus on trees to mitigate climate change builds, although this is not yet appearing in the literature reviewed in this study due to the lag in undertaking research and publication.

Decisions to expand tree cover on farmland are influenced by farmer attitudes, values, skills, business aims, market drivers and social pressures. However, farmers are more likely to plant trees if the objectives of tree planting schemes are closely aligned to their own objectives. In this regard, policy tools need to appeal to multiple 'types' of farmer, who may have different motivations for and attitudes towards tree expansion. Alongside this, policy tools need to be flexible, adaptable and capable of being bundled in different ways, and farmers must be able to realise some benefit from tree expansion on their farm, rather than just the global benefit of climate change mitigation.

In order to realise the level of behavioural change needed for the scale of treescape expansion planned, there will need to be a change in farmers' values, cultural beliefs and social norms. This requires starting with those most likely to engage in tree planting, with a longer-term goal

of shifting social norms over time to encourage a wider set of farmers to engage in expansion of farm tree cover. Ultimately, the aim must be for the vast majority of farmers to have incorporated trees within their farmland.

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APPENDIX 1 – ANALYTICAL FRAMEWORK

Understanding the socio-cultural opportunities and barriers to land use change from agriculture to trees and woodlands

Protocol for Literature Review

TABLE 1: RESEARCH QUESTIONS		
1	**What are the relevant range of behavioural changes (or behavioural outcomes) and what is the scale of change needed?**	● What are the practices associated with 'farming carbon' (for example: natural regeneration; rewilding; 3D/wooded buffer strips; agroforestry; enhancing and establishing hedgerows; trees in pasture; tree planting; woodland establishment, and; longer term management of these)? ● What are the social and geographical contexts where those practices currently exist in the farmed environment? ● What does the evidence suggest by way of the scale of behaviour change to scale up those practices on farmland to contribute to Net Zero targets?
2	**What are the barriers and motivations that will help or hinder establishment of those behavioural changes?**	● Are certain contexts more amenable to behaviour change? For example, farming type (e.g. dairy and grass-fed farming systems vs arable) or attitude(s) (e.g. those who identify as custodians/ guardians or producers? ● Woodland creation constitutes a long term / permanent land change. What is the evidence related to barriers and motivators for this? What is the evidence related to participation in incentive schemes and compensation schemes? ● Farming is more than a business, it is a culture and a way of life. How does culture, social norms and identity of farmers and farming help or hinder the required behaviour change? Does the evidence suggest that there may be undesirable (or desirable) pre-requisite or spill-over behaviours? For example, relating to a step change in the action to manage deer at a landscape scale.
3	**What is the best existing land manager segmentation model to use when specifically addressing increasing tree cover?**	● What are the appropriate segmentation models (or combination of segmentation models) to use when considering woodland creation, tree planting and management. ● What are the segments? ● Who are the wider 'unusual suspects'/stakeholders who have an important role in the system? ● Who would need to be involved in any subsequent, primary research?

4	**What are the key considerations for each segment, describing both the key barriers and motivations anticipated for this group?**	● What segments or groups are (and are not) incorporating woodland creation and tree planting into their business models? ● Why are those segments or groups not incorporating woodland creation, tree planting and management into their business models? ● What are the wider systems in which these segments sit and how do the people and processes of those systems interact with the various segments and their incorporation or otherwise of woodland creation and tree planting into their business models?
5	**What are the potential behaviour journeys or 'entry points' to the transition?**	● The wider farmer – land manager behavioural evidence base related to agri-environment suggests that behaviour change happens over time, with initial changes (or smaller ways to participate in schemes), leading to bigger and more impactful (and attitude) changes over time. In what ways might this potential behavioural journey play out in relation to increasing tree cover on farmland? ● What is the evidence related to historic participation of farmers / land managers in incentive schemes for woodland creation in the agricultural sector? ● Does the evidence suggest any behavioural insights that are relevant to development of a pipeline of prospective applicants to incentive schemes? ● What is the role of communications, advice and national/local stakeholder activity and local promotion and engagement activities, framing and imagery as part of proactive engagement with farmers/landowners in helping them to see woodland, wood pasture or agroforestry approaches as a valid component of their business.
6	**Where should resources be focused for the targeted removal of existing barriers and the provision of appropriate and targeted incentives?**	● Which actions would most effectively engage farmers and land managers in creation and management of their local woodlands? ● Which actions by government would be most effective in addressing barriers to tree planting and woodland creation by farmers and land managers / owners? ● What communication, advice and national/local stakeholder activity and local promotion and engagement activities are needed to assist in removing these barriers to long term land use change ● What social norms with regard to farmers and / or land managers / owners might need to shift?
7	**Where should resources be focused for the effective communication, engagement and**	● What key factors / elements should be considered for communication, stakeholder engagement and local promotion and engagement activities to encourage long term land use change to increase tree cover,

	promotion to encourage long term land use change to increase tree cover, with consideration for future primary research?	with recommendations to consider in any future primary research? ● What are the (potential) messengers, social networks, 'mavens and champions for increasing tree cover on farmland.

Conceptual framework for addressing the research questions, based on the COM-B model

The COM-B model will be used to investigate the pathways required for the desired outcome; this will include those factors that influence behaviour, the types and ranges of possible interventions, and how policy can be best devised to deliver the most efficient interventions. The COM (capability, opportunity, motivation) identifies the current situation including aspects that could be targeted to achieve a change in behaviour (B in the model). It is anticipated that the COM components will be segment specific, in the sense that different segments of the population under investigation might be influenced differently by their physical and socio-economical environment. The literature will be analysed to identify the best segmentation model for this work, which may cross cut several segmentation models for different target groups (e.g. farmers; wood owners; public owners). Similarly, the approaches to addressing the issues that will lead to a change in behaviour will be dependent on the segment of the population (i.e. farmers and landowner types) investigated; this is where the identification of barriers, entry points and focus for communication will be ascertained for each key segment. These actions would be undertaken to achieve the desired outcome, namely increased tree planting through changes in land use management and practice. It is important to note here, that although the primary outcome of woodland creation may be in relation to carbon sequestration and storage (focus of this project), other outcomes such as increasing biodiversity, flood mitigation, access to the countryside and green spaces, health and wellbeing, and social outcomes are likely to be crucial in the decision-making process with regard to tree planting and woodland creation. Details of the coding framework nodes linked to the key components presented here are in the 'coding framework' table below.

