

Article

'We're Farmers Not Foresters': Farmers' Decision-Making and Behaviours towards Managing Trees for Pests and Diseases

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Abstract: Policy makers are challenged to find ways of influencing and supporting land manager behaviours and actions to deal with the impacts of increasing pressure from tree pests and diseases. This paper investigates attitudes and behaviours of farmers towards managing trees on farmland for pests and diseases. Data collection with farmers included deliberative workshops and semi-structured interviews. Data were thematically analyzed using the COM-B (Capacity/Opportunity/Motivation-Behaviour) model to understand the drivers of farmer behaviour for tree health. Results suggested farmers had some knowledge, experience and skills managing trees, but they did not recognize this capacity. Social norms and networks impacted the context of opportunity to act for tree health, along with access to trusted advice and labour, and the costs associated with management action. Motivational factors such as self-efficacy, perceived benefits of acting, personal interest and sense of agency were impacted by farmers' self-identity as food producers. The COM-B model also provides a framework for identifying intervention design through a Behaviour Change Wheel. This suggests that enhancing self-efficacy supported by the right kind of advice and guidance, framed and communicated in farmers' terms and brokered by appropriate knowledge intermediaries, seems critical to building action amongst different farmer types and attitudinal groups.

Keywords: farmers and trees; farmer decision making; tree health; policy design; COM_B model



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1. Introduction

Maintaining and increasing the ecosystem services provided by trees, woods and forests is one way of contributing to mitigation and adaptation measures to meet the challenges of climate change and the biodiversity crisis, and realizing national and international policy ambitions around achieving net zero carbon emissions, biodiversity and nature recovery targets [1–4]. However, trees, woods and forests are under increasing pressure from a range of socio-ecological stresses, including changing environmental conditions, tree pests and diseases, which are likely to present significant barriers to achieving these policy ambitions. Looking across Europe for example, the current loss of ash trees (*Fraxinus* spp.) to ash dieback disease (*Hymenoscyphus fraxineus* (T. Kowalski)) progressing to such a degree that in many countries there is a measurable negative impact on regional and national carbon budgets, as well as biodiversity through the loss of species which rely on ash trees [5,6].

Across the globe, agricultural land managers, including farmers and agricultural businesses of all kinds, are responsible for significant numbers of trees on agricultural land as components of agroforestry systems, field and hedgerow trees, or within farm woodlands [7–9]. For example, the latest available figures for Great Britain show there are 742 thousand hectares of tree cover outside woodland, of which 74% is in rural areas [10].

Non-woodland tree cover [10] amounts to 3% of land area in rural areas. There is an estimated total canopy cover of 97 thousand hectares associated with lone trees, the majority of which, around 78 thousand hectares, is situated in England [10]. The area of farm woodland in the UK has increased from 0.8 million hectares in 2011 to 1.1 million hectares in 2021 [11]. However, a significant proportion of trees on agricultural land and in farm woodlands across the UK is undermanaged and in declining condition and include trees such as ash (*Fraxinus* spp.) and oak (*Quercus* spp.) that are under significant pressure from pests and pathogens [12].

1.1. Policy to Engage and Influence Farmer Decision Making around Trees and Tree Health

The challenge is for policy makers to find ways of influencing and supporting farmer behaviours that address tree health issues. There is a substantial body of research literature on the decision-making processes of private non-industrial forest and woodland managers and their likely responses to policy interventions, including incentives, regulation and the provision of advice [13,14]. However, when it comes to farmers and tree health issues, this existing research has some important limitations. Firstly, the majority of studies do not make it clear what kind of intervention is being considered and what the specific function of that policy tool might be [14,15]. For example, where researchers are considering the impacts of an incentive such as a grant, they rarely explain whether the grant is specifically designed to: lower costs by changing the relative price of production factors and end products; directly affect revenues that impact investment and labour decisions; or change risk perceptions because of the subsidies' insurance effect. Secondly, investigation of emerging and developing issues such as tree health has been slow to develop. A recent evidence assessment [16] found 159 studies presenting evidence about policy interventions to support tree-related behaviours amongst land managers; however, only 16 of these were specifically focused on tree health actions. Thirdly, research rarely looks at so-called non-traditional woodland managers and those managing trees outside of woodland, which includes farmers, and how they respond to policy tools promoting desired behaviours including those related to tree health.

There is, then, a fundamental need to better understand what policy makers can do to support farmers to move towards action for trees and woodlands that improves the resilience of trees on their land holdings and contributes to wider policy objectives around tree health, carbon sequestration, biodiversity and other ecosystem and societal objectives.

There is little research looking at farmers and tree diseases other than management in fruit orchards; see for example [17–19]. Research does investigate farmers' general attitudes to trees and reveals them to be very mixed. Farmers recognize the services provided by trees but also a range of disbenefits [20]. There is a significant amount of research attention around farmer attitudes to woodland creation. This builds a picture of many barriers to uptake and the need for policy tools to appeal to multiple 'types' of farmer, their varying objectives and attitudes towards trees, and their varying business contexts [21–30]. Profitability is one of the key reasons given for a lack of interest in trees, hedges and woodlands [31–33]. For some farmers, inheritance planning impacts their tree-related decision making. The time horizons involved, particularly where there are long term conditions associated with tree planting and woodland management incentive schemes, act as a significant barrier where farmers do not want to encumber future owners with onerous obligations [21]. Some studies have investigated how far agroforestry could shift farmers' attitudes to trees on farms, highlighting how policy design could do more to support this transition if it were more closely aligned with farmer objectives [34–36].

There is evidence that farmer attitudes to trees, and their subsequent behaviours, are linked to farming identities. This research emphasizes the psycho-social factors prompting varying levels of interest in or tolerance of trees in the farmed landscape; see for example [37]. Interest varies depending on: whether identities are linked with productivist or other attitudes [38]; what individuals feel it means to be a good farmer and steward of

the land [39–41]; and the degree of innovation and unfamiliarity associated with the tree management/production system [42].

