SUPPORTING INFORMATION – DIRECTED ACYCLIC GRAPH WITH JUSTIFICATIONS

This supporting information provides justification for the hypothesized causal pathways described in the Directed Acyclic Graph (DAG) introduced in our study's methods (Section 2.4.1). Our DAG outlines the links between our outcome of interest (adoption of mixed native woodland creation interventions) and its predictors (Diffusion of Innovations Theory (DOIT) framework attributes and the variables within them), as well as causal links between predictors themselves (Figure 1).

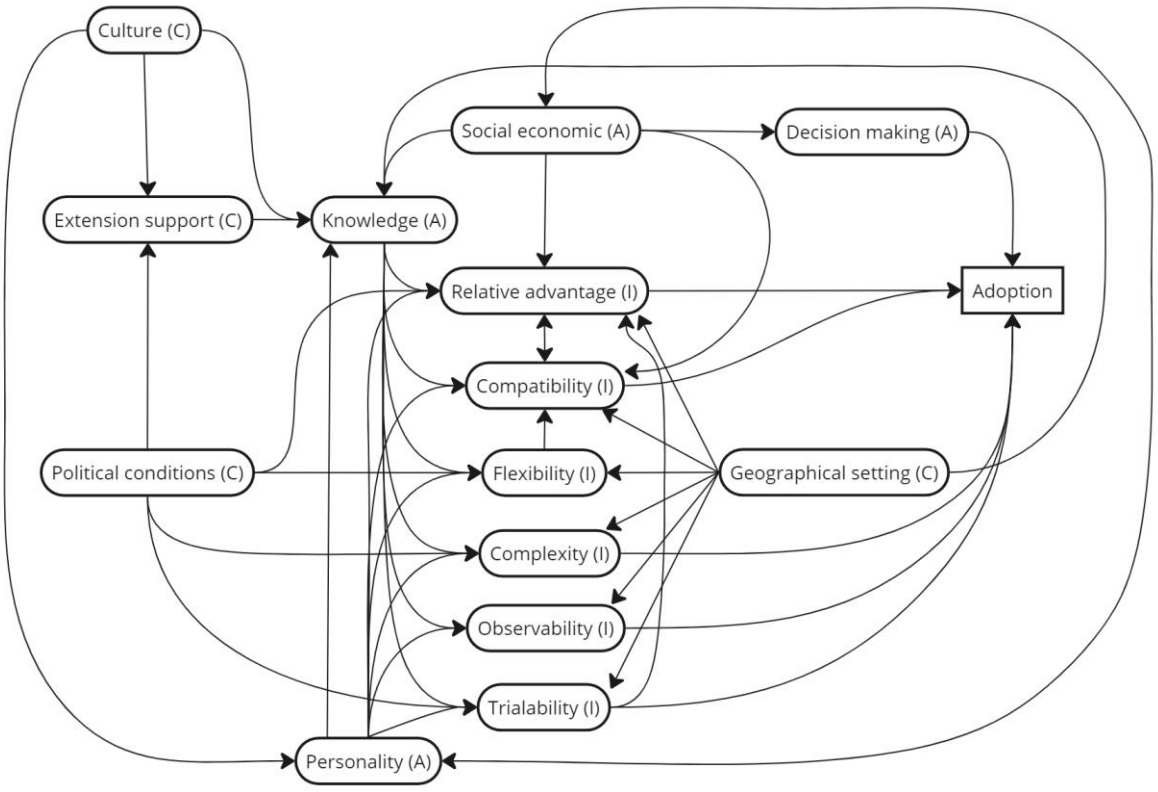

FIGURE 1

Directed Acyclic Graph (DAG) displaying the hypothesized causal connections underpinning our model. Arrows signal the direction of causal effect. I, A or C in brackets indicate innovation, adopter and context attributes respectively. Attributes assumed irrelevant for the UK woodland creation context were not included in our DAG.