Evidence Review

The aim of this assessment is to review evidence that helps to address the research questions outlined above (as specified by Natural England). These questions will underpin the protocol for the search strings and review. The search will target documents from 2010 onwards as detailed in the project specifications; but it might be of value to include any 'classic' papers that are repeated cited in the literature. The search is focussed on England; but depending on the number of documents returned it might also be useful to investigate neighbouring countries such as Wales, Ireland and France whilst taken care to note any cultural specificities in these areas.

This protocol sets out a draft framework for identification of key words, search strings and the coding framework. The first step is to identify **key words** relating to the research questions. The draft key words reflect terms used to describe the type of practice changes that are associated with tree planting and woodland creation, the outcomes from planting associated with carbon storage, the context in which planting occurs, motivations for planting, barriers to planting and segmentation models. Key words are developed into **search strings**, which are tested to ensure relevant evidence is identified through the searches, and finally agreed after discussion with the research team and Natural England. The returned documents will then be screened and any documents not addressing at least one of the research questions will be discarded. After the evidence is screened and collated into the software package Nvivo, an initial **coding framework** will be used to code the identified literature, with the addition of new codes as coding proceeds. This extraction phase means each piece of evidence contained in the retrieved documents is coded against the set of criteria guided by the research questions listed above.

For each document a score of its 'quality' will be provided to help inform any later inconsistencies in the outputs. The scoring will be on a scale on 1 to 3 with 1 being adequate and 3 being excellent. For the scoring, items considered will be appropriateness of the methodology, size of sample, replication, journal reputation (including peer review process), and number of citations (taking in to account the paper's age).

The coding and analysis will allow the extraction of data that will support responses to each of the research questions following the COM-B model. Research questions 1-3 will be addressed first.

Keywords for evidence review

Keywords related to population Farmer, land manager, agricultural woodland owner
Keywords related to practice change Natural regeneration, Rewilding, Wooded buffer strips, Agroforestry, Hedgerows, Tree planting, Woodland creation, Silvopasture, afforestation, reforestation
Keywords related to outcomes Carbon farming, Net zero, Climate change, Soil carbon, timber, biodiversity
Keywords related to motivations

Environmental attitudes, perceptions, farming type, economic, knowledge, carbon payments
Keywords related to barriers Permanence, economic, farming identity, social norms, culture, knowledge, skills, demographics, land suitability, farm size, tenure, pests, risk aversion, landscape change
Keywords related to segmentation Farmer segmentation, woodland/forest owner segmentation Land stewards, conservationists, productivist, multifunctional, community, amenity, recreational, disinterested

Search strings to identify relevant literature

Q1 & 2 search terms				
WHO	**WHAT**	**ACTION/FOCUS**		**LOCATION**
farm*	tree*	planting		England (not 'new England')
landowner*	wood*	behavi*		UK
agricultur*	forest*	motivat*		
	silvo*	percep*		
	natural regeneration	attitude*		
	wilding	decision		
	rewilding	carbon		
		payment*		
		carbon market		
	riparian	climate		
Q3 search terms				
typology	farm*	England		
classif*	wood*	UK		
segment*	forest*			
type*				

For location, this is the initial focus (England), but was widened to neighbouring areas when the number of documents and / or information retrieved was minimal.

Coding Framework

In addition to addressing the first 3 research questions directly, the coding will allow us to inform our analysis and answer the research questions 4-7. In essence the first 3 research questions are about the current starting point and understanding the current situation, whereas research questions 4-7 are focussed on articulating solutions and exploring how behaviour change can be achieved.