Some authors warn that focusing on attitudes and farming identities might lead to overly simplistic ways of understanding farmer decision making around trees and woodlands [43,44]. For example: some farmers may act differently across their land holding(s), expressing a range of identity behaviours [25]; some pro-environmental behaviours might emerge by accident rather than by design [43]; whilst at other times, it is farm-level group decision making (e.g., the farm family) or action between farms across a landscape that is more important than the decision making of one individual with a single identity [45,46].

Different kinds of farmers and land managers may be incentivized or disincentivized to uptake specific actions and behaviours by different policy designs. However, policy makers dealing with trees, woods and forests appear to find it particularly difficult to navigate the complex range of factors influencing farmer decision making and find it hard to apply empirical evidence in policy design processes [44,47,48]. The fragmented policy landscape that exists because of divisions between woodland and forestry culture, as well as between different kinds of agricultural systems, means that there are many voices, multiple pulls on policy direction, and many ways in which forestry and agricultural policy can create complex and confusing contexts and demands which are hard for either policy makers or farmers to navigate [49].

1.2. A Framework for Analysing Farmers' Tree Health Behaviours and Links to Policy Design

Although there are many different models of behaviour change that have been applied in a forestry context [50], these have focused on woodland owners and have not been explicitly linked to policy design for farmers or for tree health [46]. A recent study in the UK used a behavioural model developed by Michie et al. [51] to successfully understand farmers' attitudes and practices towards afforestation and tree planting and to identify potential policy responses [30].

Michie et al.'s [51] model, termed the COM-B model shown in Figure 1, recognizes that for behaviour change to occur, people must have the capability, the opportunity and the motivation to change their behaviours [51,52]. Capability refers to people's psychological and physical ability to engage in a particular activity, e.g., have the right knowledge and skills. Opportunity refers to factors beyond the individual that make the behaviour possible or that prompt it, while motivation relates to an individual's drivers for acting in a particular way and includes emotions, habits, desires, attitudes and preferences [51]. Motivation is influenced by both opportunity and capability, and behaviour can alter opportunity, motivation and capability.

Michie et al. [52] go on to relate the COM-B model to potential areas for intervention design through their Behaviour Change Wheel (BCW) shown in Figure 2. The BCW includes various intervention functions that may be applied across different policy categories in direct response to the sources of behaviour revealed by the COM-B model. The intervention functions include a range of approaches to influencing the revealed behaviours, including persuasion, coercion, enablement, training and education. Not all possible interventions are appropriate in all contexts, but the BCW provides a suite of approaches that can be considered across different policy categories and policy contexts.

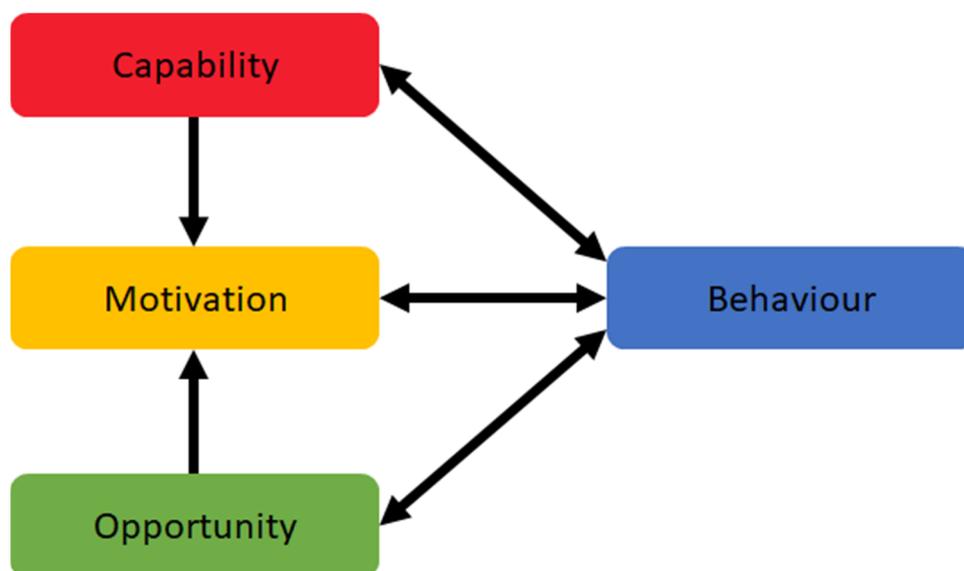


Figure 1. The COM-B Model (adapted from [51]).

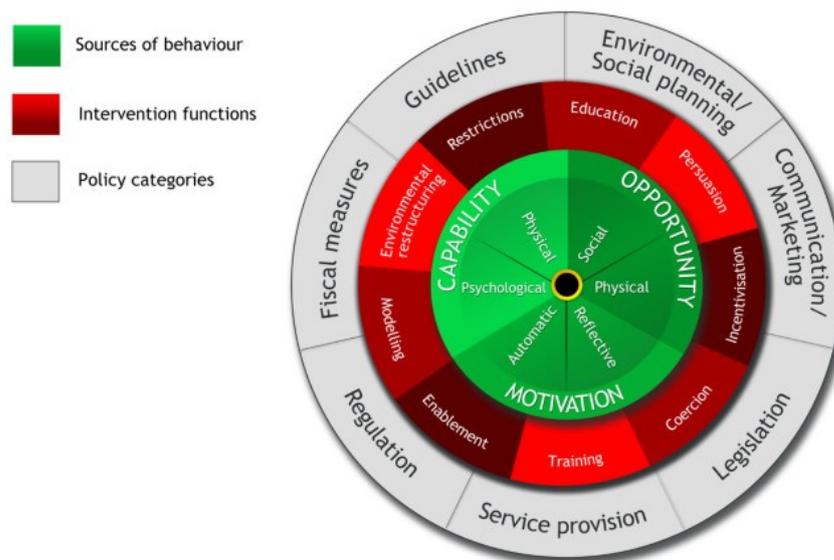


Figure 2. The Behaviour Change Wheel [53].

