PRUDENT

WP1: GREEN NUDGES LANDSCAPE ANALYSIS

D1.1: Mapping of green nudges landscape

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List of abbreviations

EC – European Commission

GA – Grant Agreement

GDPR – General Data Protection Regulation

UC – Use Case

WP – Working Package

BWS – Best-worst scaling

RCT – Randomized Controlled Trial

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1. Executive summary

The PRUDENT project aims to facilitate the transition to sustainable agriculture and forestry through science-based behaviorally informed interventions, commonly known as green nudges. These interventions subtly guide decision-making processes to encourage environmentally friendly behaviors without restricting individual choice. By systematically mapping the current state of green nudging research and assessing its practical implications, this report provides a foundation for designing evidence-based interventions that enhance sustainability in agricultural and forestry systems.

The study consists of two primary components: a comprehensive literature review and a multi-country survey conducted in four Use Cases (UC): Belgium, Finland, Italy, and Lithuania. The literature review synthesizes findings from 43 studies, covering 80 different tests of nudges in agriculture and forestry, and classifies interventions based on their effectiveness and underlying behavioral mechanisms. It reveals that reminders and simplification strategies are the most consistently effective nudges, while others, such as social norm nudges and moral appeals, despite their extensive use, exhibit variable outcomes depending on contextual factors. The review also highlights significant gaps in the research landscape, including a lack of studies on forest management practices, some agricultural sustainable practices, such as carbon farming and husbandry and animal welfare plans , and an insufficient exploration of the interaction effects between different nudges. Additionally, few studies examine the role of behavioral factors—such as risk aversion, social conformity, and pro-environmental attitudes—in shaping nudge effectiveness, limiting the ability to tailor interventions to specific farmer profiles.

We identified a particularly pronounced gap in forestry and agro-forestry research, with only five relevant papers. These studies consistently avoided examining core forestry practices, concentrating instead on related or preparatory decisions. This pattern suggests that green nudges may have limited traction in contexts involving management decisions with long temporal spans. Understanding how to effectively integrate behavioral insights into policy interventions for such extended decision horizons remains an important avenue for future investigation.

The empirical component of the study includes a multi-country survey designed to assess farmers' and forest owners' perceptions of green nudges for the adoption of sustainable practices, their potential acceptability, and their perceived effectiveness. The survey applies a Best Worst Scaling (BWS) approach and uses a between subject design to differentiate between acceptability and perceived effectiveness. The survey targeted distinct farming contexts: mixed farms in Belgium, forest owners in Finland, winegrowers in Italy, and wheat farmers in Lithuania. For each UC, the baseline adoption of a relevant sustainable practice is assessed.

We find that the adoption of sustainable practices varies across countries and is influenced by distinct socio-demographic and behavioral factors. In Italy, larger farm size predicts interest in green multi-risk insurance, with economic concerns as a key barrier. Environmental concerns, risk-seeking attitudes and perceiving the intention to adopt green insurance as a social norm positively influence the intention to adopt the new risk management tool. This suggests that nudges *reframing risks*, *social norms nudges* or *moral appeals* would work better in this UC. These recommendations have, however, to be contrasted with results from the We BWS analysis indicating that *reminders, reframing losses and benefits,* and *making actions visible* are among the nudges that are perceived as the most effective. Conversely, *social norm nudges* are perceived as one of the least effective and the least acceptable.

In Belgium, prior engagement in sustainable practices predicts voluntary buffer strip adoption, with bureaucracy and economic concerns as barriers. Virtue signaling (desire to appear sustainable to consumers) positively influences adoption, implying that *visible sustainability labels* could enhance uptake. On the other hand, the BWS analysis indicates that *default nudges* and *reminders* are perceived as the most effective and acceptable in this sample.

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In Finland, older forest owners are more likely to implement continuous cover forestry, with the characteristics of the forest being a barrier. Environmental concerns and belief that others are adopting the practice drive uptake. This indicates that *moral appeals* and *social norm nudges* could encourage adoption. However, one should note that *social norm nudges* are perceived among the least effective and acceptable, while *default* and *reminders* are the most acceptable based on results from the BWS analysis. *Reframing losses* and *benefits and reminders are* perceived as the most effective strategies.

In Lithuania, longer farming experience predicts crop rotation adoption. The belief that crop rotation is the norm positively influences adoption, meaning that *social norm* campaigns may be effective. However, results from the BWS suggest that *social norm nudges* are perceived as one of the least effective and acceptable options by farmers. On the other hand, *reminders* are one of the nudge interventions that are perceived as the most acceptable and effective.

Overall, reminders emerged as the most consistently accepted and effective nudge across all countries, whereas social norm-based interventions were among the least preferred. However, country-specific variations highlight the importance of tailoring nudging strategies to local contexts.

The study also underscores the importance of integrating behavioral insights into agricultural policy frameworks. Given that behavioral factors play a crucial role in the adoption of sustainable practices, policies should complement traditional regulatory and financial incentives with well-designed nudging strategies. Nudges should be designed taking into consideration farmers and forest owners' acceptability and perceived effectiveness. Their design should be also informed by thorough analysis of the behavioral factors underlying the adoption of the practice and contributing to the nudge effectiveness. Future research should focus on identifying optimal combinations of nudges, understanding the long-term effects of interventions, and expanding the geographical scope of studies to include regions where green nudging research remains limited. Additionally, more attention should be given to how individual behavioral traits interact with different nudging strategies, as this would enable the design of more targeted and effective interventions.

In conclusion, this report provides a critical assessment of the current landscape of green nudging in agriculture and forestry. It highlights both the potential and the limitations of nudges as tools for promoting sustainability, emphasizing the need for context-specific, evidence-based approaches. By addressing the existing research gaps and incorporating behavioral science into policy design, green nudges can serve as valuable instruments for fostering the adoption of sustainable agricultural and forestry practices, ultimately contributing to broader environmental and climate goals.

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2. Introduction

The PRUDENT project aims to accelerate the transition to sustainable agriculture and forestry practices and smart farming technologies and help change the way agriculture and forestry systems currently operate. By identifying and evaluating the most effective green nudges, in the context of appropriate behavioral and experimental settings, it will enable behavioral change towards more sustainable agriculture and forestry. **Green nudges** are subtle interventions that encourage sustainable behaviors (UN, 2020). They are increasingly recognized as vital in promoting environmentally friendly practices in agriculture and forestry. By influencing decision-making processes, nudges can lead to the adoption of sustainable farming techniques and smart technologies, thereby enhancing productivity, while mitigating environmental impacts.

To achieve the overarching goal of shifting behaviors towards **sustainable agriculture and forestry practices**, as a first step the PRUDENT consortium performed a systematic mapping of the current state-of-play in green nudging, in the context of WP1 (T1.1). This systematic mapping includes: (a) A **literature review** of existing scientific papers identifying the different typologies of green nudges, the underlying behavioral mechanisms that affect farmer/forest onwer adoption of sustainable practices, as well as the green nudges' usage and effectiveness across different value chains; (b) A **multi-country BWS survey** (**four surveys-one per UC)**, to investigate farmers and foresters' baseline information on behavioral lock-ins and drivers for sustainable behavior and current sustainable agriculture and forestry practices used, involving a choice experiment aiming to elicit farmer/forester preferences for different nudging solutions in order to identify effective nudges; (c) A **segmentation analysis**, based on survey results, to identify clusters of farmers and forest owners[1] with homogenous characteristics with regard to behavior towards sustainable practices.

The following sections of the deliverable start with the literature review, discussing its conceptual framework, methodology, results and key outcomes. Then, a thorough analysis of the multi-country survey methodology and results, including outcomes from the segmentation analysis, provides details on the research conducted at local level in the four project UCs (Italy, Belgium, Finland and Lithuania). Finally, the conclusion of the deliverable provides a summary of the findings, and the next steps for further development.

3. Literature review

3.1. Introduction

Sustainable agricultural and forestry practices are essential for ensuring long-term food security, preserving ecosystems, mitigating climate change, and promoting economic resilience. These practices aim to address the challenges posed by intensive forestry and farming, which, while enhancing short-term yields and revenues, has resulted in significant environmental issues such as soil degradation, water resource depletion, and biodiversity loss (Pradhan & Meena, 2023). By adopting innovative and environmentally conscious techniques, sustainable agriculture and forestry seeks to improve productivity while minimizing negative ecological impacts (Garcia & Alamanos, 2022). Furthermore, these practices contribute to building more resilient farming and forestry systems that can adapt to climate variability and reduce overall environmental footprints (Dahlgreen & Parr, 2024).

The economic benefits of sustainable practices are equally compelling. By reducing dependency on expensive chemical inputs like fertilizers and pesticides, farmers can lower production costs while improving profitability (Pradhan & Meena, 2023). Techniques such as agroforestry and conservation tillage

[1] Throughout the document, within the forestry sector, we refer to private forest owners who own less than 25 ha (Aurenhammer, 2020), as opposed to general "foresters" who may also refer to governmental or private experts managing forests, employed by larger-scale owners or authorities.

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improve soil health and productivity over time, offering long-term financial gains (Garcia & Alamanos, 2022). Growing markets for sustainably produced goods also offer premium pricing opportunities, driving economic incentives for adopting green practices (Dahlgreen & Parr, 2024). Moreover, these practices reduce risks associated with climate variability, ensuring financial stability for agricultural communities (Giannarakis et al., 2022). However, premium prices for sustainably produced products are still controversially discussed (Grunert et al. 2014).