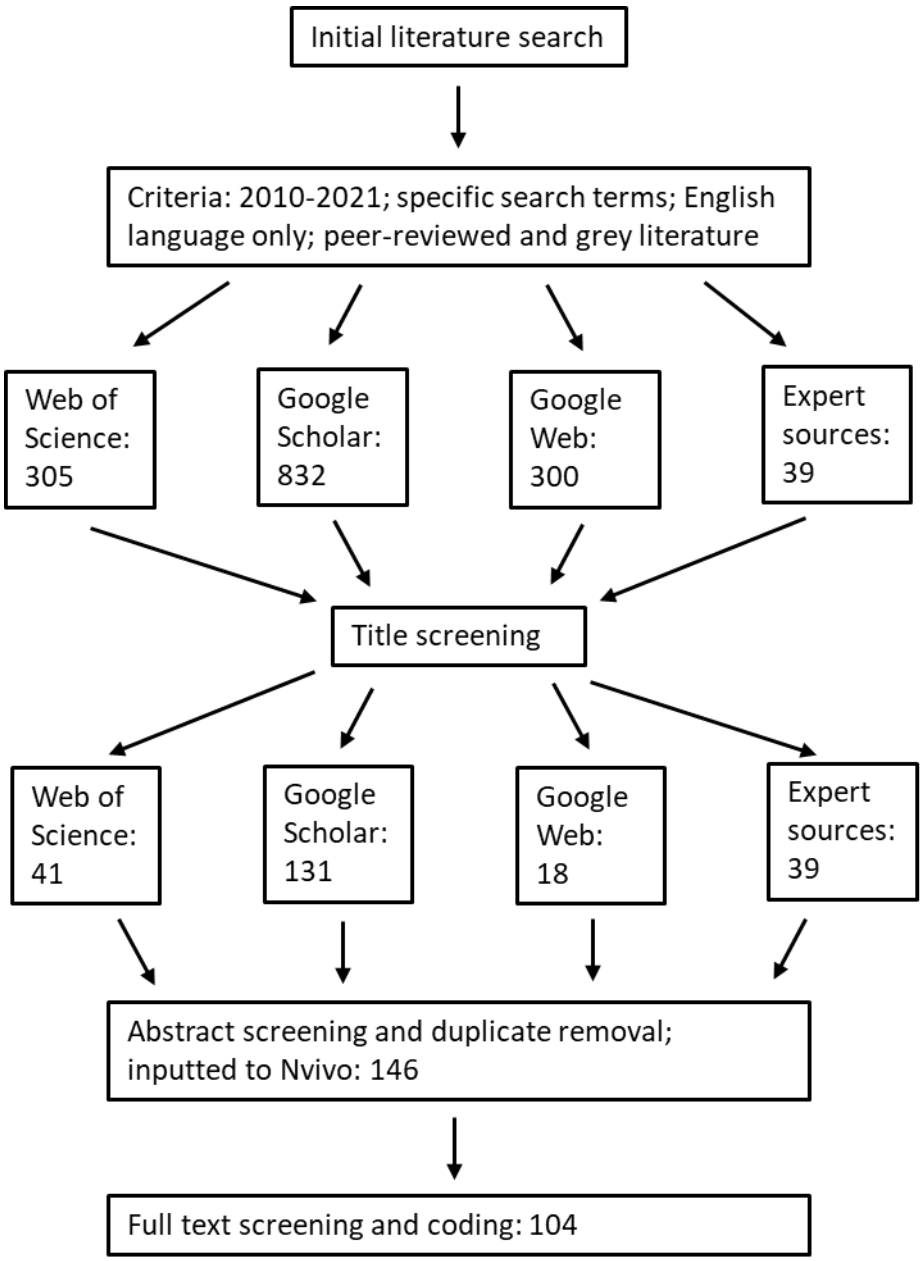
Code	**Sub-codes**	**Sub-code**

Behaviour change	Tree planting [afforestation, reforestation]	Wooded buffer strips	
		Hedgerows	
	Natural regeneration		
	Rewilding	Access; tourism	
	Pre-requisite/spill-over behaviours	Deer management; pest and disease awareness/management	
	Agroforestry	Silvopasture	
	Long-term management	Diversif*	
Capability	Socio-economical	Skills	
		Farmer age	
		Number of employees	
	Physical / environmental	Soil type	
		Local tree landscape	
	Psychological	Knowledge	Management
			Training and advice
			Schemes/policy
		Previous experience of woodland	
		Previous experience of grants	Woodland grants
			AES
		Education	
Opportunity	Physical	Economic	Financial resources
			Markets (timber, woodfuel, tourism, carbon)
			Grants
			Diversification
		Time	
		Farm size	
		Tenure	
		Land suitability	Upland/lowland
			Soil type
		Farm type	Arable
			Livestock
			mixed
		External barriers	lack of data to inform decisions
			bureaucracy in grant schemes
		Advice	access to
			trust in advisors
		Grazing pests	
		Employment gains & losses	
	Social	Social norms	Descriptive norms

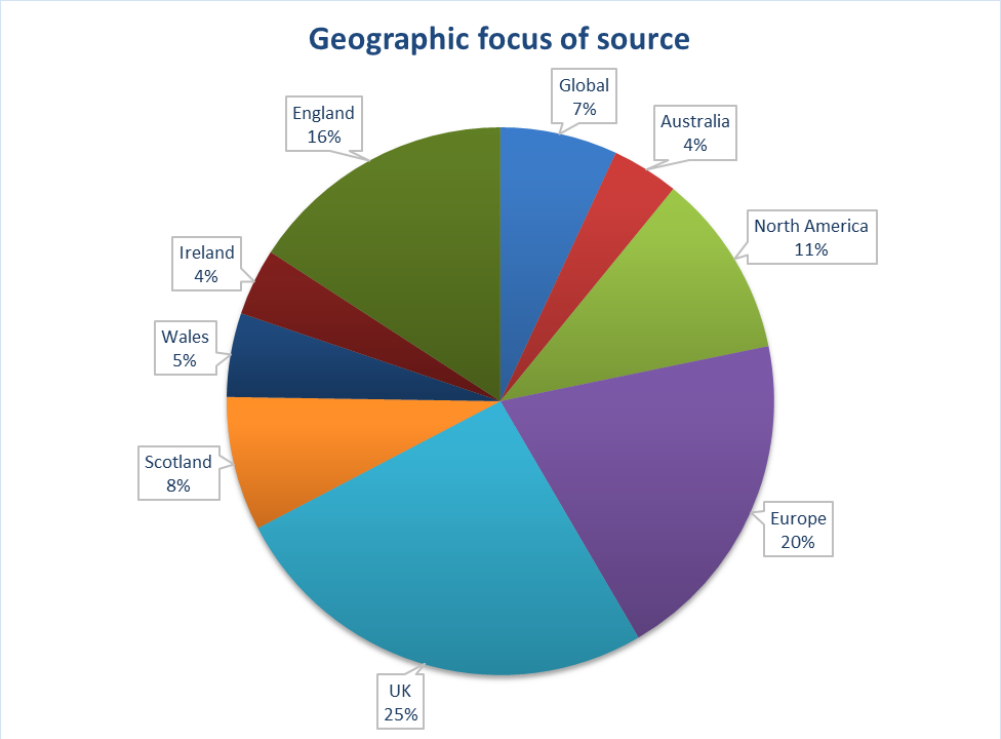
			Injunctive norms
		Public attitudes to farming/ woodland/ scrub/ grazing	
		Family or peer pressure	
		Networks	
Motivation	Reflexive	Self-efficacy (beliefs about capabilities)	
		Social network/ group / movement	
		Response efficacy (beliefs about consequences)	
		Agency (loss of control) Permanence of change (woodland creation as long-term investment)	
		Personal interest/attitudes	Wildlife/biodiversity/rewilding
			landscape
			shooting
		Risk aversion	
		Perceived benefits of woodland expansion	
		On-farm benefits (e.g. shelter for livestock, reduce run off etc)	
		Perceived disbenefits (e.g. increase in pests)	
	Automatic	Self identity (beliefs about farming and environmental stewardship)	
Segments	Farmer segments	Segments engaged in tree planting/woodland creation	
		Reasons for non-planting	
		Interaction with wider system/communication	
	Woodland owner segments	Segments engaged in tree planting/woodland creation	
		Reasons for non-planting	
		Interaction with wider system/communication	
Historic uptake of grant schemes Woodland and AES	What worked		
	Barriers to uptake		
	Recommendations for action		
Communication needs	Provide information/advice	Knowledge transfer, including communication tools	
		Provide tips	
		Checklists	
		Messengers/Champions	
	Stimulate target group	Concrete plans	
		Talk to each other	
	Feelings	Emotions	
		Framing	
		Priming	
	Values, norms	Cognitive dissonance (align to their values)	
		Injunctive norm (link to social approval)	