The causal links between DOIT attributes in our DAG are defined based on the Innovation-Decision Process, which describes an individual's (or another unit of adoption) journey

from first learning about an innovation, to its eventual adoption or rejection. According to DOIT, this process is divided into five stages: Knowledge, Persuasion, Decision, Implementation, and Confirmation (Rogers, 2003). The Knowledge stage encompasses the potential adopter's first awareness of the existence of the innovation, and its first understanding of its functioning. During the Persuasion stage the potential adopter builds a favourable or unfavourable attitude towards the innovation, mainly by gathering and evaluating more information about it. In the Decision stage the innovator acts on the information gathered and the attitudes built during the previous two stages adopting or rejecting the innovation. A Confirmation stage ensues where the adoption or rejection decision is questioned by the innovator, if sufficient justification is found the decision may be maintained, otherwise it may be reversed. For adopters, there is an intermediate stage between Decision and Confirmation, the Implementation stage. During this stage adopters use the innovation fully for the first time (some may have trialled it before), learning more about it and its use, and sometimes adapting it (re-invention). In some cases, the Implementation stage finishes when the innovation is fully incorporated into the adopter's established practices, losing its novelty in the process. In others it leads to the Confirmation stage (Rogers, 2003).

Our survey and consequently our DAG (Fig. 1) focuses on the first three stages of the innovation-decision process: Knowledge, Persuasion and Decision.

The potential adopter first learns about the innovation (Knowledge phase), either actively or passively. This can happen because of extension support efforts or because potential adopters are looking through information that matches their interests, needs and/or attitudes, and discover the innovation (Rogers, 2003). We capture the effect of extension

support on knowledge in our DAG through a causal link between these two attributes. The presence of extension support not only influences adopters' chances of gaining awareness of the innovation (knowledge stage), but also their access to more knowledge about the innovation afterwards (persuasion stage) (Rogers, 2003).

In our DAG, extension support is itself influenced by the culture and political conditions of the area. Culture has been shown to influence extension support provision by shaping preferences around the type of champions (Shane et al., 1995) and product launch strategies used (Dwyer et al., 2005; He & Lee, 2020). We also link culture directly to knowledge because cultural factors such as traditionalism or degree of socialisation (Wejnert, 2002) influence how open and/or exposed adopters within a particular culture are to new knowledge. Political conditions are linked to extension support in our DAG since forestry policy can undoubtedly affect the type, quality and/or amount of support and facilitation available to landholders. For instance, within Europe, predominantly neo-liberal countries, tend to have forestry advisory services with less state involvement and a higher diversity of consultants and agents from the private and NGO sector, whilst post-socialist countries have a higher state involvement in forestry advice (Lawrence et al., 2020).

Political conditions can also affect the relative advantage, flexibility, complexity and trialability of an innovation. For example, insufficient grants can modulate the economic benefits and costs of adoption, affecting the perceived relative advantage of potential adopters of woodland creation initiatives (Hemery et al., 2018, 2020; Pannell et al., 2006; Rogers, 2003; Wejnert, 2002). Bureaucracy is another barrier to woodland creation as it adds complexity to the adoption process (Hemery et al., 2018, 2020; Rogers, 2003).

Finally, political conditions could also affect the flexibility of an innovation or the degree to which it can be changed. In the case of UK woodland creation, the UK Forestry Standard sets the approach of the four UK governments to sustainable forest management, outlining a set of requirements, such as the maximum area that can be planted with a single species (Forest Research, 2023). Changes to the UK Forestry Standard or forestry laws and regulations, could therefore increase or reduce the amount of flexibility adopters have when implementing woodland creation projects.

Similarly to extension support, the socio-economic characteristics of the adopter influence its ability to first learn about an innovation (knowledge stage) and continue learning about it afterwards (persuasion stage) (Rogers, 2003).

Knowledge about an innovation increases as adopters progress through their journey towards a final decision to adopt or not (Innovation-Decision Process). This is particularly true when potential adopters start to actively gather and evaluate information about the innovation (persuasion stage). The result of this process are changes in the way innovation attributes are perceived by adopters (Rogers, 2003). We capture this in our DAG by linking knowledge to relative advantage, compatibility, complexity, observability, and trialability; the innovation attributes DOIT classes as most important during this stage; as well as flexibility, an innovation attribute proposed by some authors (Mahajan et al., 2021), and rooted in the concept of re-invention proposed by DOIT (Rogers, 2003).