2. Materials and Methods

The research applied the COM-B model [51] to analyze farmer behaviour in the context of managing tree pests and diseases to answer the following questions:

1. What are the factors driving farmer action or inaction for tree health and management?
2. What interventions are likely to support the behaviours and actions policy is seeking from farmers to manage tree pests and diseases?
3. What are the implications for other tree- and woodland-related policies on agricultural holdings?

2.1. Study Population

The research was undertaken as part of a policy co-design project working towards the design of a Tree Health Pilot scheme testing policy mechanisms that will ultimately offer land managers incentives, advice, guidance and other support to facilitate specific behaviours around tree health [53–55]. The focus of the Tree Health Pilot is to support land managers as individuals or as groups to manage tree health through the treatment and

felling of diseased trees affected by specific priority pathogens and pests, and restocking areas where trees have been lost using planting stock accredited as ‘biosecure’. The co-design process involved land managers in the design of policy options designed to achieve these behaviours. The co-design process began in 2018 and stretched over three years, with the launch of the Tree Health Pilot in autumn 2021, which will end in the design of a full scheme in 2024. Each year of the co-design process was characterized by different steps in the design journey, starting with a period of discovery, then definition of the design brief, through to design of potential policy options. The nature of the discussions and evidence and information collection during each of these steps varied, moving from broad and exploratory to more focused and detailed around specific behaviours and policy option design (see Figure 3).

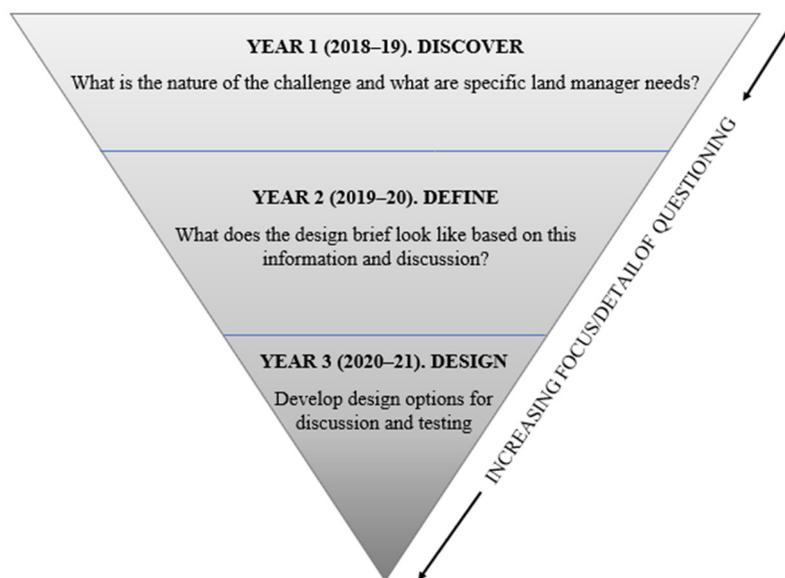


Figure 3. Different stages in evidence collection during the Tree Health Pilot policy co-design process.

As well as researchers and government policy makers, the co-design process engaged with a broad diversity of landowners and managers with responsibility for dealing with tree pests and diseases in woods, forests and trees outside woodland. This included, amongst others, owners of small woodlands, managers of mixed estates, commercial foresters and managers focused on conservation and amenity objectives. Invitations to take part in the co-design process and specific events were extended through ‘gatekeeper organizations’, i.e., those with connections to, or memberships drawn from, the different land manager types. The owners and managers engaged in the co-design were self-selecting depending on their willingness and ability to take part in an extended period of collaborative engagement. This is usual with co-design processes. However, farmers proved particularly hard to engage with; numbers were low in comparison to the other groups, despite working with gatekeeper organizations and organizing co-design events aimed specifically for them. Consideration of the different contexts in which farmers work was included by working across NUTS regions North West (Cumbria; Merseyside), South West (Gloucestershire, Wiltshire and Bristol/Bath; Dorset and Somerset) and South East (Kent; Surrey; East and West Sussex), which helped to account for various tree pest and disease distributions and different ecological, market and socio-economic conditions affecting agricultural businesses in different parts of the country. A series of face-to-face farmer events planned for March 2020 did not take place because of the interruptions brought about by COVID 19 restrictions, which impacted on the overall sample size achieved.

2.2. Data Collection and Analysis

Data collection with farmers was undertaken in two ways: through farmer focused deliberative workshops and through semi-structured interviews as shown in Table 1. In Year 1, the scope was broad and focused on establishing farmers' current understandings of tree health, any actions they already took to manage tree health issues and how they might be supported to act for tree health in future. In subsequent years, questions elaborated more detail about why specific behaviours around tree management occurred and the detail of policy options that might support the action desired by policy makers. The two half-day deliberative workshops were undertaken in face-to-face and online settings. Workshops included presentations and interaction with a forest health officer with knowledge of tree pests and diseases in their region. This knowledge exchange activity was seen as a way of attracting farmers to the events. The semi-structured interviews (SSIs) in years one and two were conducted by telephone and lasted between 40 and 90 min; question guides covered the same question sets as the workshops. Workshop discussions and SSIs were digitally recorded and sent for professional transcription.

Table 1. Data sources and sample sizes.

Stages	Date	English NUTS Region Covered	Data Collection Engagement	Method Used	No.
Year 1 (2018–19)	March 2019	North West	Deliberative workshop	Face to face venue Discussion guide	8
	March 2019	South West and South East	Semi-structured interviews	Telephone	7
Year 2 (2019–20)	March 2020	South West, South East and North West	Semi-structured interviews	Telephone	8
Year 3 (2020–21)	January 2021	South West, South East and North West	Deliberative workshop	On-line platform Discussion guide	21
TOTAL					44

Some data about the farmers who took part in the workshops and interviews were also collected using a questionnaire. This provided case data and insight into participants' farming systems, what kinds of trees and woodlands they had, and whether they had any experience of engaging with the forestry and woodland sector, including the uptake of incentives.