		Descriptive norm (demonstrate others behave this way)
		Align to identity/ self-image
		Commitment/consistency
	Nudges	Feedback
		Stimulus
		Default
	Small triggers/prompts	Reduction small barriers/frictions
		Prompts
		Substitution
	Rewards & losses	Present bias – shift costs to future & bring rewards to present
		Reciprocity
		Scarcity – emphasis limited availability of opportunity

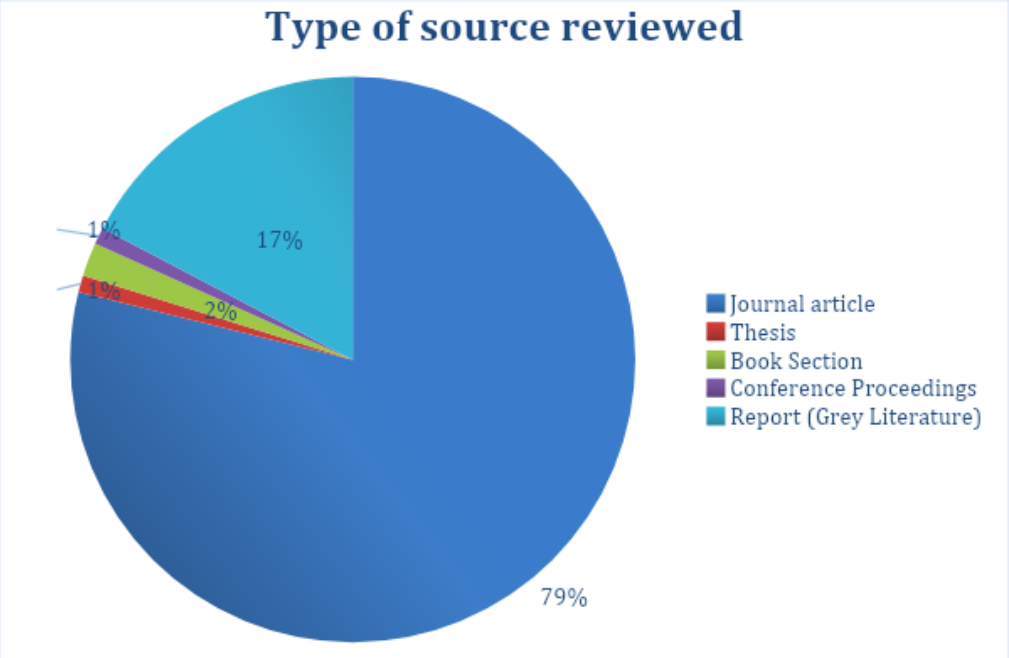
APPENDIX 2 – NUMBER OF DOCUMENTS RETRIEVED, SCREENED, RETAINED AND CODED



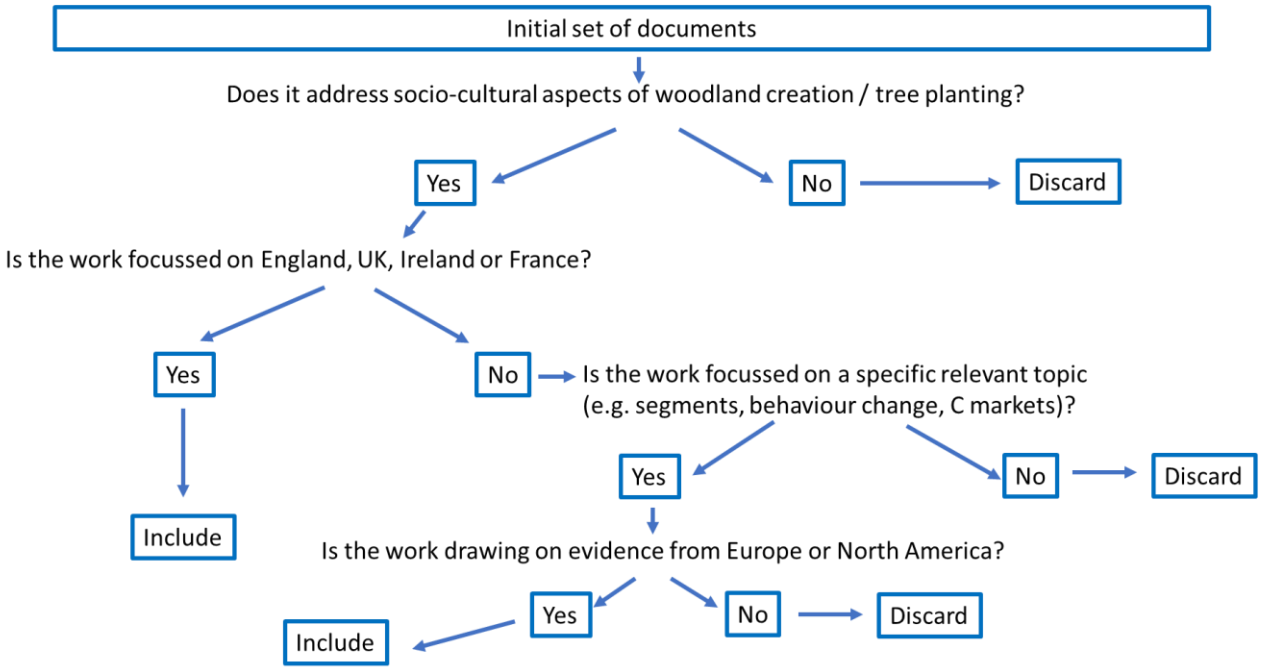
Overview of documents by geographical source