From an environmental perspective, sustainable practices have profound impacts on reducing resource depletion, minimizing pollution, and enhancing biodiversity, as well as preserving natural resources. Conservation tillage, cover cropping, and integrated pest management improve soil health, reduce erosion, and sequester carbon, mitigating climate change (Pradhan & Meena, 2023). Precision agriculture reduces water usage and minimizes fertilizer runoff, preventing the eutrophication of water bodies (Garcia & Alamanos, 2022). Agroforestry systems restore degraded lands, provide habitats for wildlife, and improve ecosystem services like pollination and nutrient cycling (Dahlgreen & Parr, 2024). By building ecosystem resilience and maintaining biodiversity, these practices ensure the stability of natural and agricultural systems for future generations (Giannarakis et al., 2022). The effect of sustainable practices on natural resources preservation is crucial. For example, applications such as crop rotation and cover cropping improve soil structure and fertility, reducing reliance on synthetic inputs and preventing soil degradation (Pradhan & Meena, 2023). Precision irrigation systems, such as drip and sprinkler technologies, address water scarcity by optimizing water usage (Garcia & Alamanos, 2022). Agroforestry not only stabilizes ecosystems but also provides renewable resources like timber and fuelwood without depleting forests (Dahlgreen & Parr, 2024). Integrated pest management reduces chemical pesticide use, protecting soil and water from contamination and ensuring the availability of resources for future generations (Giannarakis et al., 2022). Lastly, the role of sustainable practices in climate change mitigation is critical, by enabling greater carbon sequestration and reducing carbon dioxide emissions (Pradhan & Meena, 2023), or minimising input use, reducing greenhouse gas emissions (Garcia & Alamanos, 2022).

The adoption of sustainable agricultural and forestry practices is heavily influenced by policies that provide the necessary framework, incentives, and regulations (van Zanten et al .2014). The European Union's Common Agricultural Policy (CAP) is designed to be a cornerstone in driving sustainable agricultural practices (EC 2020). As part of its 2023-2027 objectives, CAP aims to reduce pesticide use by 50%, cut nutrient losses by at least 50%, and make 25% of EU agriculture organic by 2030. Alongside CAP, other EU policies, such as the Biodiversity Strategy and the Nature Restoration Law, emphasize restoring ecosystems and halting biodiversity loss, while the Circular Economy Action Plan (CEAP) promotes resource efficiency and waste reduction.

The EU Forest Strategy for 2030, part of the European Green Deal, sets out a vision for protecting, restoring, and sustainably managing Europe's forests. It emphasizes their role in climate mitigation and adaptation, biodiversity conservation, and rural livelihoods. The strategy calls for enhanced forest resilience, stricter protection of primary and old-growth forests, the adoption of close-to-nature forestry practices, and the planting of at least three billion additional trees by 2030.

To meet these goals, the strategy mobilizes EU policy tools such as eco-schemes under the Common Agricultural Policy, funding from programs like Horizon Europe and LIFE, and a proposed framework for EU-wide forest monitoring. It also promotes biodiversity- and climate-friendly forest management plans and encourages the use of carbon farming and payments for ecosystem services. By aligning with other Green Deal initiatives, the strategy reinforces the central role of forests in achieving the EU's environmental and climate targets.

National and regional policies also play a critical role, such as the Finnish Forest Act (2014), which balances forestry productivity with conservation, and the Flemish CAP measures, which include initiatives like ecosystem-based buffer strips and voluntary management agreements. These policies could collectively support environmentally responsible farming by providing financial and regulatory incentives for crop diversification, sustainable water management, and integrated pest management. Together, these

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frameworks help steer agriculture toward sustainability, balancing economic, environmental, and social priorities while aiding farmers in transitioning to practices that protect biodiversity, soil health, and water quality.

Interest in behaviorally informed policies has grown as a complement to standard approaches for promoting sustainable agriculture and forestry. Nudges are gaining traction for encouraging sustainable farming practices. While not a substitute for regulatory or market-based policies, they can enhance their acceptability and effectiveness. Their relevance has increased, especially considering recent protests against traditional regulatory measures (Dessart et al. 2019; Palm-Foster and Messer 2021) .

In this context, a green nudge refers to a non-coercive, behaviorally informed intervention that subtly guides farmers toward more environmentally sustainable choices—such as adopting agroecological practices, reducing chemical inputs, or participating in eco-schemes—without altering economic incentives or restricting freedom of choice. These nudges operate by adjusting the choice architecture, for instance by setting sustainable defaults, simplifying applications for green subsidies, or using social norm messaging. This approach builds directly on the concept of nudges introduced by Thaler and Sunstein (2008), which emphasize influencing behavior through changes in decision environments rather than mandates or financial incentives.

However, despite a growing body of research on nudges in agriculture and forestry over the past two decades, gaps remain in understanding their optimal implementation. The effectiveness and adoption of green nudges depend on several enabling mechanisms, including low cognitive burden, salience of the intervention, alignment with local norms, and trust in the source of the nudge. At the same time, their impact can be hindered by factors such as contextual mismatch, complexity, short-term economic costs, and perceived manipulation.

No study has systematically examined the relationship between nudge types, targeted sustainable practices, and the behavioral mechanisms driving their success. Furthermore, no comprehensive review has identified effective combinations of nudges and agricultural practices.

This section addresses these gaps through a systematic analysis of the literature on green nudges and their impact on adopting sustainable agricultural and forestry practices. We link nudges to underlying behavioral factors and the specific sustainable practices they aim to promote, identifying successful combinations while highlighting areas for further research.

Our approach follows several steps. First, we categorize, from a conceptual standpoint, agricultural nudges into eight types, adopting a broad definition that includes all non-monetary policies informed by behavioral science. These interventions modify the choice environment to encourage environmentally sustainable behaviors through heuristics (e.g., simplifying information), reminders, social norm nudges, choice architecture (e.g., default options, salience of choices), and non-monetary incentives (e.g., feedback, certification labels). We classify nudges into the following categories: default options, social norms, simplification and heuristics, reminders, risk reframing, signaling and social recognition, moral appeals, and loss-benefit framing.

Nudging strategies leverage or correct behavioral biases—departures from purely rational decision-making—making them relevant only in the presence of such biases. From a conceptual perspective based on the relevant literature, we indicate associations between behavioral biases and nudges.
Second, we align these categories with the objectives and practices defined in the EU CAP strategic plans and the EU Forest Strategy. For each study, we identify the promoted agricultural or forestry practice and classify it under key sustainability goals: climate mitigation and adaptation, water quality protection, soil conservation, biodiversity protection, reduced pesticide use, and improved animal welfare.

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Finally, we use the literature review to empirically map nudge types to sustainable practices, identifying predominant areas of research, commonly used nudge-practice combinations, and their effectiveness.

The exercise is important for policy and academic reasons. From a policy perspective, it contributes to indicating successful combinations of nudges and practices. From an academic perspective, it highlights the areas needing further research. It also provides the basis to further develop a conceptual framework for the design of nudges in agriculture and forestry which combines the nudge potential, i.e., the behavioral factors each nudge leverages or takes advantage of, with the characteristics of the sustainable practices. This should lead to a theoretical best match between practices and nudges.

Overall, this work contributes to advancing the knowledge of nudges in agricultural and forestry contexts. In that, we move forward with respect to the recent literature review studies. Most closely related to us are Palm-Forster and Messer (2021) and Schubert (2017). Palm-Forster and Messer provide a set of methodological recommendations for conducting experiments in the agricultural domain whilst Schubert develops ethical guidelines for the use of nudges in general. We complement these approaches by providing best practices to maximize the effectiveness of nudges with a focus on agriculture. We also contribute to the environmental and agricultural economic literature by providing a literature review of nudges in agriculture. In this regard, we extend and complete Čop and Njavro (2024)'s review of the literature. We differ from them by providing an analytical framework to assess nudge effectiveness by nudge type and by agricultural practice. We put a particular emphasis on measurement, and internal and external validity. We also look at the extent to which nudge effectiveness is heterogeneous and related to behavioral factors, nudge type, and farming practice. All of this allows us to derive concrete policy recommendations for practitioners and scholars interested in this topic.

3.2. Conceptual framework

3.2.1. Green nudges and behavioral factors in agriculture and forestry

In this section, we propose a classification of nudges used in agriculture. We consider eight classes of nudges. In what follows, we provide a definition, an example for each class of nudge, and the related behavioral factors through which they are expected to work. Figure 1 below represents visually the links between nudges and behavioural factors

The classification is inspired by Münscher et al. (2016), Sunstein (2019), Sunstein et al. (2019), and Jesse and Jannach (2021). Each of these four typologies differs in the number of categories (from 10 in Sunstein (2019) to just three in Münscher et al. (2016)) and how they are constructed (based on type of intervention (Sunstein, 2019) or on the impact channel of the nudge (Münscher et al. (2016). For our typology we follow the approach of Jesse and Jannach (2021) which basically splits one of the categories of Münscher et al. (2016), decision information, into two depending on whether the information is related to other or not. The new categories are "decision information" and "social decision appeal. Each of our eight nudges is therefore classified in one of Jesse and Janach (2021)'s four categories: decision information, decision structure, decision assistance and social decision appeal as summarized in Table 1.