The qualitative workshop and interview data were analyzed using Nvivo software. The analytical approach was descriptive thematic analysis [56,57], which is an appropriate method to understand a set of experiences, thoughts or behaviours across a data set [58]. A two-step coding process was applied. Firstly, a deductive or directed coding of content was undertaken using a predetermined coding framework. The COM-B model provided the main themes, and the more detailed factors associated with farmers' capability, opportunity and motivation to manage tree health were articulated based on previous work applying the COM-B model [30] to create specific sub-themes. All themes and sub themes are detailed in the results section in Table 2.

The second step in the coding process was to review the sub-themes and ensure coding was robust and no additional sub-themes should be added. Researchers then reviewed the coded dataset to collaboratively assess the importance or strength of sub-themes, identify relationships between sub-themes (thematic mapping and matrix coding) and identify notable exceptions or contradictions to the general patterns by specific cases. Assessing the prevalence or strength of sub-themes and notable exceptions and contradictions in this kind of analysis is not fixed on frequency across or within a dataset; rather, it is understood by identifying the way in which a sample population 'normalizes' their experiences and attitudes [56,59].

Table 2. Summary of key factors influencing farmer behaviours for tree health, organized by COM-B theme and coded sub-theme, assessed by importance of sub-theme.

COM-B Theme	Coded Sub-Theme	Assessed Importance of Sub-Theme
Capability (economic, psychological and physical factors affecting the ability to act)	Previous experience of tree management and tree health actions	Medium
	Utilizing and interpreting forestry and tree health information and building knowledge	High
	Farmer skills in applying experience and knowledge of tree health	High
Opportunity (external physical and social factors that enable individual action)	Access to trusted advice and guidance about tree health issues	High
	Economic losses and benefits associated with tree health issues	Medium
	Availability of labour able to deliver tree health actions	Low
	Pressure from family, peers and the public to deal with tree health issues	Low
	Networks and how membership can facilitate action for tree health	High
Motivation (internal factors that stimulate or drive action)	Social norms and how peer identities and views impact individual motivation	High
	Agency: sense of losing or gaining control motivating action for tree health	Medium
	Personal interest	Low
	Perceived benefits/disbenefits of managing for tree health	Medium
	Self-efficacy, i.e., belief in capability that the choices being made will be successful	High
Behaviours (resulting actions/behaviours)	Self-identity, i.e., how tree health fits in with how individual farmers see themselves	High
	Actions for tree health that were being carried out	Low
	Not carrying out tree health actions	High
	Managing trees for particular benefits	Low
	Resilience of trees, woods and farming systems related to trees	Medium

3. Results

Table 2 provides a summary of the key factors in the COM-B model that were shown to be influencing farmer behaviours and those assessed as the most important or influential as identified by the researchers in coding step 2.

3.1. Capability

Farmers' perceptions of their capability were closely linked to their motivation and degree of confidence to manage tree health issues. Their sense of self-efficacy, the perceived benefits and disbenefits of acting for tree health, and their self-identity all influence their motivation and link back to their perceptions of tree management and tree health knowledge (whether tacit, practical or scientific/technical) and skills (ability to perform an action, including experiential application of knowledge) that they believe they have.

3.1.1. Previous Experience of Managing Trees and Tree Health Issues

Farmers involved in the research generally claimed to have little experience of tree management and management of tree health issues. They asserted that for most farmers, including themselves, these issues were a low priority, with the day-to-day issues of agricultural production taking priority. However, the data showed that most farmers in the sample could describe links with trees and woodlands on their land holdings and the

wider landscape, including emotional connection, enjoyment and attachment to particular trees. Those farmers who described previous experience of managing trees, including tree health and uptake of incentives, had been supported by land agents and similar advisors that they perceived to have ‘expert knowledge’.

3.1.2. Using and Interpreting Forestry and Tree Health Knowledge

It was clear that a degree of awareness about tree health issues does exist amongst farmers, since between them, those involved in the research could list a whole range of historic and contemporary disease outbreaks affecting trees and woodlands, including: Dutch elm disease (*Ophiostoma novo-ulmi* and *Ophiostoma ulmi*), ash dieback (*Hymenoscyphus fraxineus*), acute oak decline, Ramorum disease of larch (*Phytophthora ramorum*), needle blight (*Dothistroma septosporum*), honey fungus (*Armillaria mellea*) and oak processionary moth (*Thaumetopoea processionea*). They could also describe how they recognized trees were failing to thrive. The information that built this awareness was sourced through a range of organizations, with links to advisors and to peer networks being important to the communication and sharing of that information, as well as experiential learning. They also emphasized how developing this kind of knowledge continues to be a low priority, because the sense of value attributed to trees, particularly financial value and profitability, can mitigate against the motivation to utilize forestry and tree health knowledge.

3.1.3. Farmer Skills Applying Knowledge and Experience for Tree Health

Despite the demonstration of a certain level of technical knowledge, farmers persisted in claiming they did not have any knowledge or practical skills relating to trees and tree pests and diseases. They consistently described their skillset as belonging to farming, not forestry. Their own practical and tacit knowledge—built through actions such as identifying a non-thriving tree, felling dead trees or laying hedgerows—was not interpreted as relevant knowledge or skills. This meant their sense of self-efficacy was not developed, with the farmers tending to perceive the necessary knowledge and skills for tree health management to lie with others they acknowledge as ‘expert’.

These findings did vary across farmer types in the sample. Compared with tenant farmers and small holders, farmers with trees within farming systems, e.g., agroforestry, and estate managers were more networked and more confident about their tree health awareness and ability to apply it.

3.2. Opportunity

The data showed that external factors that might facilitate farmers’ actions for trees and tree health were very closely linked with the factors underlying their motivation to act. The importance of social and peer networks to accessing trusted advice, exchanging information and developing skills and confidence emerged as critical to creating opportunities to act for tree health. Belonging to these networks could create a bridge to issues of self-identity and reinforce perceptions of self-efficacy.