The innovation attributes in turn influence themselves, we capture this through causal links in our DAG. We link relative advantage and compatibility through a two-way link since they influence each other and, in some cases, have even been shown to not be

empirically different (Rogers, 2003). Flexibility links with compatibility since it makes innovations more or less adaptable to potential adopters' circumstances affecting the innovations' compatibility with their practices, needs, values and believes. The main effect of flexibility is that the innovation can be re-invented more easily, generally leading to faster adoption rates and sustainability, which is the continued use of an innovation after diffusion ends (Rogers, 2003). For our study we considered two aspects linked to the trialability of an innovation: experimenting on a partial basis and reversibility. We only measured reversibility, since experimenting on a partial basis is hardly applicable to woodland creation, which requires a very long time until woodland is fully stablished and therefore cannot be tested on a short-term basis. As a result, in our DAG, trialability only connects to relative advantage, since reversibility is likely to modulate the relative advantage perceived by potential adopters particularly in terms of risks. For innovations that can be tested on a partial basis, trialability can act indirectly on all innovation characteristics through its influence on the adopters' knowledge, since they will be learning and updating their attitudes towards the innovation through their trials (Rogers, 2003).

All innovations attributes are influenced by the geographical setting of the potential adopter. This happens directly through the constraints put on adoption by the ecological conditions of a place, as well as through the adopters' proximity to the materials or providers needed to adopt. But also, indirectly through knowledge, which will be easier to access when potential adopters are closer to previous adopters or have easier access to communications and/or transport infrastructure (Wejnert, 2002). An example of this within a woodland creation context would be that of a landholding with low suitability for

woodland creation (i.e. very cold, windy and with very poor soils) and remote. A potential adopter managing this landholding and living in it, would be less likely to access knowledge about woodland creation, and to see the undertaking as an advantageous, compatible, flexible, observable, trialable, and easy to understand and do intervention.

The socioeconomic characteristics of an adopter also influence adoption decisions (Montes de Oca Munguia et al., 2021; Rogers, 2003; Wejnert, 2002). We incorporate this into our DAG through causal links that join socioeconomic attributes to knowledge, relative advantage, compatibility, personality and decision making. The links between knowledge and socioeconomic characteristics of adopters are patent in several of the generalizations of DOIT, such as: "*Early knowers have more education* (generalisation 5-1), *and higher social status* (generalisation 5-2), *than later knowers*". DOIT also suggests that, generally, earlier adopting units are bigger, wealthier and have higher status than later ones. This probably happens through effects on the perceived relative advantage and compatibility of an innovation, since potential adopters that are larger and wealthier are likely to have more money and time to invest trying new ideas, seeing them as more compatible and less risky. Finally, the socioeconomic characteristics of an adopter, mainly its size, also affect decision making. For example, larger organisations are more likely to follow collective or authority (small group of individuals with power, status or expertise decide) decision making processes, and to have more formal procedures for decision making in place (Rogers, 2003).

DOIT outlines an adopters' personality as a key variable associated to their innovativeness or *"the degree to which an individual (or another unit of adoption) is relatively earlier in adopting new ideas than other members of a system"* (Rogers, 2003). In other words,

personality traits modulate how fast or slow an adopter makes decisions regarding an innovation (i.e. moves through the Innovation-Decision Process). DOIT suggests personality filters the communications adopters pay attention to while learning about an innovation *(selective exposure)*, and moderates their likely impact on them (*selective perception*) (Rogers, 2003). We connect personality to knowledge in our DAG to capture this. This link accounts, for example, for the possible effect personality traits such as intelligence or curiosity have on knowledge (Rogers, 2003). Personality also connects to all innovation attributes in our DAG (Fig. 1), to account for the effect personality has on the process by which potential adopters evaluate an innovation by imagining its consequences. This process is fraught with uncertainty, particularly about the risk and benefits of adoption. Personality traits such as self-confidence, risk orientation, openness to change or ability to cope with uncertainty, modulate responses to uncertainty, consequently affecting the speed and outcome of final innovation adoption decisions (Rogers, 2003; Wejnert, 2002).