Default nudges. Default nudges consist of framing the practice promoted as the default option, therefore altering the decision structure. For instance, to promote organic fertilizers, one can offer them by default when ordering crops. To increase the take-up rate of eco-schemes, one can automatically enroll farmers: they must actively opt out instead of opting in actively. These nudges are considered to be the most effective in particular when dealing with repetitive behaviors based on habits (Mertens et al. 2021), however their acceptance by farmers is low (Colen et al. 2024) and policy makers might be reluctant to implement them. While in principle this intervention retains freedom of choice for the farmer it can blur the line between mandatory and voluntary measures.

Related behavioral factors:

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The precise behavioral factors on which default nudges are expected to play are still debated in the literature. According to Beshears and Kosowsky (2020), this kind of nudge bypasses both system 1 and 2 decision making[2]. One of the most favored hypotheses for the mechanism of default nudges is that they play on people's passive decision model (Van Gestel et al. 2021, Gärtner, 2018, Ortmann et al. 2023). Indeed, most decisions are made passively. For instance, most people buy the most accessible product brands in supermarkets and stick to the default options of insurance policies. Default nudges facilitate some decisions by reducing the effort to make them. Another explanation is that default nudges are perceived as recommendations from the policy maker. Pre-selecting some options is thus perceived as a signal by the decision maker of the preference of the policymaker (McKenzie et al. 2006). Such nudges would then be more effective on those characterized by a desire to appear virtuous and to conform to norms. Finally, another mechanism relates to reference-dependence: namely, the default option acts as a reference to which the other non-selected options will be compared in terms of gains and losses (Dinner et al., 2011). In this case, default nudges would be more effective on the most loss averse.

Social norm nudges. Social norm nudges make salient the number of farmers doing a given sustainable practice (descriptive norm), the trend in the adoption of a sustainable practice (dynamic norm), or the number of farmers believing a sustainable practice ought to be implemented (injunctive norm). For instance, this information can be delivered through communication campaigns embedding simple messages stating the number of forest owners already implementing continuous cover forestry.

Related behavioral factor:
The objective is to play on people's desire to fit in with their social group by emphasizing what others are doing. This can drive either imitation or conformity behavior. Indeed, people often rely on what others do to determine the appropriate conduct to adopt (Ferraro and Price, 2013) be it because a majority behavior has to be the right thing to do (imitation) or because they don't want to diverge from the crowd (conformity). In other words, social norms, or at least the perception of social norms, strongly influence behaviors (Levitt and List, 2007). Social norm nudges are thus more likely to work on "conformers", i.e., those that like conforming with norms.

Simplification. Choice environments are complex. This makes it easy to omit some consequences of choices. Simplification interventions are simple heuristics (i.e., decision rules) that facilitate the decision process. The objective is to help people make more rational decisions by removing all the "clutter" (i.e., the unnecessary complications in how information is provided) or giving easy tools to address complicated information better. For instance, expressing carbon emissions in terms of the number of kilometers driven in a car or adding red labels to carbon-intensive options are simplification nudges.

Related behavioral factors:
Contrary to default nudges that take advantage of people's passive decision mode, simplification interventions aim at making thoughtful decisions easier. Simplification interventions are akin to the so-called "boosting" strategies (Hertwig and Grüne- Yanoff, 2017). Boosts do not target a feature of human behavior (e.g., procrastination, impatience, loss aversion), they target competences. In our case, simplification interventions make it easier for decision makers to use their analytical competences.

Figure 1: Relations between the eight main nudge categories and behavioural factors identified from the literature.

[2] System 1 and System 2 are terms introduced by Kahneman (2011) to describe two modes of human thinking: System 1 is fast, automatic, and intuitive, while System 2 is slow, deliberate, and analytical. Many nudges target System 1 by appealing to heuristics or habits, though some may also engage System 2 when reflective processing is involved.

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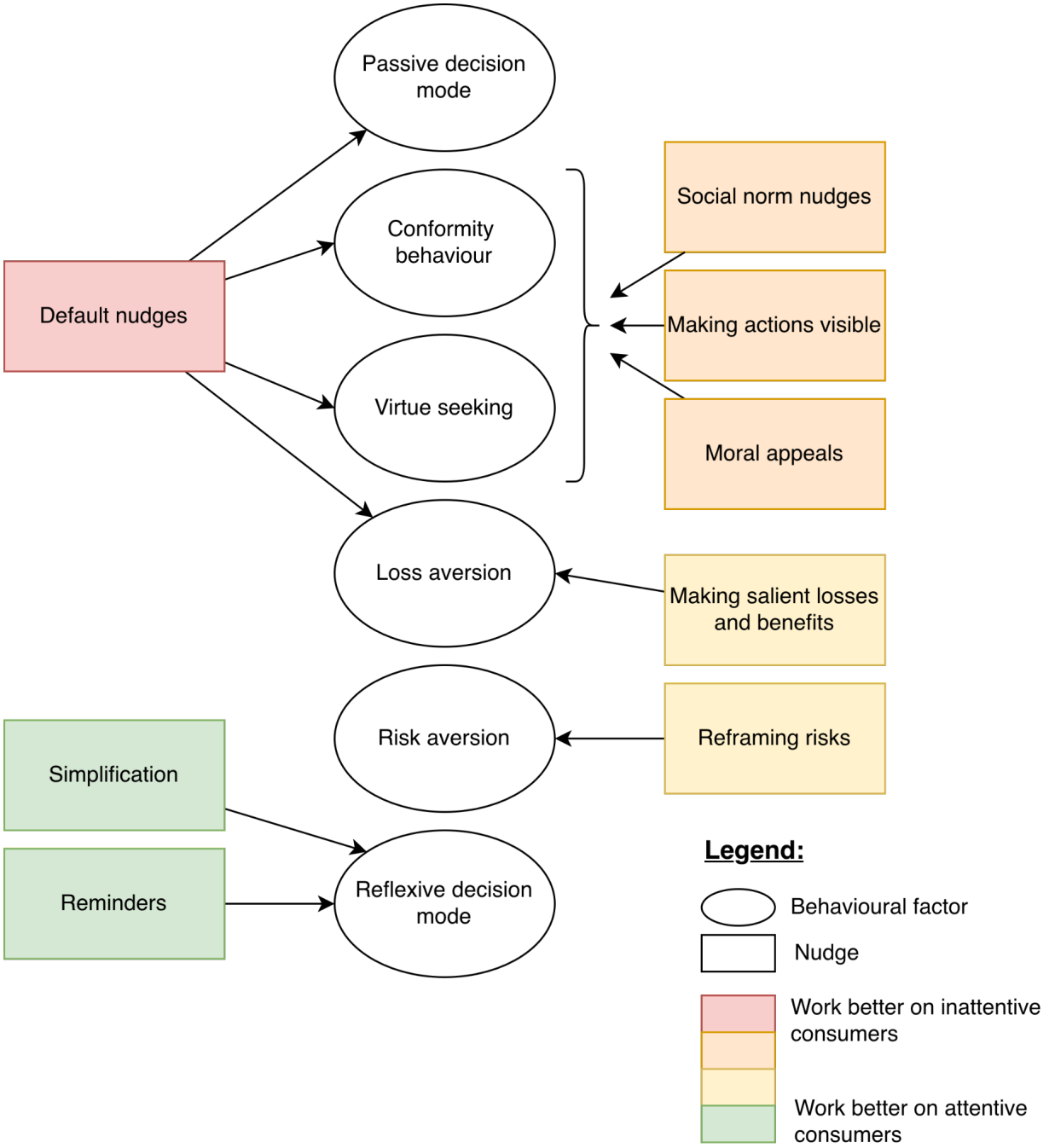

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Table 1. Classification of selected nudges against according to nudge typology

Tested nudge	Typology according to Jesse and Janach (2021)
Default	Decision structure
Simplification	
Social norm	Social decision appeal
Visibility of actions	
Moral appeals	
Reminders	Decision assistance
Reframing risks	Decision information
Salience of benefits	

Source: own elaboration based on Jesse and Jannach (2021)

Reminders. Contrary to *simplification* that focuses on *how* information is provided and information nudges, reminders do not *add new* information. They provide regular and timely alerts to recall and facilitate the adoption of sustainable practices or re-focus people's inattention towards important information. For instance, this can take the form of text messages sent to farmers at key periods (e.g., application deadline for eco-schemes).

Related behavioral factors:
Reminders are also part of the "boost" family (Hertwig and Grüne- Yanoff, 2017). Here too, they help decision makers make more rational decisions. They are particularly effective for those being inattentive, or those who tend to postpone difficult decisions by making key information more salient (Bordalo et al. 2022).

Reframing risks. This type of intervention can take two forms. It can help people *better assess* the risk associated with a given practice by simplifying uncertain outcomes (e.g., "one in a hundred farmers loses X when doing Y", instead of "1% of farmers lose X when doing Y"). Alternatively, risks can be reframed to *make salient* the uncertainty associated with a practice (e.g., "doing X risks causing Y€ in losses", instead of no information).

Related behavioral factors:
When *risk reframing* is used to help farmers better grasp the consequences of their action, they can be considered as boost strategies: they help farmers make use of their analytical competences (Hertwig and Grüne- Yanoff, 2017). In this case, these interventions should be particularly effective on those lacking attention, or with low numeracy. When *risk reframing* simply makes salient the risks associated with a decision, it will alter its appeal. Framing an option as riskier decreases its appeal as we tend to dislike uncertainty, overestimate the risk of losing and underestimate the risk of winning (Kahneman and Tversky, 2013). These interventions are particularly relevant for farming due to the increased risk associated with sustainable practices (even if just because they are new to the farmer) and prevalence of risk aversion among farmers (Rommel et al. 2023).