3.2.1. Access to Trusted Advice and Guidance about Tree Health Issues

Farmers were aware that information about tree health is available from many sources and they also appreciated the need for clear guidance on the management of pests and disease that was aimed at their agricultural context. Trust in the individuals or organizations providing the information was critical. Whilst specialist expertise was recognized as essential, farmers mentioned having greater trust in organizations that had an agricultural remit and membership or were well known environmental non-government organizations (eNGOs), compared to private contractors and public and government agencies. Whether or not the motivations and advice being given by private contractors and government was impartial was questioned. Accessing advice and guidance through established farmer-focused channels, e.g., National Farmers’ Union of England and Wales (NFU) newsletters, rather than through forestry and woodland organizations serving a largely different com-

munity, brings issues to the attention of the farming audience. However, needing guidance as to the importance of the information about tree health, i.e., why a particular farmer should be interested in it, or prioritize it, was still questioned, as this participant said:

I suspect the vast majority of members, farming members would, if there was an article about tree diseases would breeze over it. It's not high on people's radar. (Farming estate manager with woodland, South East region, 2020)

Farmers felt that aspects of the information they wanted to access might be achieved through material resources (e.g., websites, booklets, media articles). However, there was a consistent and strong discussion about the need for much more active guidance and advice that was relational (i.e., delivered through face-to-face, human interaction) and specific to their particular context (i.e., focused on their land holding, and their socio-economic and material landscape). The importance of existing systems of agricultural advisor–advisee relationships was highlighted, where shared understanding of a farmer's circumstances could lead to joint learning and development of new behaviours and actions.

3.2.2. Economic Losses and Benefits Associated with Tree Health Issues

Farmers frequently made the point that farm woodlands and trees in general are rarely a profitable enterprise and that this contributes to them being a low priority in comparison to other on-farm production and activity. Fear of making a loss, whether direct financial costs or through farmers' time, is a disincentive to tree health management and applying for grants to support it. The situation for tenant farmers was described as being even more disadvantageous, since the landowner rather than the tenant would be the one to benefit from expenditure on tree health management. Although farmers do recognize the public goods provided by trees (wildlife and biodiversity, landscape aesthetics, animal shelter and wind breaks were all frequently mentioned), the disbenefits of acting for tree health are a significant motivational barrier overall.

... the only thing I would say is when you're actually sending out information or you know trying to, it would be good to actually show the overall cost. You know what you believe is the overall profits that can be made from woodlands if they're managed correctly. ... because at the end of the day as I say it all comes down to the bottom line. (Farmer with woodland, South East region, 2020)

There is a common theme through the data that farmers feel they should be financially recompensed for managing tree disease and that financial incentives would increase the visibility of tree health as an issue and raise it as a priority. Financial incentives could also contribute to farmers having a sense of agency through providing decision-making options. But in contrast, regardless of financial support, the economics of farm businesses mean that for some farmers the loss of trees from the landscape can also be viewed as an economic benefit. As one person put it:

Certainly, in the intensively farmed landscape just slinging money at a problem with trees, I think you'll find that a lot of farm managers would say, well, you know, if those trees disappear then I've got a few more acres to play with. (Farming estate manager with woodland, South East region, 2020)

3.2.3. Availability of Labour Able to Deliver Tree Health Actions

Most respondents indicated that they do not have on-farm labour capacity to carry out the management of trees for pests and diseases, so this was a barrier to action. The importance of networks was key here too. Those farmers already engaged in woodland management and woodland creation could draw on contacts already made to undertake some of the work that might need doing (practical or advisory), whilst other farmers struggled for lack of such networks.

3.2.4. Pressure from Family, Peers and the Public to Deal with Tree Health Issues

What came through in the data was that for some farmers, the pressure to leave their land, trees and woodland in good condition as a legacy for the next generation arose from the perceived expectations of peers and the public. In some cases, pressures came from a desire to ensure that the 'next generation' of family successors and future inheritors of the 'public good' inherited land and trees in good condition. However, succession was also viewed as a disincentive to manage for tree pests and diseases if this relied on grants that tied the next generation to on-going obligations (e.g., maintaining tree cover for the duration of a grant term).

3.2.5. Networks and How Membership Can Facilitate Action for Tree Health

The importance of networks in the provision of trusted advice and building knowledge has already been noted above. Networks were also seen as important to delivering action, whether that might be around finding contractors to undertake tree health work, provide training or practical demonstrations or provide support to apply for tree health incentives. Lots of effective groups were mentioned, including Farmer Facilitation groups and networks, topic specific networks, e.g., Agroforestry Forum, Farm Woodland Forum, and events and networking opportunities provided by specific organizations such as Linking Environment and Farming (LEAF), Country Land and Business Association (CLA) and Royal Forestry Society (RFS). It was the local level nature of the network that farmers said was important for making connections with those able to facilitate action on the ground. The data revealed the importance of a few key individuals able to make connections between farmers and other stakeholders to provide access into supportive networks of practice:

... we've got a National Park woodland officer who's very helpful, and the system works quite well that you can ring him up, ask him questions, and he'll come out, and he's known by everyone and trusted, can find who you need, and I think that last thing of being trusted is what's so important. He's not some remote person that changes every year. He's been here for 20 years. (Workshop participant, 2021)

I'd just give [mentions name] a buzz and she'd be able to tell me the relevant person or get the relevant person to get in contact with me. (Soft and top fruit business with shelterbelts and woodland, North West, 2020)

3.2.6. Social Norms and How Group Identities and Views Impact Individual Motivation

It was notable that many of the participants felt they were an exception to the majority within the farming community because they knew something about trees, tree management or tree health. They described themselves as more willing than most farmers to broaden their attention and activity to include farm trees:

... but the difference is, unlike perhaps many farmers who see woodlands, many farmers see woodland as it's just there and to be ignored, I do try and give it some attention and some management. (Farmer with woodland, South East, 2020)

They describe how farmers at meetings and events are unlikely to want to talk about issues such as tree health which are outside of their normal concerns. This has an impact on the ability of farmers to build motivation and a sense of self-efficacy.