Overview of documents by type of source reviewed



APPENDIX 3 – DECISION TREE FOR EVIDENCE INCLUSION



APPENDIX 4 – CODE DEFINITIONS

Coding explanation

Self-evident codes are not explained

Behaviour change

- Agroforestry: combing agriculture with trees, either by growing crops alongside trees, or silvopasture, where animals are grazed alongside trees.
- ***Long-term management***: this implies over decades rather than years and refers to a permanent change; e.g. from arable to woodland
- ***Natural regeneration***: where land has been left to allow natural recolonization and succession
- ***Pre-requisite spill-over behaviours***: behaviour already evident which is necessary for future woodland management (e.g. deer management)
- ***Re-wilding***: on the one hand similar to natural regeneration but with active management and introduction of species deemed native or original to the area (e.g. beaver or bison reintroductions)
- ***Tree planting*** (the subcategories might need riparian and woodland adding, hedgerow trees – also perhaps need to include different woodland categories – broadleaved, commercial plantation, mixed)

Capability

- ***Education*** (level attained)
- ***Farmer age***
- ***Farmer skills*** (in applying experience and knowledge; in keeping up to date)
- ***Knowledge*** (access and interpretation of information)
- ***Previous experience*** (with regard to farming practices incl tree planting)

Motivation

- ***Loss or gain of control (agency***): relates to losing (or gaining) decision options in the future
- ***Perceived benefits of tree planting***
- ***Perceived disbenefits of tree planting***
- ***Personal interest, attitude***
- ***Risk aversion***
- ***Self-efficacy (beliefs about capabilities):*** confidence in succeeding in the choices being made
- ***Response***-efficacy: belief that the action will or will not make a difference

- ***Self-identity***: e.g. to a group or community or network
- ***Social network, group influence***: how this affects motivation

Opportunity (P=physical; S=social)

- ***P-Advice***
- ***P-Economics***: financial
- ***P-Employment***: in the local community, on-farm labour availability
- ***P-External barriers***: planning
- ***P-Farm size***
- ***P-Grazing pests***: e.g. deer
- ***P-Land suitability:*** environmental; topography; hydrology; soil type
- ***P-Time*** (incl. issues with bureaucracy here)
- ***S-Family, peer pressure*** (incl. succession on family farms here)
- ***S-Networks***
- ***S-Public attitudes***: regarding what farmers should be doing
- ***S-Social norms***: Injunctive norms – linked to social approval, e.g. perception that woodland creation will be approved or disapproved by a certain group (e.g. social, or farmers). Descriptive norms - perceptions of what peers are doing e.g. perception that woodland creation is being undertaken by the majority of other farmers.
-

Segments

- ***Farmers engaged in the tree planting***
- ***Farmers interaction with wider system:*** environmental and social
- ***Farmers reasons for non-planting***
- ***Woodland owners engaged in the tree planting***
- ***Woodland owners' interaction with wider system:*** environmental and social
- ***Woodland owners' reasons for non-planting***

Historic uptake of grants

- ***Barriers to uptake***
- ***Recommendations for action***
- ***What works***
- ***What fails to work*** (when grants are taken up but outcomes aren't those desired)

Intervention needs

- ***Coercion***: e.g. by buyers; linking to incentives - Creating expectation of punishment or cost
- ***Education***: knowledge exchange - Increasing knowledge or understanding

- ***Enablement*** - Increasing means/reducing barriers to increase capability or opportunity not captured by edu, training and environmental re-structuring)
- ***Environmental re-structuring***: - Changing the physical or social context
- ***Incentivisation*** - Creating expectation of reward
- ***Modelling real life examples:*** pilots, trials, champions - Providing an example for people to aspire to or imitate
- ***Persuasion*** - Using communication to induce positive or negative feelings or stimulate action
- ***Restrictions, rules***: regulations - Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)
- ***Training*** - Imparting skills

Outcomes

- ***Access***: for local communities
- ***Biodiversity***: either range of species, particular habitat, or species at risk
- ***Carbon reduction***: less emissions or greater uptake
- ***Health and wellbeing***: of farmers and local communities
- ***Timber***
- ***Woodland products***

APPENDIX 5. CRITICAL APPRAISAL PROTOCOL

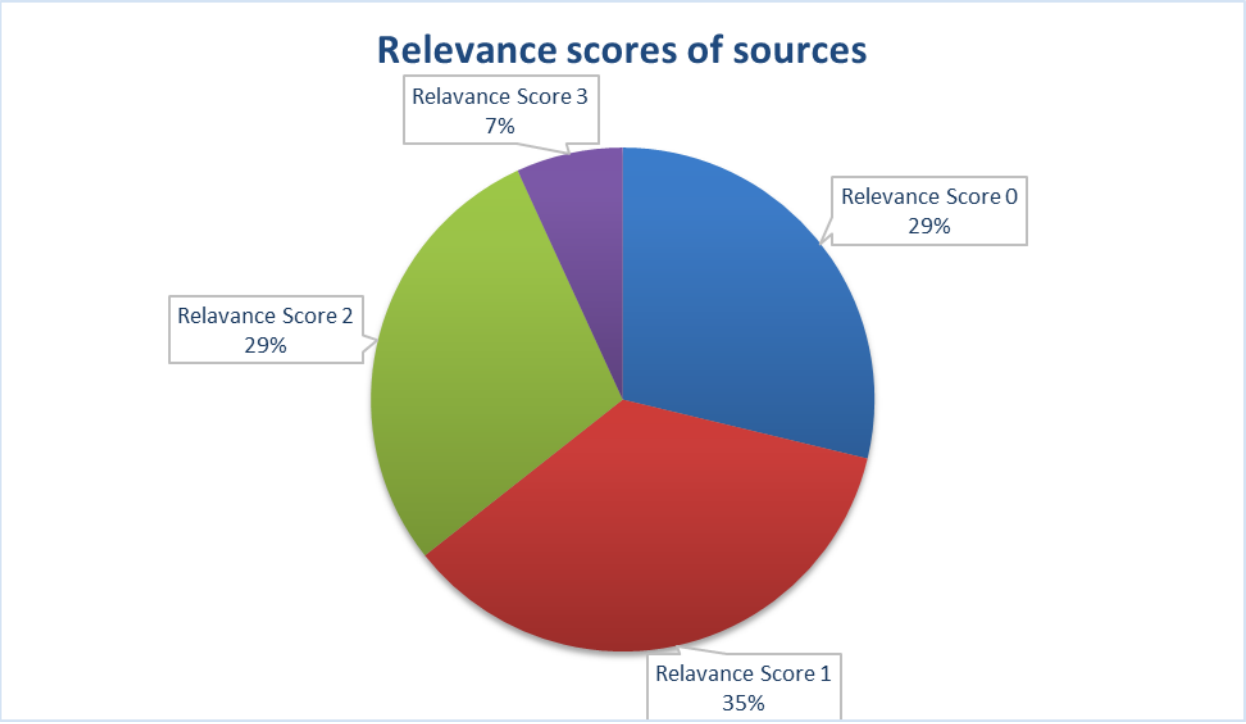
The critical appraisal process included reviewing the paper to identify the location of the research (UK, England, Wales, Scotland, Europe etc., and the type of reference being reviewed (journal, book section, report, etc.). It then assigns scores to each piece of evidence according to relevance (Box 1) and robustness (Box 2) criteria. Scoring and criteria for quality of evidence includes a ranking of each piece of evidence from 1-3 based on the following (one single score is assigned):