In our DAG, personality is influenced by the culture and socio-economic characteristics of the adopter. Culture modulates the personality of adopters within a national population or subgroups within that population (Wejnert, 2002). Herbig and Palumbo 1994, provide an example of this in their comparison of the adoption of industrial practices in an American and Japanese cultural context, showing innovations were adopted earlier by American actors due to their individualistic and risk-taking values, but spread faster amongst Japanese actors who value collectivism more than Americans (Herbig & Palumbo, 1994). The personality and socio-economic characteristics of adopters are linked by a two-way connection in our DAG. We do this to highlight that certain personality traits could

lead to changes in the socio-economic status of an adopter and vice versa. Research shows that socioeconomic status partially explains differences in individuals' personality traits (Luo et al., 2022), and that conversely, some personality traits can help individuals improve their socioeconomic status, generally compensating for background socioeconomic disadvantages only to a small extent, except for intelligence which can help an individual fully overcome background disadvantages (Damian et al., 2015).

REFERENCES

Damian, R. I., Su, R., Shanahan, M., Trautwein, U., & Roberts, B. W. (2015). Can personality traits and intelligence compensate for background disadvantage? Predicting status attainment in adulthood. *Journal of Personality and Social Psychology*, *109*(3), 473–489. https://doi.org/10.1037/pspp0000024

Dwyer, S., Mesak, H., & Hsu, M. (2005). An Exploratory Examination of the Influence of National Culture on Cross-National Product Diffusion. *Journal of International Marketing*, *13*(2), 1–27. https://doi.org/10.1509/jimk.13.2.1.64859

Forest Research. (2023). *The UK Forestry Standard The governments' approach to sustainable forest management*. www.nationalarchives.gov.uk/doc/open-government-licence/version/3

He, M., & Lee, J. (2020). Social culture and innovation diffusion: a theoretically founded agent-based model. *Journal of Evolutionary Economics*, *30*(4), 1109–1149. https://doi.org/10.1007/s00191-020-00665-9

Hemery, G., Petrokofsky, G., Ambrose-Oji, B., Edwards, D., O'Brien, L., Tansey, C., & Townsend, M. (2018). *Shaping the Future of Forestry: Report of the British Woodlands Survey 2017*. https://sylva.org.uk/downloads/BWS2017report.pdf

Hemery, G., Petrokofsky, G., Ambrose-Oji, B., Forster, J., Hemery, T., & O'Brien, L. (2020). *Awareness, action, and aspirations in the forestry sector in responding to environmental change: Report of the British Woodlands Survey 2020*. https://sylva.org.uk/downloads/BWS2020-report.pdf

Herbig, P. A., & Palumbo, F. (1994). The Effect of Culture on the Adoption Process: A Comparison of Japanese and American Behavior. In *TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE* (Vol. 46).

Lawrence, A., Deuffic, P., Hujala, T., Nichiforel, L., Feliciano, D., Jodlowski, K., Lind, T., Marchal, D., Talkkari, A., Teder, M., Vilkriste, L., & Wilhelmsson, E. (2020). Extension, advice and knowledge systems for private forestry: Understanding diversity and change across Europe. *Land Use Policy*, *94*. https://doi.org/10.1016/j.landusepol.2020.104522

Luo, J., Zhang, B., Antonoplis, S., & Mroczek, D. K. (2022). The effects of socioeconomic status on personality development in adulthood and aging. *Journal of Personality*. https://doi.org/10.1111/jopy.12801

Mahajan, S. L., Jagadish, A., Glew, L., Ahmadia, G., Becker, H., Fidler, R. Y., Jeha, L., Mills, M., Cox, C., DeMello, N., Harborne, A. R., Masuda, Y. J., McKinnon, M. C., Painter, M., Wilkie, D., & Mascia, M. B. (2021). A theory-based framework for understanding the establishment, persistence, and diffusion of community-based conservation. *Conservation Science and Practice*, *3*(1). https://doi.org/10.1111/csp2.299

Montes de Oca Munguia, O., Pannell, D. J., & Llewellyn, R. (2021). Understanding the adoption of innovations in agriculture: A review of selected conceptual models. In *Agronomy* (Vol. 11, Issue 1). MDPI AG. https://doi.org/10.3390/agronomy11010139

Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders.

Australian Journal of Experimental Agriculture, *46*(11), 1407. https://doi.org/10.1071/EA05037

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Shane, S., Venkataraman, S., & MacMillan, I. (1995). Cultural Differences in Innovation Championing Strategies. *Journal of Management*, *21*(5), 931–952. https://doi.org/10.1177/014920639502100507

Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. In *Annual Review of Sociology* (Vol. 28, pp. 297–326). https://doi.org/10.1146/annurev.soc.28.110601.141051