Making actions visible. Providing public recognition to farmers implementing environmentally sustainable practices can make these practices more attractive. Indeed, these nudges create additional non-monetary incentives as people care about their reputation. Public recognition can take the form of certification labels, for instance.

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Related behavioral factors: Making actions visible when they relate to desirable behaviors can reinforce self-concept and social identity therefore appealing to intrinsic motivations (Bopp et al. 2019). It can also leverage social recognition and social signaling (Lowenstein et al. 2014).

Moral appeals. Emphasizing the moral aspects of a decision can also be a way to increase the take-up rate of environmentally sustainable practices. For instance, one can present buffer strips near watercourses as the "right thing" to do to preserve water quality and biodiversity. These nudges play on people's internal moral compass and desire to have a positive role for society.

Related behavioral factors: like social norm nudges, moral appeals work on people's intrinsic motivation by leveraging identity and values. Moral appeals can also appear as injunctive norms indicating the behavior deemed appropriate by society. As such, it relies on people's desire to conform or imitate what most people do.

Making salient losses or benefits. Emphasizing what one might lose by sticking to a given practice can decrease its appeal and favor environmentally sustainable ones. For instance, one can emphasize that monoculture decreases soil quality and expected future revenue streams compared to crop rotation. The underpinning idea of this nudge is like *reframing risks.* The difference is that we do not insist on probabilities but on outcomes by playing on the fact that people dislike losing more than they like winning.

Related behavioral factors: Making farmers aware of the potential benefits or losses related to adoption (or non-adoption) of sustainable practices improves the information available when taking the decision therefore trying to mobilize system 2 thinking. In particular, if losses are made more salient this should activate loss aversion which is one of the most common behaviors for decisions under risk (Brown et al. 2024).

3.2.2. Sustainable agricultural and forestry practices

Agricultural and forestry practices are classified using the framework proposed by the EU for the CAP strategic plans and the New EU Forestry Strategy for 2030[3]. The EU CAP framework identifies practices that are instrumental in managing the transition towards a sustainable food system and in strengthening the efforts of European farmers to contribute to the EU's climate objectives and to protect the environment. To this end, the CAP introduced eco-schemes, as a policy tool. Agricultural practices eligible for support under eco-schemes must fulfil specific criteria to ensure their effectiveness in promoting sustainability. These practices should address key areas such as climate action, environmental protection, animal welfare, and the reduction of antimicrobial resistance. Additionally, they must be tailored to national or regional needs and priorities, ensuring that they respond to local challenges and policy objectives. To qualify, their level of ambition must exceed baseline requirements, including conditionality, thereby fostering higher environmental and animal welfare standards. Furthermore, these practices should actively contribute to achieving the targets set by the EU Green Deal, aligning with broader sustainability and climate goals. Sustainable practices in forestry generally do not qualify for compensations under the eco-schemes CAP system. However, the Commission encourages Member States to accelerate the roll out of carbon farming practices, for instance via eco-schemes on agroforestry or rural development interventions to cover biodiversity-friendly re- and afforestation investments, agroforestry and other non-productive investments for environment- and climate-related objectives.

[3] A comprehensive description is provided at available at https://agriculture.ec.europa.eu/sustainability/environmental-sustainability/sustainable-agricultural-practices-and-methods_en and https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0572

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First, the CAP framework proposes general objectives covering various areas of environment, climate change and animal welfare actions:

a. Climate mitigation – including reduction of GHG emissions from agricultural practices, as well as maintenance of existing carbon stores and enhancement of carbon sequestration
b. Climate change adaption – including reduction of GHG emissions from agricultural practices, as well as maintenance of existing carbon stores and enhancement of carbon sequestration
c. Protection or improvement of water quality – and reduction of pressure on water resources
d. Prevention of soil degradation – soil restoration, improvement of soil fertility and of nutrient management
e. Protection of biodiversity – conservation or restoration of habitats or species, including maintenance and creation of landscape features or non-productive areas
f. Actions for a sustainable and reduced use of pesticides
g. Actions to enhance animal welfare – or address antimicrobial resistance

Second, the framework proposes a selection and organization of agricultural practices by topic. For each practice, the strategic objectives are highlighted.

In Table 2, panel A, all the agriculture practices proposed in the EU framework are reported, classified by topic, together with the objectives they contribute to. In the last column, we indicate whether the practice is covered in the current literature review exercise. A practice is covered when at least one paper studied the application of nudge to the given practice. The rest of the analysis focuses on the latter group of practices.

Similarly, in Table 2, panel B, we replicate the analysis for forestry and agro-forestry practices that are proposed within the CAP framework and in the EU Forestry Strategy 2030 and refer to the same strategic objectives.

Table 2. Classification of agricultural and forestry practices

Panel A: Sustainable agricultural practice	**Strategic objectives**							**Included**
	a	b	c	d	e	f	g	Y/N
1. Organic farming practices								Y
Conversion to organic farming	x	x	x		x	x		N
Maintenance of organic farming	x	x	x		x	x		N
Integrated Pest Management			x	x	x	x		Y
Buffer strips with management practices and without pesticides		x	x	x	x			N
Mechanical weed control		x		x	x			N
Increased use of resilient, pest-resistant crop varieties and species	x					x		Y
Land lying fallow with species composition for biodiversity purposes		x		x	x			N
2. Agro-ecology								Y
Crop rotation with leguminous crops	x	x		x		x		N
Mixed cropping - multi cropping		x		x	x	x		N
Cover crop between tree rows on permanent crops - orchards, vineyards, olive trees - above conditionality	x		x	x	x	x		N
Winter soil cover and catch crops above conditionality	x	x	x	x				N
Low intensity grass-based livestock system	x		x	x			x	Y

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Use of crops/plant varieties more resilient to climate change		x	x		x	x		Y
Mixed species/diverse sward of permanent grassland for biodiversity purpose (pollination, birds, game feedstocks)			x	x	x	x		Y
Improved rice cultivation to decrease methane emissions (e.g. alternate wet and dry techniques)	x							Y
Practices and standards as set under organic farming rules		x	x	x		x		N
3. Husbandry and animal welfare plans								Y
Feeding plans: suitability of and access to feed and water, feed and water quality analyses (e.g. micotoxins), optimised feed strategies							x	Y
Friendly housing conditions: increased space allowances per animal, improved flooring, free farrowing, provision of enriched environment, shading/sprinklers/ventilation to cope with heat stress		x					x	N
Practices and standards as set under organic farming rules							x	N
Practices increasing animal robustness, fertility, longevity and adaptability, e.g., lifespan of dairy cows; breeding lower emission animals, promoting genetic diversity and resilience	x	x					x	N
Animal health prevention and control plans: reducing risk of infections that require antimicrobials, enhanced biosecurity, vaccination, etc.							x	N
Providing access to pastures and increasing grazing period for grazing animals	x	x					x	Y
Provide and manage regular access to open air areas							x	N
4. High nature value (HNV) farming								Y
Land lying fallow with species composition for biodiversity purpose			x		x	x		N
Shepherding on open spaces and between permanent crops, transhumance and common grazing		x		x	x	x	x	Y
Semi-natural habitat creation and enhancement	x	x	x	x	x	x	x	Y
Reduction of fertiliser use, low intensity management in arable crops	x	x	x	x	x	x	x	Y
5. Carbon farming								Y
Conservation agriculture	x			x				N
Rewetting wetlands/peatlands, paludiculture	x		x	x				N
Minimum water table level during winter	x		x	x				N
Appropriate management of residues, i.e., burying of agricultural residues, seeding on residues	x		x	x				Y
Establishment and maintenance of permanent grassland	x		x	x	x	x		N
Extensive use of permanent grassland	x		x	x				N
6. Precision farming								Y
Nutrients management plan, use of innovative approaches to minimise nutrient release, optimal pH for nutrient uptake, circular agriculture	x		x	x		x		Y

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Precision crop farming to reduce inputs (fertilisers, water, plant protection products)					x	x		Y
Improving irrigation efficiency		x						Y
7. Improve nutrient management								Y
Implementation of nitrates-related measures that go beyond the conditionality obligations			x	x	x			Y
Measures to reduce and prevent water, air and soil pollution from excess nutrients such as soil sampling if not already obligatory, creation of nutrient traps			x	x	x			Y
8. Protecting water resources								Y
Managing crop water demand (switching to less water intensive crops, changing planting dates, optimised irrigation schedules)		x						Y
9. Other practices beneficial for soil								Y
Erosion prevention strips and wind breaks		x		x	x			Y
Establishment or maintenance of terraces and strip cropping		x		x	x			N
10. Other practices related to GHG emissions								Y
Feed additives to decrease emissions from enteric fermentation	x							N
Improved manure management and storage	x							Y

Panel B: Sustainable (agro) forestry practice	**Strategic objectives**							**Included**
	a	b	c	d	e	f	g	Y/N
1. Agro-forestry								Y
Establishment and maintenance of landscape features above conditionality	x		x	x				N
Management and cutting plan of landscape features					x	x		N
Establishment and maintenance of high-biodiversity silvo-pastoral systems	x	x		x	x			Y
2. Sustainable forestry								
Conversion of coppice to high forest	x	x		x	x			N
Promotion of natural regeneration	x	x		x	x			N
Maintenance and enhancement of deadwood					x			N
Use of native species and species diversification		x			x			N
Longer rotation periods / delayed harvest	x				x			N
Protection of old-growth and veteran trees	x				x			N
Reduction of fire risk (e.g., through thinning or fuel load management)		x		x				N

Overall, we can notice that, although our review does not cover all the sustainable practices proposed within the EU framework, at least one of each of the eleven main categories is covered. The most covered practices are related to high nature value farming, water protection, and nutrient management. Conversely, fewer papers focus on carbon farming and husbandry and animal welfare plans practices.