Box 1 Relevance

Scoring and criteria for relevance
Each piece of evidence ranked from 1-3 on the basis of the following (one single score assigned):

- The relevance of the research method used to the review
- The relevance of the evidence to the target subject/population of the review
- The relevance of the outcome measured

Score 3: Fulfils criteria and includes studies that assess initiatives and funding towards, and experience of and potential for, farm-based afforestation in the UK and socio-cultural and socio-economic aspects of farmer's involvement in these
Score 2: Partially fulfils criteria in that some aspects of the study are not relevant
Score 1: Fulfils few criteria in that few aspects of the study are relevant
.



Box 2: Robustness

Category of type of evidence

A: Quantitative studies e.g. numbers participating before-after or matched to a control population; numbers of species monitored In a longitudinal survey

B: Qualitative studies e.g. interviews, case studies to collect data on attitudes, behaviour, hypothetical studies to assess potential behaviour, behavioural intentions (e.g. theory of planned behaviour)

C: Reviews e.g. literature reviews, summarises, desk based analysis, workshop and conference outputs

D: Evaluation of projects and programmes including methods above

Scoring and criteria for robustness

Each piece of evidence is ranked from 1-3 on the basis of the following (one single score is assigned):

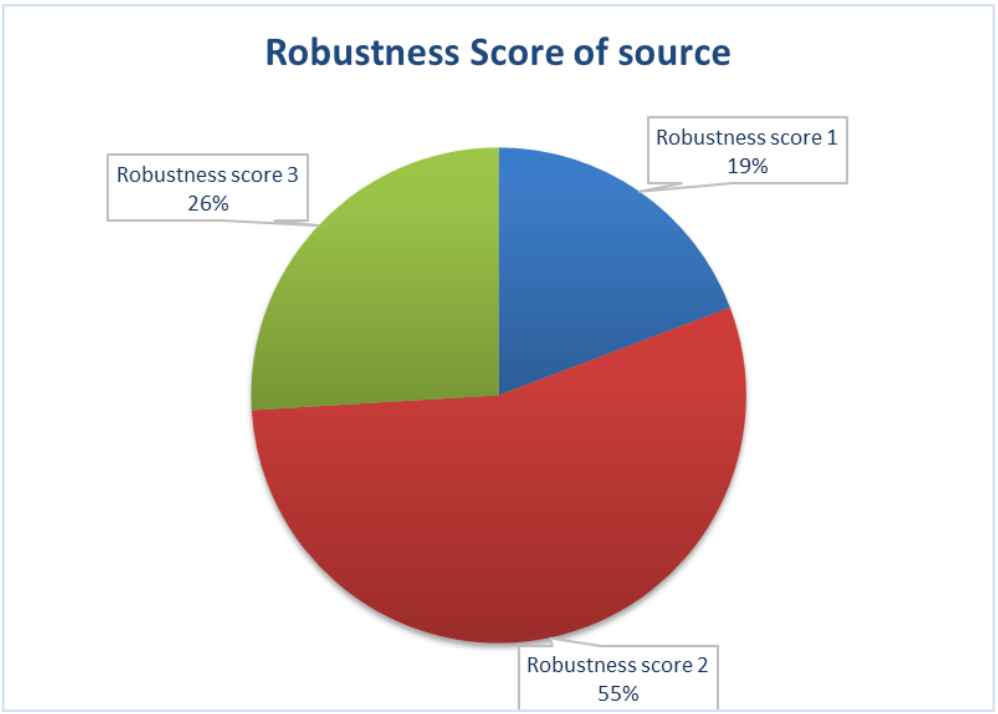
- The methodology used is clearly and transparently presented
- Peer reviewed
- Numbers and types of farmers and/or stakeholders involved suit the studies research aims (n=>20)

Score 3: Fulfils criteria and includes studies interviewing, surveying or consulting farmers and/or stakeholders where numbers and sampling method provide a largely representative rather than illustrative number (n= >20).