In addition, even though farmers could recognize that the trees and woodlands on their holdings and those of the wider community were unmanaged, they were collectively regarded as 'beyond the farm', and certainly not a (profitable) crop that requires intensive management. There was a sense of community fatalism that trees and woodlands can or might overcome health threats without human intervention, and that natural cycles would reach a new balance and that nature would prevail. This was also a set of norms reinforced by those farmers with a conservation and legacy ethic, who tended to believe that managing for tree pests and disease would somehow be detrimental to biodiversity and natural ecological processes. The following comments were typical:

I would probably think, well that woodland's been there for the last 300 years and I guess it's what happens and some trees die and some trees sort of survive and nature has a way of compensating. (Farmer with woodland, South East, 2020)

I think a lot of these things have almost got to run their course it's my belief that at some point in the future that whatever it was that used to prey on Agrilus (a beetle genus associated with pathogen transmission on oak), its population will increase again and therefore the whole thing will slightly get back into balance, maybe. (Farming estate manager with woodland, South East, 2020)

. . . we tolerate a certain level of disease ash dieback it's part of a bigger ecosystem and has a benefit to biodiversity despite causing some tree damage. (Farmer with woodland, North West, 2019)

These beliefs and norms within a group reinforce the perception that there is little need to act, and can negatively impact the motivation to manage tree pests and diseases.

3.3. Motivation

Motivation was influenced by opportunity as well as capability. Motivation operated at both an individual as well as a group level. It is important to note that personal interest in trees and environmental issues was not as strong a motivator for action as individual identities and group norms, a sense of agency and self-efficacy.

3.3.1. Agency: Sense of Losing or Gaining Control Motivating Action for Tree Health

There were individual and group aspects to the issue of agency. At an individual level, many farmers feared that engaging in tree health actions, including disease identification, would force them into spending money and time on a problem they did not want to prioritize, lock them into bureaucracy, or lead them to carry out management actions they did not want to engage with. Those managing farming estates had a different view, believing that managing tree pests and disease might restore their agency, i.e., their control, over the profitability of their woodland holdings.

Another concern was the need for community-level action on tree health. Lack of agency and efficacy working at landscape scale was related back to other examples of disease outbreaks that have impacted agricultural businesses. For example, experiences with government-mandated badger culling to control the spread of tuberculosis in cattle, which exposed divisions in the farming community around the required collaborative response.

3.3.2. Self-Efficacy

Self-efficacy is the belief in one's capability and that the choices being made will be successful. Self-efficacy has been explained throughout these results as being interlinked with farmers' perceptions of their capability and with peer norms and networks.

3.3.3. Self-Identity

Self-identity in this context is how tree health fits in with how an individual farmer sees themselves. Farmers do not see themselves as foresters or woodland managers. One participant described forestry and agriculture as being 'completely divorced'. Much of the narrative in the dataset reflects this and describes why farmers do not engage with trees. For example, trees are generally taken for granted and not 'seen'. As some participants stated:

. . . basically, as farmers we're out looking at our stock, or we're looking at our arable lands, whether the corn is growing, whether the sheep are laying. You don't actually, naturally, look up at the trees too much unless there's something pretty obvious. (Workshop participant, 2021)

. . . you know woodland is so much just in the background for me I guess, you know most of my energy and attention is towards our commercial crops. (Farmer with woodland, South East, 2020)

If you put a farmer and forester in the same field, they'll never make eye contact. The farmer looks down at the soil, the forester up at the branches. (Farmer with woodland, North West, 2019)

Other aspects of farming identity and how this translated into tree management were also displayed by participants. For example, 'tidying' up dead or dying trees that the public and others find 'unsightly' was not regarded as relevant to the management of tree health. However, it was undertaken as part of landscape management associated with what it is to be a successful farmer (i.e., tidiness) and what farmers believe others expect from a farm. Other farmers in the sample with a stronger agro-ecological and conservation ethic, and some of those thinking about legacy, were able to describe how their identities as custodians of the land meant that care of woodlands was slowly becoming part of what they do and part of their identities.

I think to be fair farmers will carry on what they've always done, and you know if a tree looks sick, we'll cut it down and burn it or whatever. But they won't necessarily tell anybody about it or think anything of it. (Farmer with woodland, South East region, 2020)

3.4. Behaviours

Different farmers vary in their response to tree health issues depending on their motivations, conditioned by their understanding of the issues and the level of concern this prompts. Many participants brought attention to the fact that planting trees or creating woodland to keep trees in the landscape was a more pressing issue than managing tree health:

I'm thinking well actually for us the biggest issue is getting trees planted not, not looking at the odd one that's dying. (Farming tenant with woodland, North West region, 2020)

... that's probably why I wanted to speak to you more than anything else, it's not a question of pest and diseases, it's actually getting the blooming trees there in the first place. (Farming tenant with woodland, North West region, 2020)

This was connected with the issue of longer-term resilience to change including: the economic and policy context brought about by the UK's exit from the EU and the different land use choices that might be made; climate change impacts on local ecological land management processes; and making links with the wider pest problems impacting land holdings. Many farmers questioned whether managing tree health would actually improve the resilience of trees and woodland in these kinds of contexts. They questioned how far the economic resilience, profitability and suitability to future ecological conditions of trees and woodlands depended on tree health management. They felt other issues to be more pressing, for example, species selection for planting, the management of pests such as deer and squirrels, and the contribution of trees to overall farm health.

4. Discussion

4.1. Important Drivers of Behaviour and Action

How these results map onto the COM-B model is shown in Figure 4 below. The diagram helps to reveal the importance of particular factors and the strength of the relationships and linkages between them.