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3.2.3. Classification of methods: experimental approach and measure of outcomes

Different methods are used in the literature to assess the effect of a nudge. Here, we provide a broad classification following Palm-Forster and Messer (2021) and Harrison and List (2004). We focus on different methodologies that have been used to assess nudge effectiveness in our review. The methods vary along several attributes: (1) the location of the experiment, (2) source of values, (3) participants' awareness of the research, (4) experiment framing, (5) whether experiment decisions link to real world behavioral changes, (6) the participant pool, and (7) experiment incentives. All approaches present several advantages and disadvantages that we assess in the lenses of internal and external validity of the study and of the challenges posed by the experimental designs (Palm-Forster and Messer, 2021; Palm-Forster et al. 2019).

Internal validity refers to the ability to isolate a treatment effect by controlling for confounding factors (covariates) that may influence the outcome of interest. In other words, it determines whether the observed relationship between a treatment and an outcome is truly causal. In observational studies, treatment assignment is beyond the researcher's control and often influenced by confounding variables. However, random assignment mitigates these concerns, allowing researchers to establish causal effects on the outcome of interest, since program participation is not subject to any selection issue.

External validity, on the other hand, pertains to the extent to which causal relationships identified in a study can be generalized to different settings, contexts, and populations. Unlike internal validity, which is widely recognized as essential in economic experiments, the importance of external validity is more complex and often debated. This discussion is particularly relevant when extrapolating findings from laboratory experiments to real-world applications. In field experiments and randomized controlled trials (RCTs), researchers and policymakers frequently question whether results observed in one setting will hold in different environments, populations, or time periods. Additionally, there is often uncertainty about how well findings from field experiments will scale when applied on a larger scale.

Survey experiments. In the context of a survey (online or on paper), subjects are exposed to random treatments (information, videos, etc) within the survey. The outcome is collected through self-reported hypothetical survey questions, for instance willingness to pay, preference for, etc. Hence, the decision-making process is not financially incentivized, although survey participation may imply some flat payment (show-up fee). The hypothetical outcome is collected within the same survey. For instance, people are asked if they want to adopt a new practice (e.g., reduced tillage). This is always declarative and not always incentivized (meaning, their answers do not affect their payments). The experiment framing is typically context-specific, and the participation pool includes the target group (farmers and forest owners). The context-specific nature of the sample and of the framing make this approach rather externally valid, to the extent to which the sample is representative of the target population of interest and the practice is framed as the target practice. The internal validity is threatened by the hypothetical nature of the outcome measurement. Several bias may confound the causal effects such as hypothetical bias (the tendency to over-report), strategic answering, and experimenter demand effects.

Lab experiments and Lab-in-the-field experiments. These experiments are characterized by the fact that participating subjects are exposed to random treatments, are required to carry out tasks and take decisions that have some financial consequence. This means that choices are incentivized: that respondents decisions affect their payments. Subjects can be students, farmers, and forest owners (i.e., the target population). The framing of the experimental task can be neutral or more context specific. The choice of the subjects' pool and the framing affect the extent to which the experiment is a good representation of the real-world decision-making process. The location of the experiment can be a university lab, a mobile lab, or web platforms designed by the researchers. In lab experiments participants go to the university lab; in lab-in-the field experiments researchers come to the field to administer the experiment. Both share the advantage of keeping a high degree of control over the decision-making process and allowing the opportunity to isolate mechanisms. They are also relatively cheap and simple to

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implement as they do not require the involvement of stakeholders. The context-specific nature of the sample and of the framing make this approach externally valid, to the extent to which the sample is representative of the target population of interest and the practice is framed as the target practice. However, the decision set is always provided by the researcher. As such, it cannot mimic all the possible features and complexities of reality. The internal validity improves compared to the survey experiments, as the decision-making is incentive compatible and should be more representative of a rational agent.

RCT/field experiments. In these experiments, participants (farmers and forest own ers) make actual decisions that can influence their agricultural operations and/or the land they manage. In a real-world context, subjects are exposed to random treatments and real-world outcomes are collected via survey (self-reported) or via administrative data (secondary data). Participants may or may not be aware of being part of a study. Field experiments are most likely to provide convincing external validity. Note, however, that the external validity of field experiments is limited by attributes of the research setting and characteristics of the participants. Depending on the nature of the treatments, they are typically more expensive to implement than the other methods and typically imply collaboration with national/local institutions.

***Stated preference/*Discrete Choice Experiment.** These methods are usually based on self-reported preferences collected through surveys. Treatments are not randomly assigned. In discrete choice experiments, people are asked to choose between different alternatives and features (e.g., building a park with given characteristics at cost K$ versus status-quo). Each respondent repeats the choice several times, every time some features of the alternatives are varied (e.g., size of the park, information presented etc). There is therefore the possibility to test a nudge in this setting as a feature of the good to be evaluated. Given the non-experimental nature of the exercise and the hypothetical outcome reporting, this approach does not perform well in terms of internal validity. Its external validity, once again, depends on the representativeness of the study sample and of the contextualization of the exercise.

Observational Study/quasi-experiment. These approaches exploit the occurrence of real-world events/policy interventions (e.g., the introduction of a nudge) and rely on administrative data. This means that outcomes are measured in the real-world on the target populations. The challenge of this approach is related to the identification of causal effects, as several confounding factors may bias the impact evaluation of the nudge. When secondary data are available, several micro-econometrics techniques allow ex-post impact evaluations, controlling for selection bias and confounding factors: difference-in-differences, instrumental variables, regression discontinuity designs, propensity score matching, synthetic controls, etc. (Angrist and Pisschke, 2009). While the external validity is high, in relation to the reference context, the internal validity depends on the credibility of the assumption underlying the econometric approach used.

3.3. Methodology

The literature review focuses on published journal articles or working papers available online at the time of the search (November 2024). We conducted our searches on Scopus and Google Scholar, using keywords such as “farm”, “forest”, “nudge”, or “experiment” (see Table 3 for the full list). We complement the search results with a snowballing approach using the AI-powered search engine “Elicit”.

To be eligible, research papers had to be written in English and use one of the methodologies listed in Section 3.1.3. The experiments had to contain a control group against which the nudge intervention will be compared. The focus of the studies had to be on the promotion of environmentally sustainable practices in agriculture or forestry. Hence, studies on sustainable consumption and consumers’ decision-making were excluded. The time window of the papers we included in our review spans from 2015 to 2025.

Our review covers studies both within and outside the European Union's context. It also includes experiments that use farmers and other convenience samples, like students, as subjects to make the decisions. For each study, we record the focus country, and the type of subjects involved.

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We screened out studies that did not meet these criteria and ended up with 43 papers assessing 80 nudges. This means that papers usually assess more than one nudge at the time, against a control group or a baseline scenario without nudge. Notably, we only found four papers assessing seven nudges that are related to forestry. Those papers were categorised as focusing on "agro-forestry".

We classified studies based on the type of nudge assessed, the practices studied, and the method used. These classifications are presented in section 3.1. Nudge effectiveness is assessed based on the presence of statistically significant treatment effects (at least at 10% significance level). We are aware that this approach could lead to the underestimation of nudge effectiveness, as studies could be underpowered. As such, they could find non-significant treatment effects, while effects could be small, but the experimental design is not adequate to identify them. The problem of underpowered nudge studies has been highlighted in literature (Palm-Forster and Messer, 2021; Palm-Forster et al. 2019).

The screening and sorting were done in three rounds. First, a member of the scientific team reviewed the papers and classified them. Then, a second member of the team reviewed the classification and validated or amended it. Finally, in the third round, two other team members went over the full list of papers and reviewed all potential disagreements between the previous two reviewers.

Table 3: Keywords and scientific fields considered for the paper search

Keywords	Farm, farming, farmer, landowner, forest, forester, forestry, forest owner, nudge, nudging, behavioral intervention, behavioral policy, RCT, experiment, field
Scientific fields considered	Social sciences, economics, Business and administration, decision science, multidisciplinary, arts and humanities, psychology, agricultural science, environmental science, energy, comparative science, earth science, engineering science

3.4. Results

In conducting our analysis of the literature, we set our unit of analysis at the "study" level. We define a study as the material (data, method, analyses) mobilized to analyze the effect of one nudge. As such, a research paper assessing two nudges causally counts as two studies.

3.4.1. Description of studies

In what follows, we provide descriptive statistics regarding the 43 papers reporting the results of 80 nudges. Researchers studying green nudges in the agricultural context focus overwhelmingly on Europe and the USA. Indeed, 51% of the nudges are assessed in a European context, 22% in the USA, 14% in Asia, 8% in South America, and 5% in Africa. The full breakdown of the number of studies per country is displayed in Figure 2 .