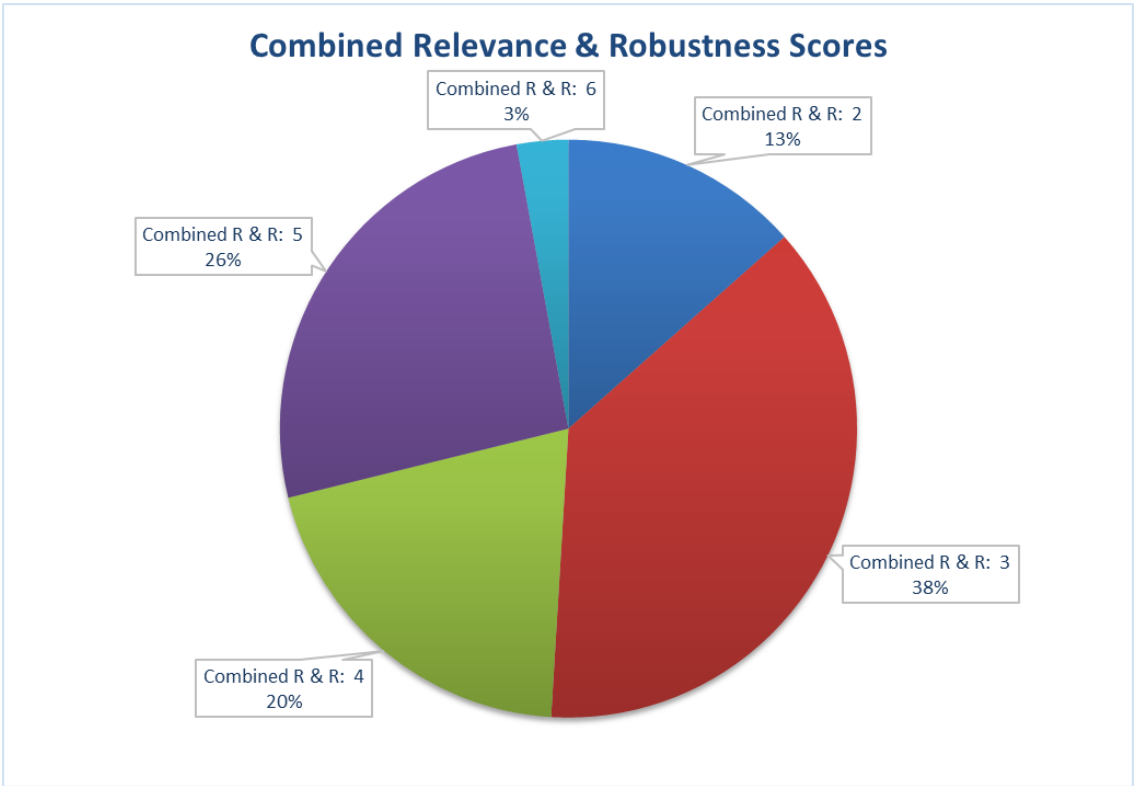
Score 2: Partially fulfils criteria (for example non peer reviewed study with reliable methodology);

Score 1: Few criteria fulfilled and /or analysis from desk studies, interpretations, expert knowledge, or inferences from previous studies.

A minimum quality appraisal level was set that defined those articles to be included and those of insufficient quality for use in any synthesis.



Combined score:



APPENDIX 6. SUMMARY OF SEGMENTATION STUDIES DRAWN FROM THE LITERATURE REVIEW

Table 1. Overview of woodland manager and owner segmentation studies

Profile Types	Key characteristics	Proposed utility for segmentation profiles	Sample characteristics	Source
● Model owners ● Potential Defectors ● Prime prospects ● Write-offs	4 groups derived from a 'prime prospects' (for support and 'nudging') grid. Model owners already display desired behaviours; 'write-offs' are the most difficult to influence; 'potential defectors' might be persuaded with effort; 'prime prospects' are those most likely to be influenced by interventions that change behaviour.	Segmentation model based on owner engagement with woodland and attitude towards stewardship. Used to develop and target Forest Service extension support and materials.	8,000 non-commercial woodland owners, USA	Butler *et al*., 2007
● Dutyists ● Reluctants ● Marketeers	'Dutyists' felt a duty to provide access as a result of grants; 'Reluctants' did not want to provide access even with incentives but would tolerate it to achieve other goals; 'Marketeers' would only provide access with sufficient incentives.	Attitude towards provision of public access	Woodland managers in SE England. Based on Questionnaire and interviews; principal components analysis used to group owner types.	Church & Ravenscroft, 2008

• Ecological land stewards • Economic land stewards • Multi-functionalists • Community stewards • Others	Most managers look for some economic 'success' before tackling other goals'; no group sought economic benefit in isolation from environment/social objectives; Woodland creation an option across all types but driven by different reasons and anticipated outcomes.	Understanding the drivers of land use change	600 land managers; telephone survey and 24 follow-up interviews. Scotland	Sutherland *et al*., 2011
• Nature Lovers • Family foresters • Creatives • Bush crafters	Based on activities conducted when visiting owned woods. Range from art and creative activities to fuelwood collection and wildlife habitat management.	Focus on activities undertaken and perceptions of woodland owners. (Note: survey updated in 2016 but not the typology)	149 respondents to an on-line survey of Small Woodland Owners Group members	Woodlands.co.uk, 2011 (cited in Eves *et al*., Vol 2, 2015)
• Multi-functional owners • Self-interested owners • Hobby conservationists • Custodian	Owner perspectives on woodland management. Objectives range from 'guardianship' and wildlife/habitat protection to multi-functional use. Range from private and personal use to provision of access and public benefit.	Woodland management & public good provision	30 private woodland owners from 3 areas of England	Urquhart, 2008

• Community woodland owner • Farmer woodland owner • Traditional woodland owner • Resident new woodland owner • Absentee new woodland owner	Motivations for management vary from provision of public amenity for 'community woodland owners' to personal enjoyment, timber value and possibly shooting for 'new woodland owners'	Reasons for: ownership, management, and motivation for public goods provision	20 woodland owners in SE England	Urquhart, Courtney and Slee, 2010
• Investors • Multi-functional owners • Private consumers • Conservationists • Amenity owners • Individualists	'Investors' (smallest group in the sample) are the most financially oriented group and focused on timber production, not provision of public benefit. Individualists made up largest group (24% of sample) focused on managing for personal enjoyment, tend not to seek grant funding. 'Conservationists' focused on conservation of wildlife habitats and are more grant dependent.	Objectives: ownership & management perceptions on public goods provision; constraints on management	Survey of 426 woodland owners in 3 areas of England	Urquhart and Courtney 2011

Encouraging woodland creation, regeneration and tree planting on agricultural land