The diagram shows that even though individual capability is important to farmer decision making, in the case of tree and tree health management, the importance of opportunity as it influences motivation is emphasized. Farmers' membership of networks is shown to have a significant impact on all factors that make up their motivation to act for tree health, with their access to trusted advice reinforcing this. Self-identity and self-efficacy are factors which emerge as particularly influential within motivation, as they are both strongly linked to capability and, we believe, are likely to impact the way in which opportunity is viewed. Self-identity relates to individual identity as well as community identity in this context and

is influenced by the social norms associated with the opportunity. Farmers generally saw trees as something other than a crop, natural world elements that could be left relatively untended, but also whose healthy cultivation would require forestry expertise, with their farming identities perceived as something different to that of a forester. The language that farmers used suggests that they do not ‘see’ trees, that they are “off the radar”, “in the background”, that they cannot be brought into sight because attention and gaze is drawn to the everyday behaviours required for agricultural production. Trees were seen when there were reasons to do so, i.e., when there was commercial benefit. Tree health was not a significant reason to do so, even though the actions policy makers are looking for are largely about the pre-emptive and pro-active treatment and felling of diseased trees, i.e., being a steward as well as keeping things tidy and well-kept, normally actions recognized as integral to farming identity [39–41].

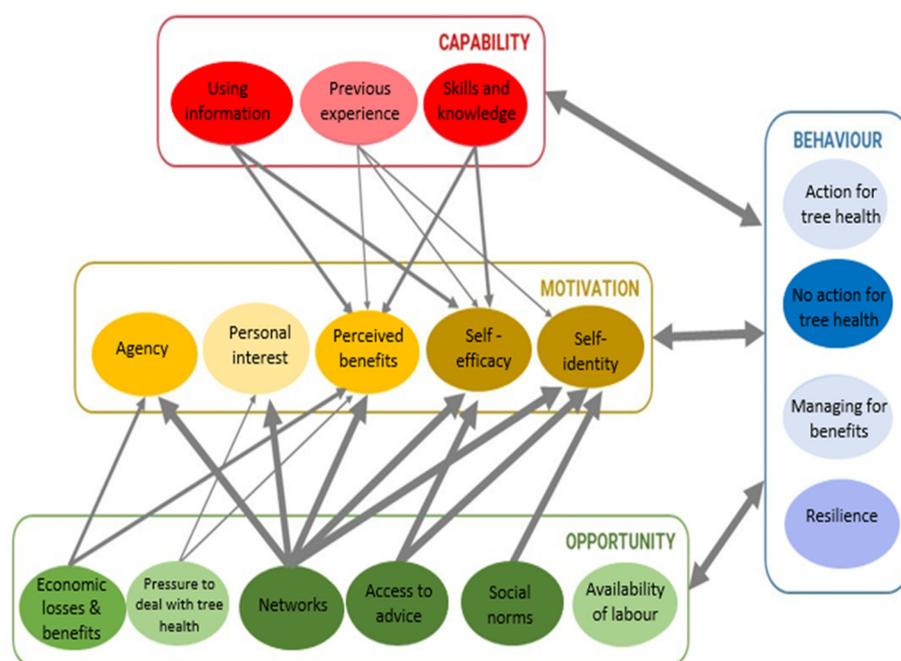


Figure 4. The strength of relationships between factors influencing farmer behaviours for tree health organized by COM-B theme and coded sub-theme. Intensity of color in circles represents the importance of sub-themes/factors. The width of linking arrows relate to the importance/strength of factors and relationships.

What could make a difference in this context was the interaction of self-identity and self-efficacy as it related to the capability to interpret and operationalize forestry and tree health knowledge and skills, and the confident use of the opportunity of networks to help do so. Where existing tree health awareness and skills in accessing trusted tree health expertise was higher or associated with greater self-confidence to act, there was some evidence of different farming identities emerging from the data. These were farmers whose existing behaviours included:

- Generating the majority of income from agricultural production;
- Managing on-farm plantations in relation to a historic grant incentive;
- Managing estates where income comes from a mix of activities including agriculture and forestry;
- Integrating trees on farm through systems including agroforestry;
- An agroecological and conservation focus to their land custodianship.

Farmer characterizations of this sort are relatively common, although examples as they relate to trees or tree health are very few. A study in England [60] characterized farmers by their attitude to tree planting and likely uptake of incentives for woodland creation; it

established five different identities, including 'Farmer First' and 'Casual Farmers', where lack of knowledge and advice about trees, as well as beliefs that farming is about producing food, were key psycho-social barriers to woodland creation. Research in Scotland [25] divided farmers into three groups likely to plant woodland or not and related differences to education, environmental interest and farm diversification. Another study in Australia [61] found three groups of values driving perceptions and behaviours relating to agroforestry: trees as an economic proposition, trees as uneconomic and trees as essential regardless of economics. This suggests a need for further research that identifies different farmer types in terms of their attitudes to trees and woodlands beyond woodland creation, including tree health and how existing behaviours impact capability, opportunity and motivation.

4.2. Policy Interventions Likely to Support Farmers to Take Actions for Managing Tree Pests and Disease

4.2.1. Policy Categories

Applying the Behaviour Change Wheel suggests three policy categories that are likely to be important in supporting and enhancing farmers' actions for tree health. Firstly, recognizing the farming focus of farmers and the range of attitudes towards trees on farmland (from conservation-focused to apathy) calls for appropriate 'communication/marketing' approaches that are tailored to farmers' social norms and identities. Therefore, communications about grant schemes to support action for tree health need to emphasize the benefits to farmers and reflect their motivations and interest. For instance, this might involve making it clear how action for tree health aligns with wider Environmental Land Management (ELM) schemes that farmers are likely to engage with, such as the Sustainable Farming Initiative and the Local Nature and Landscape Recovery Schemes. Secondly, appropriate communication also extends to the provision of 'guidelines' that are generated to provide information to farmers on how to manage for tree pests and disease. This might include specific consideration of how to deal with trees in the farmed landscape, including farm woodland, hedgerow trees and infield trees. Thirdly, regulation for tree health management can establish rules or principles of behaviour or practice, but again needs to be sensitive to the particular context (physical and psychological) within which farmers operate.

4.2.2. Intervention Functions

Based on our research, there are specific intervention functions that are likely to be appropriate for supporting and encouraging farmers to act for tree health: education, training, persuasion, incentivization, restriction, environmental restructuring, and modelling and enablement.