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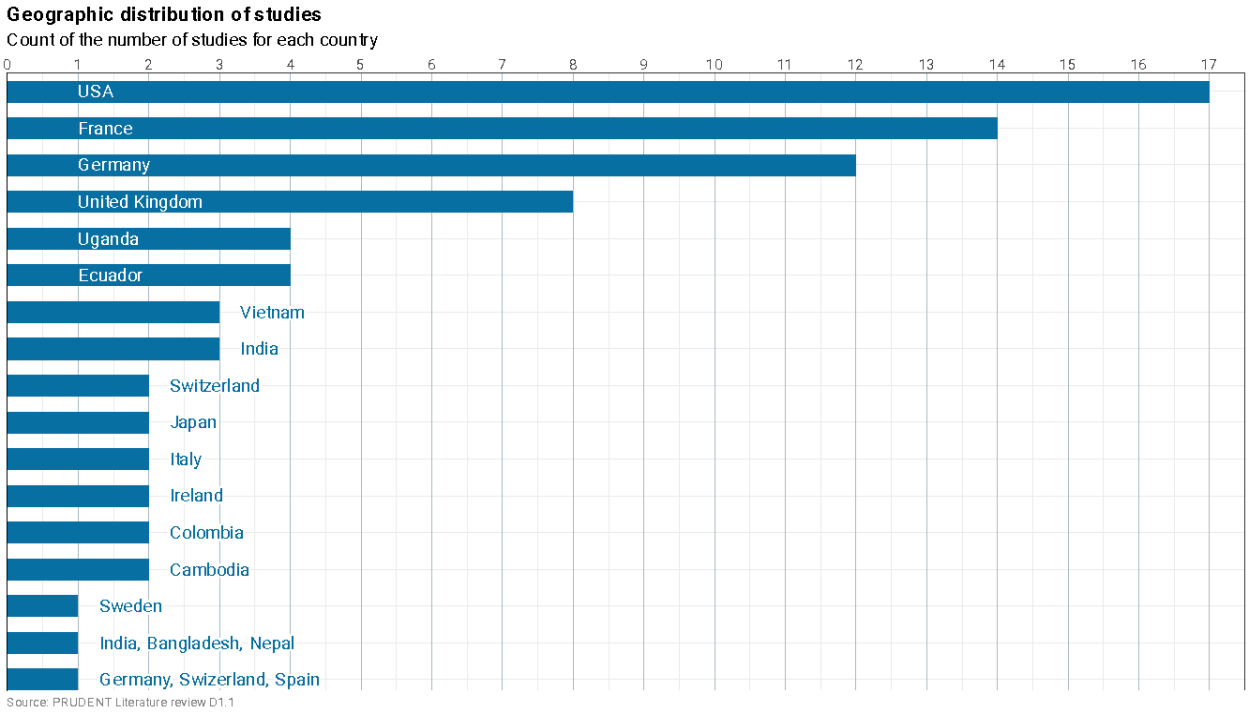
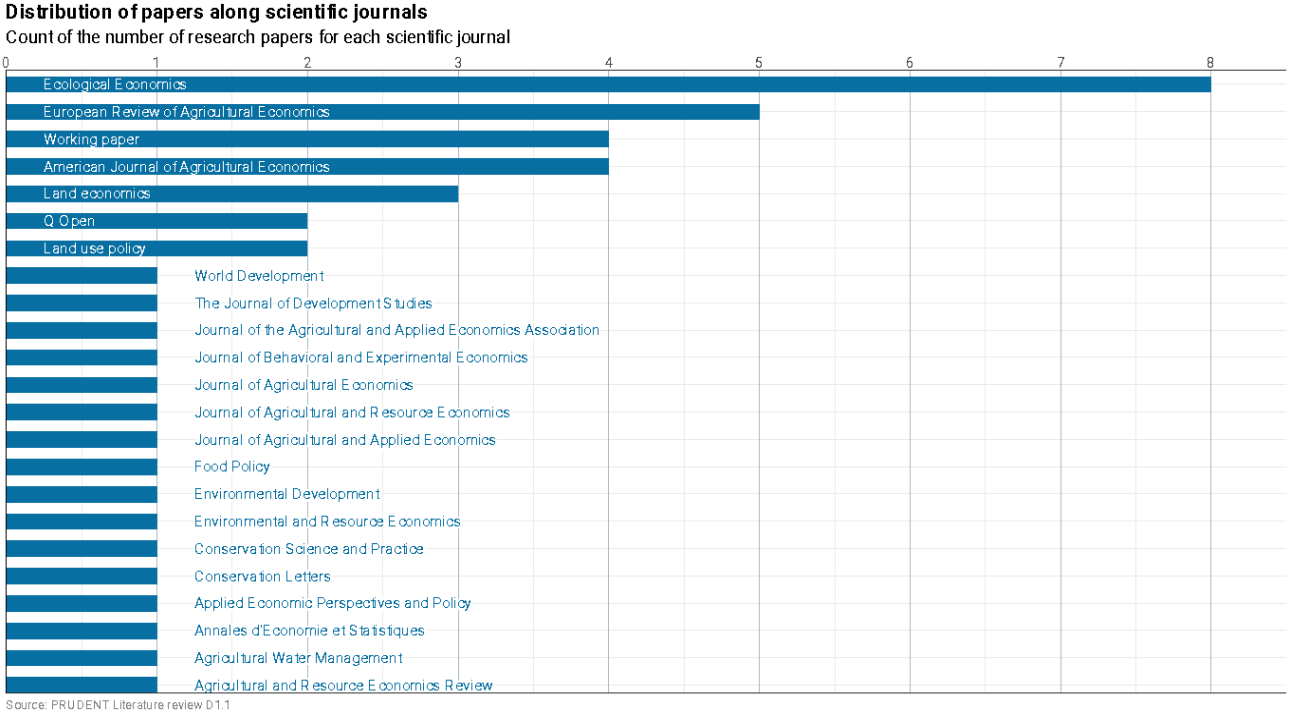
Figure 2: This graph presents how studies are distributed across countries.



Studies are published in environmental economics, agricultural economics or development economics outlets. The journals *Ecological Economics, European Review of Agricultural Economics,* the *American Journal of Agricultural Economics,* and *Land Economics* publish a large share of the papers analyzed in this review. This is shown in Figure 3 .

Figure 3: This graph presents how research papers are distributed across academic journals



Most studies use relatively small sample sizes, with a few relying on very large samples (located in the USA and Europe). The median sample size in our sample is 287, while the average size across the full sample is 1915 observations. The distribution of sample sizes across studies is plotted in Figure 4 .

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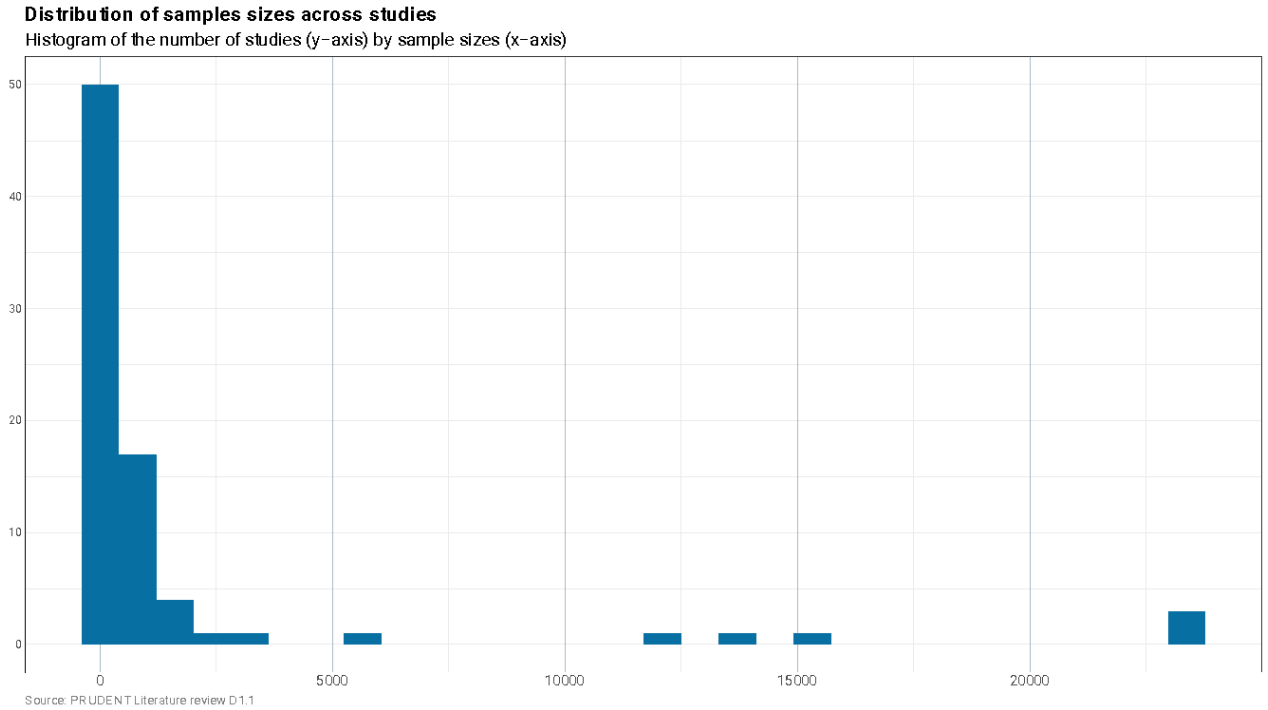
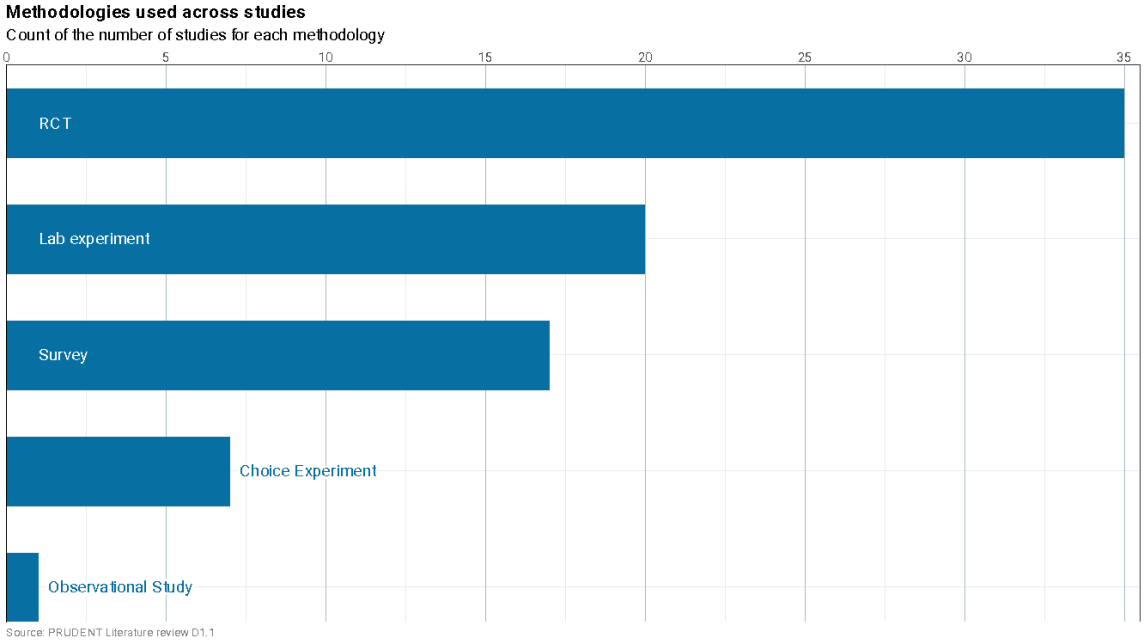
Figure 4: This histogram presents the distribution of sample sizes in our sample of studies