Behaviour types: ● Non-adopter ● Potential adopter ● Past adopter ● Continuing adopter **Motivations types:** ● Preservationist ● Utilitarian ● Homesteader **Reasoned action types:** ● Doer ● Observer ● Neutral ● Rejecter	3 typologies developed based on Theory of Reasoned Action. Past behaviour based on conducting patch cutting in previous 10 yrs; intention is likelihood of cutting in next 5 yrs. Motivations based on survey responses: consumptive; living off the land; non-consumptive. Reasoned action typology developed from attitudes measured on whether patch cutting was perceived as bad/good for the land and wildlife (determined by a cluster analysis of attitude, norm, and perceived behavioural control)	Exploring how landowner typologies can be used to inform what mix of tools may most effectively engage different types of private forest landowners in forest habitat management.	Mail questionnaire from 1,036 woodland owners. Southern Tier of New York state, USA. Typologies previously developed using PCA & cluster analysis. Reasoned action typology created segments using variables from Reasoned Action Approach	Dayer *et al*., 2014
● Individual investors ● Individual 'weekend woodlanders' ● Farmers ● Forest management companies ● Private traditional estates ● Community groups (4 – 300 members)	Interview respondents identified different types of woodland owners, in terms deemed 'useful for management'. Community groups (mainly cooperatives) noted as a growing type of woodland owner	Aims are to assess how beliefs in climate change have influenced private forest management practices; identify constraints and analyse the implications for implementing climate change policy in forestry.	Semi-structured interviews with 12 key informants who provide advice to, or manage woodlands in, the private forest sector in North Wales.	Lawrence & Marzano, 2014

• industrial productionist • non-industrial productionist • for-profit recreationist • for-profit multi-objective • non-profit multi-objective • recreationalist • species conservationist • ecosystem conservationist • passive owner.	Five overarching forest management roles: profit-oriented, multi-objective, recreationalist, conservationist and passive owner divided into 9 forest owner functional types based on: - provision of private versus public goods and services, - generation of profit versus non-profit goods and services, and - management intensity	Develop an index of forest owner sustainability; finding multi-objective and conservationist owners generally practise the most sustainable forms of forest management and industrial productionists the least sustainable.	Meta-analysis of literature on forest owner & manager typologies and decision-making mechanisms. Europe and USA focus.	Blanco *et al*., 2015
• Investors • Honestly disengaged • Private retreat • Private consumers • Multi-functional owners • Inactive conservationist • Active conservationists	Based on size of woodland ownership and management priorities. Range from 'investors' who manage purely for profit to 'conservationists' who manage for wildlife enhancement	'Intuitive typology' focused on Woodland ownership and management	Private woodland owners, England (developed from literature review)	Eves *et al*. Vol 2, 2015

Encouraging woodland creation, regeneration and tree planting on agricultural land

• Timber Producers • Multi-functional Owners • Profit-seeking Guardians • Aspiring Managers • Disengaged Conservationists	Management level varies from very high for Timber producers to very low for the 'Aspiring manager' and 'Disengaged conservationists'. Timber producers have largest areas of woodland, conservationists the smallest.	Segmentation model for woodland managers/owners	Woodland Managers/owners, England	Eves *et al*., Vol 3, 2015
• Timber Producers • Multifunctional Managers • Enterprise Focused Managers • Eco-centric Managers • Individualists	Segments range on a continuum from those focused on timber production and enterprise management with a focus on generating profit, to committed conservationists, and additional types such as the 'individualists' new to woodland management with small woodland and low forestry skills level.	Builds on the 'Woodland Management' segmentation model developed by Eves *et al*., Vol.3, 2015, and reconfigures some of the 'types'.	Woodland managers perceptions of resilience. Uses previous survey and interview data sources	Ambrose-Oji *et al*., 2018
• 'Optimizers' (economy-oriented) forest owners • Traditional • Passive • Environmentalists • Multi-functional	Varies on a continuum from Optimizers focused on generating profit to the 'environmentalists focused on 'environmentally-friendly' forest management – but with recognition of sub-groups within the five broad classifications. The 5 'types' are present in all 20 case studies.	Forest owner management and decision making. Focus on creating 'meta-profiles' of ownership types	160 forest owners & 88 public forest managers in 20 case study areas across 10 EU member states	Deuffic *et al*., 2018

Table 2. Overview of woodland creation segmentation studies

Profile Types	Key characteristics	Proposed utility for segmentation profiles	Sample characteristics	Source
• Farmers • Estate owners/managers • Inward investors • Socially responsible investors Note: suggests 8 Types could be created by taking into account those who have/don't have woodland creation experience	Landowners or land managers based on a continuum, from small-scale farmers creating woodland for multiple objectives, to large investors who plant large areas to maximise long-term timber revenues.	Typology developed from experience, previous work (Lawrence and Edwards, 2013) and literature review.	UK focus on land managers (based on work by others).	Moseley *et al*., 2014
• Traditionalists • Multi-functional • Pragmatists • Constrained farmers • Conservation planters	Range from the 'traditional' farmers focused on food production with no interest in planting, to the 'conservationist' who want to increase wider environmental benefits from a more wooded landscape	'Intuitive typology' focused on Woodland creation	Private woodland owners, England (developed from literature review)	Eves *et al*. Vol 2, 2015

• Farmers first • Business oriented farmers • Casual farmers • Pragmatic planters • Willing woodland owners	Segments vary according to: priority attached to farming activity, ownership of woodland, attitudes toward habitat conservation, and stated intention to plant in the future. Farmers First see woodland only as a source of income (or shelter); while willing woodland owners manage for personal recreation and wildlife.	Segmentation model for woodland creation	UK farmers	Eves *et al*., Vol 4, 2015
• Future increasers • Non-increasers • Past increasers	Future increasers identified as 'best bets' because they own woodland, are active managers, well educated, tend to be younger, involved in environment schemes. Related to farms with above average number of employees.	Farmer intentions to afforest land and attitudes to woodland expansion.	1,735 farmers, (based on 2013 telephone survey); Scotland	Hopkins, *et al*., 2017
• Green gold • Multiple benefits • Native networks • Woodland culture • Wildwood	Green gold is a vision based on large scale plantations with high environmental standards; a focus on productive species and high value timber (e.g. non-native conifers). Native networks are semi-natural woodlands, restored and reconnected at all scales, enabling integration with other land uses. Woodland culture envisions a well-forested landscape; encompasses small-scale diversity of tree species, woodland	Future visions for woodland expansion. Focus on developing insights into woodland types to improve targeting and communications.	18 land management organisations – workshop and interviews; Scotland	Burton *et al*., 2018

	type and tenure; communities empowered and manage local woodlands, with local people making their living from woodlands in a wide variety of ways.			

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