Education and training should reflect farmers' identity as 'farmers not foresters' and are closely linked to the provision of advice and capacity building. According to the COM-B model, training inputs to both physical and psychological capability, whereas education inputs largely to psychological capability, but also reflective motivation. As our research suggests, farmers already have a lot of existing skills and knowledge relevant to tree management, but they do not necessarily recognize this or have the confidence to act. For instance, farmers are familiar with dealing with pests and disease in relation to crops, so advice might support farmers to transfer that knowledge into the context of tree management. Further training could be provided, where appropriate, to furnish farmers with the skills to better manage for pests and disease, such as innovative silviculture practice or identifying resistant or tolerant tree species for afforestation or restocking. This may involve practical skills such as how to identify a pest or disease or what action to take, or it might be giving farmers the confidence to know where to look for appropriate sources of information or expertise (either online or identifying specialists, such as forestry contractors or arboriculturists). Importantly, education on tree (health) management should be integrated into agricultural training programmes (for new entrants), recognizing that farming is not just about growing crops or raising livestock, but that it is also about wider land/environmental management and stewardship.

However, alongside providing appropriate education and training, the important private and public benefits of managing for tree health needs to be clear to farmers. Intervention functions such as persuasion and environmental restructuring can help to slowly shift social norms, such that tree management becomes integrated into wider farm management. Persuasion as an intervention function can impact on both automatic (impulsive or emotional responses) and reflective (planned or conscious behaviours) motivation, whereas environmental restructuring influences automatic motivation and both physical and social opportunity. This relates to effective communication (see above), demonstrating how action for tree health can provide benefits to the farmer and farm business. Modelling behaviours such as providing examples of other farmers engaging in tree health management contributes to automatic motivation and can help to shift behaviours through positive peer to peer learning. There is already an existing model of demonstration farms and peer networks that support farmers' food production functions, but this could provide a useful vehicle to incorporate examples of tree (health) management and demonstrate the benefits of integrating trees into wider farm management activities within the wider context of the farming business.

Although funding for tree health management did not appear to be the primary factor for motivating action for tree health in our study, farmers did indicate that they are unlikely to engage in proactive management for tree health if they would incur costs. To support this, incentivization through grants could help; however, this would need to reflect the specific issues of managing trees on farmland (e.g., potential access issues to remote woodland, managing trees alongside rights of way).

The intervention functions recommended above are predominantly nudge or carrot approaches to influencing behaviour change. However, stick approaches such as regulation may also be needed alongside these softer tools, and input to both physical and social opportunity. Some pests and diseases are already regulated for, and land managers may be required to act through Statutory Plant Health Notices (SPHNs). These orders require land managers to fell or treat infected or infested trees to contain or eradicate a pest. Generally, action as a result of a SPHN is at the land manager's expense. Potentially, this can lead to perverse outcomes such as pre-emptive felling of healthy trees or a reluctance to plant new trees (an important objective of the UK government's net zero strategy) in order to avoid costly tree health management in the future. Combining regulatory tools with grant incentives can help to avoid such unintended consequences by providing grants to assist tree health action to land managers issued with a SPHN.

The intervention function enablement is concerned with increasing the means to or reducing the barriers to capability and opportunity. It links to the other functions, recognizing that one function is unlikely to be sufficient to affect the desired behaviour change. For instance, the provision of appropriate advice, education, training and communication can increase capability, while persuasion, modelling and incentivization both improve the opportunity and remove barriers to act.

5. Conclusions

We have shown the utility of the COM_B model and Behaviour Change Wheel together as research tools for making explicit areas in which policy makers could focus their design efforts. As we applied it, the model clarified and simplified relationships between different aspects of the broad areas and factors that are commonly included in behaviour change science. We note that although the COM-B model suggests that capability and opportunity influence motivation, our research suggests that motivation can influence how opportunity is perceived. The simplification we were able to achieve using the model might be considered a limitation in so far as the relationships between factors may be positive or negative and may flow two ways rather than unidirectionally as we have illustrated them.

The Behaviour Change Wheel presented intervention functions open to policy makers, but which options might address the issue of farmer identity that appears to be a significant factor in influencing farmers decision making around tree health is more difficult to discern.

The behaviours policy makers are looking to encourage and facilitate, appear, on the surface at least, to reflect behaviours that already make up what it means to be a ‘good farmer’. Therefore, the interlinking issue of self-efficacy supported by the right kind of advice and guidance, framed and communicated in farmers’ terms, seems critical in shifting perceptions of how managing trees can fit into farming culture, overcome resistance to change and build on some of the action that is already taking place.

One of the objectives we set for this research was to understand the wider implications for other tree- and woodland-related policies on agricultural holdings. We conclude that utilizing knowledge of farmer decision making for tree management and tree health requires collaboration between farmers, extension services, social scientists and policy-makers that crosses boundaries [44]. In this case, significantly, that means crossing the traditional boundaries of science, practice and policy between the worlds of farming and forestry, important since tree health in particular is an issue that exists ‘outside the forest’ and across farming landscapes. Our research draws similar conclusions to others suggesting that this link could effectively be built through the provision of knowledge, advice and guidance [62] mediated by trusted knowledge brokers and intermediaries [63], which is framed, communicated and marketed in a way that overcomes identity and cultural barriers associated with different farmer types and attitudinal groups [42]. From a policy perspective, further development of ways to differentiate between farmers according to their relationship to trees and tree management will also help to focus policy design and messaging [46]. Change is likely to be fostered by crossing the farming–forestry divide by mixing these psycho-social approaches to policy design that supplement the provision of financial support suited to the business models of different kinds of farmers [64–66].

The major challenges facing farming in the UK and beyond are complex, including economic and legislative shocks such as the UK’s exit from the EU, as well as policy drives towards greater integration of trees in farming landscapes as part of the change required for net zero transition. Understanding the behavioural factors underlying farmers’ environmentally sustainable practices will continue to be a priority area for research, practice and policy.

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