The most frequent method to evaluate green nudges is through randomized control trials. Indeed, 45% of nudges are assessed using randomized control trials, 26% are assessed in lab experiments, 19% in stated survey experiments, 9% using a choice experiment, and only 1% with an observational study. Figure 5 presents the count of studies by method. One should notice that although RCTs are the most used methodology, their use in the European context remains limited.

Figure 5: This graph presents the frequency of the research methods applied in studies



As for the timing of publications, there seems to be an increasing trend in the number of research papers with a pick in 2023. Figure 6 shows the count of research papers across time and methods.

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Figure 6: This graph displays the distribution of research papers over time

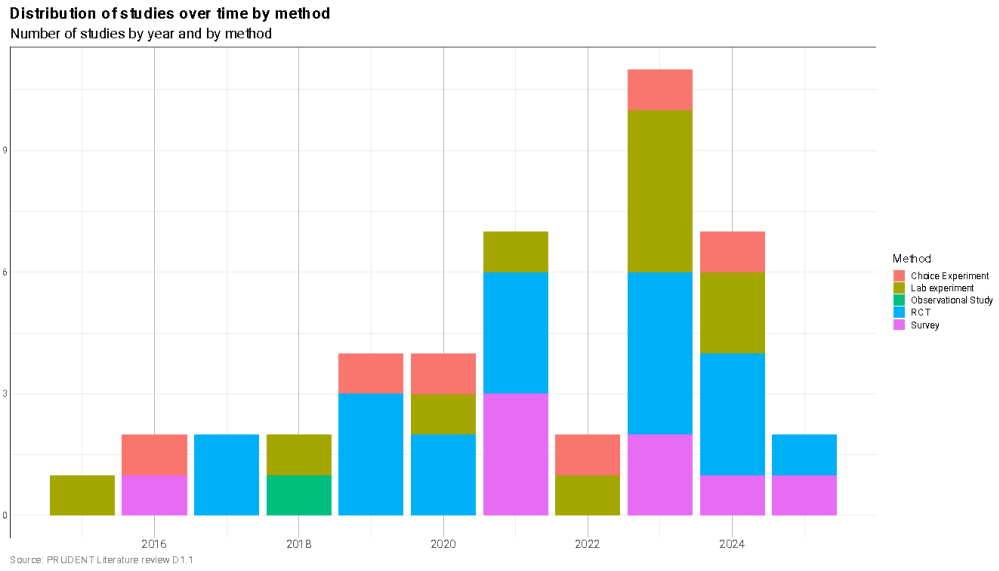

Figure 7 indicates that researchers tend to focus in majority on agricultural practices related to pesticide use, biodiversity, and water quality. Actions to enhance animal welfare are the least frequent. It is important to note that 10 out of 80 studies did not specify a specific agricultural practice.

Figure 7: This graph displays the distribution of studies along the environmental objectives of the farming practices studies

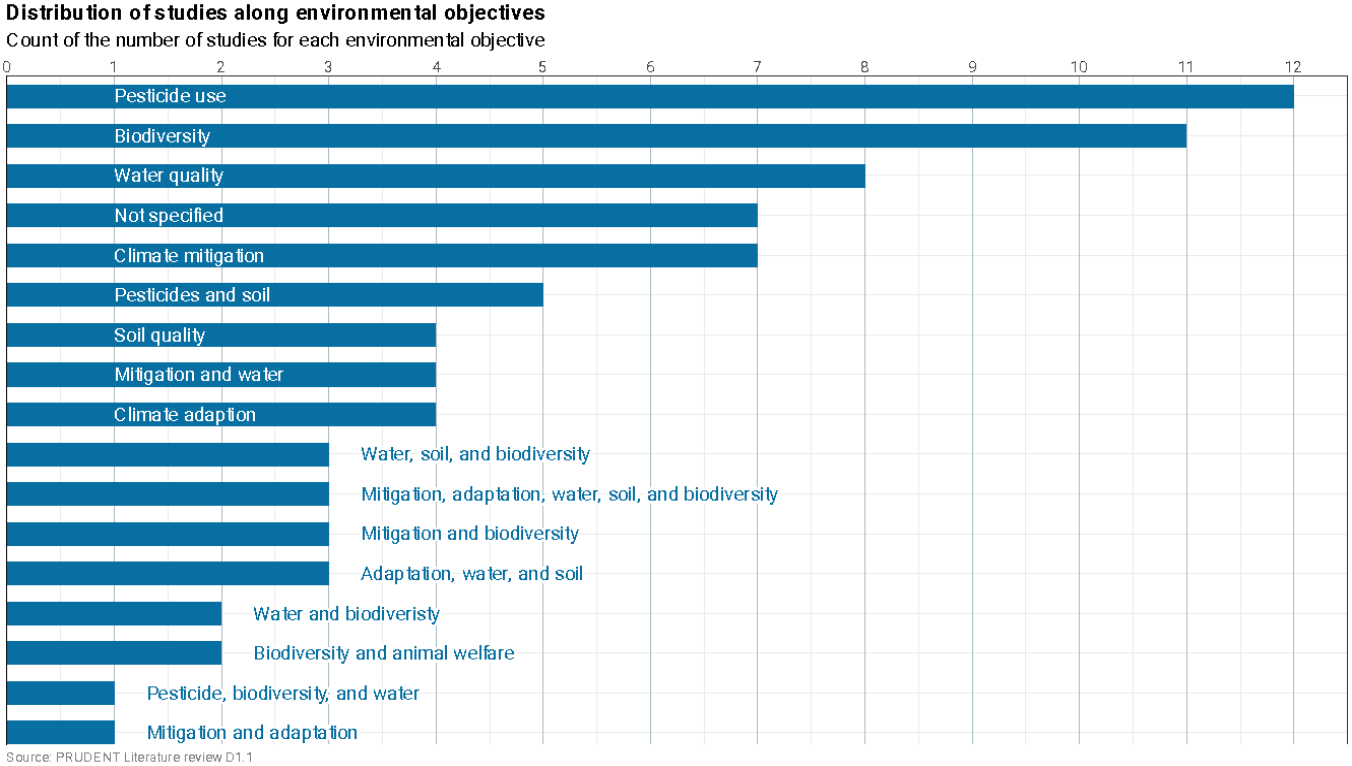

Figure 8 shows that enrollment in agri-environmental schemes is one of the most frequent practices researchers focus on, followed by precision farming, and agroforestry. On the other hand, carbon farming, integrated pest management and other practices beneficial for soils count as the agricultural practices that are the least studied. Similarly, practices related to agro-forestry remain understudied. Due to the limited number of papers looking at agro-forestry practices, we do not further disaggregate this category. In

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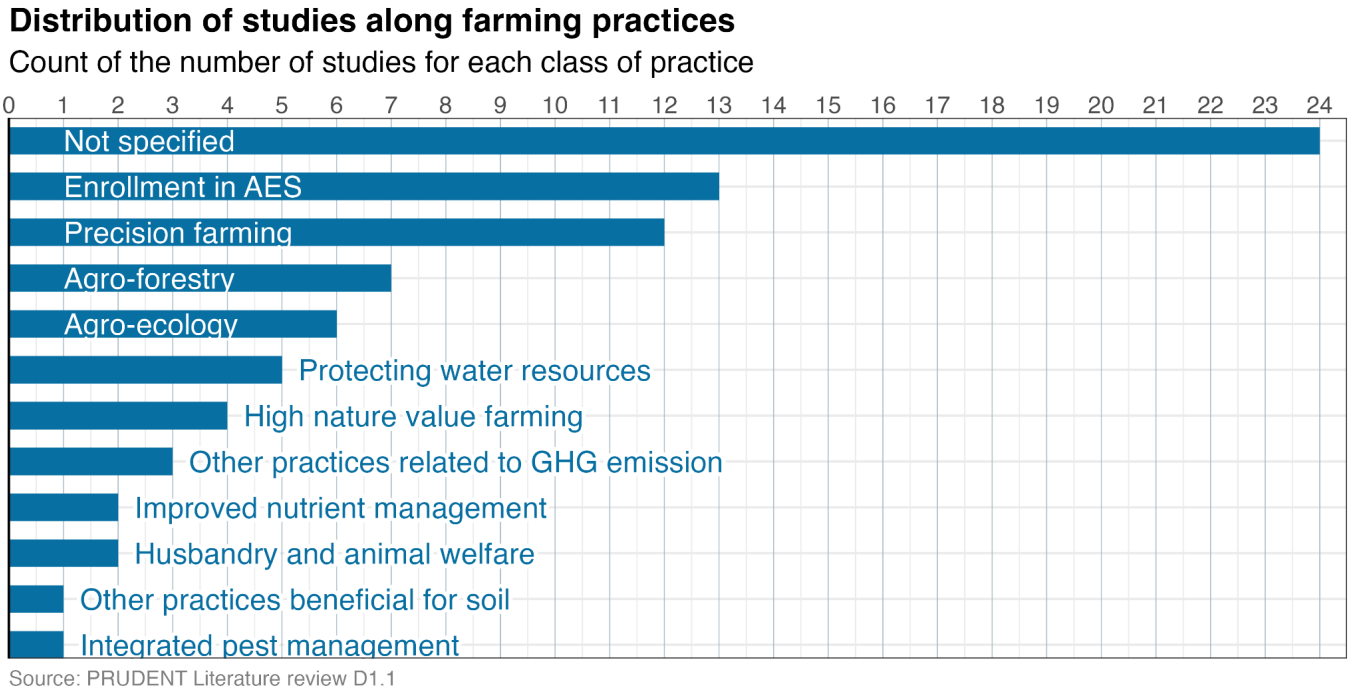
section 3.5, we discuss at length the main characteristics of the practices falling under the agro-forestry category.

Figure 8: This graph displays the distribution of studies along the farming practices studied



3.4.2. Nudges in agriculture and forestry

To highlight patterns between nudges, their effectiveness, and the domain in which they are applied, we generate Tables 4, 5 and 6. Table 4 presents the number of studies for each nudge, the number of times these studies found the nudge to work (i.e., being the treatment effect positive and statistically significant), the average sample size used to test each nudge, and the share of studies using stated outcomes, as opposed to real-world or incentivized outcomes. Table 5 presents the number of studies for each agricultural practice, the number of times these studies found the nudge to work, the average sample sizes, and the share of studies with a stated outcome. Table 6 combines the results on nudges and practices and presents the share of studies finding the nudge to work for each practice.

Table 4 reveals several takeaways. First, social norms are by far the most studied nudge: over one third of the studies. Reminders, moral appeals and making salient losses and benefits follow with 20, 17 and 12.5% of studies. Only one study applied default.

Second, reminders and simplification appear to be the most effective strategies. Indeed, both strategies work more often than they fail and, importantly, the average sample size of the studies finding a positive effect for these nudges is larger than the average sample size of the studies finding no effects. This suggests that the studies which did not find a significant effect might have been underpowered. Furthermore, the studies reporting a significant effect look at observed or incentive-compatible outcomes more frequently than those finding no effect. All of this strongly supports the effectiveness of these approaches. One could not say the same for nudges making salient losses and benefits, moral appeals, and social norm nudges. For the first, there are more studies finding the nudges to be effective, but on smaller samples compared to studies finding them to be ineffective. Similarly, for moral appeals and social norm nudges, the average sample size of studies finding no effects is much larger than that of studies finding a positive effect. This strengthens the idea that those nudges might only work on small and peculiar samples and become ineffective when the sample is enlarged. For social norms and making salient losses

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and benefits, studies finding that nudges work rely more often on stated outcomes compared to those finding no effects.

Third, we find that some nudges remain understudied. This is the case of default nudges, making actions visible and reframing risks. For these three nudges, more evidence is needed before drawing any conclusions on their effectiveness.

Table 4: Distribution of studies by nudge types

Nudge	Number of studies (%)	Results	Average sample size per result	Share of studies using stated outcomes (in %)
Default	1 (1.2)	1 worked	701	0%
Making actions visible	3 (3.7)	1 didn't work	177	0%
		2 worked	154	100%
Making salient losses and benefits	10 (12.5)	4 didn't work	6305	75%
		6 worked	354	83%
Moral appeals	14 (17.5)	7 didn't work	1200	57%
		7 worked	249	29%
Reframing risks	2 (2.5)	2 didn't work	290	100%
Reminders	16 (20)	7 didn't work	779	86%
		9 worked	4705	44%
Simplification	7 (8.7)	3 didn't work	902	33%
		4 worked	3124	0%
Social Norm	27 (33.7)	2 backfired	354	0%
		15 didn't work	2661	40%
		10 worked	724	60%

Table 5 reveals three takeaways. First, the most frequently tested practices, *enrolment in agri-environmental schemes* and *precision farming* do not seem very "nudgeable": less than half of the studies find a positive significant effect of nudges. We observe a similar pattern for practices related to agro-forestry.

Second, studies focused on protecting water resources stand out with large sample sizes, no results inferred from stated outcomes, and all of them finding a positive significant effect of the nudges. Similarly, studies focusing on practices related to agroecology also seem to show promising results with a high "success rate" and few outcomes that are self-reported.

Third, practices related to carbon farming, husbandry and animal welfare, improved nutrient management, soil improvement, and greenhouse gas emissions are studied with methodologies involving stated outcomes, which question the external validity of the studies.

Table 6 does not reveal any clear patterns. This would tend to support the idea that the choice of nudge is not necessarily based on the characteristics of the practice itself. Yet, looking at the practices that are the most studied in literature, we observe two aspects. For enrolment in agri-environmental schemes, social norm nudges and simplification are the most frequent options chosen by researchers, even though their success rate is below 50%.

For precision farming, social norm nudges and reminders are the nudges favored by experimenters. Here again, their success rate is low, 50% for social norm nudges and 50 % for reminders.

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Table 5: Distribution of studies by agricultural practice

Practices	Number of studies (%)	Share of studies finding positive significant effects (in %)	Average sample size of studies	Share of studies with stated outcomes (in %)
Agroecology	6 (7.5%)	67 %	616	50 %
Agroforestry	7 (8.8 %)	43 %	548	5 7%
Enrolment in AES	13 (16.3 %)	38%	844	38%
High nature value farming	4 (5%)	50%	98	0%
Husbandry and animal welfare	2 (2.5%)	50%	262	100%
Improved nutrient management	2 (2.5%)	0%	354	100%
Integrated pest management	1 (1.3 %)	0%	532	0%
Other practices beneficial for soil	1 (1.3 %)	100%	1,821	100%
Other practices related to GHG emission	3 (3.8 %)	67%	150	100%
Precision farming	12 (15 %)	50 %	292	50 %
Protecting water resources	5 (6.3 %)	100%	744	0%
Not specified	24 (30%)	42%	4,998	62%

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Table 6 : Distribution of studies by nudge type and agricultural practice

Practice	Making salient losses or benefits	Moral appeals	Simplification	Social norm	Making actions visible	Reminders	Default	Reframing risks
Agro-ecology	0% (2)	100% (1)	100% (1)	100% (2)				
Agro-forestry	100% (1)			0 % (2)	0% (1)	33 % (3)		
Enrolment in AES		0% (3)	33% (3)	40% (5)		100% (1)	100% (1)	
High nature value farming		100% (2)		0% (2)				
Husbandry and animal welfare	100% (1)		0% (1)					
Improved nutrient management	0% (1)	0% (1)						
Integrated pest management				0% (1)				
Other practices beneficial for soil						100% (1)		
Other practices related to GHG emission	100% (1)			50% (2)				
Precision farming	100% (1)		100% (1)	50% (4)		50 % (4)		0% (2)
Protecting water resources		100% (2)		100% (1)		100% (2)		
Not specified	67% (3)	40% (5)	100% (1)	13% (8)	100% (2)	40% (5)		

3.5. Discussion

Interaction of different nudges. An aspect that we have not tackled in the previous section is whether nudges, when used in combination, become more effective. We could not formally test this as very few studies employed the proper methodology to disentangle the individual effect of each nudge tested and their cumulative effect. Indeed, to test if combining nudge A with nudge B yields any improvement, one

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needs to be able to separately test the effect of nudge A, nudge B, and nudge A+B. This implies having four groups, a control group, and the three corresponding treatment groups.

Most studies testing nudges in combination did not check this criterion and instead relied on three groups: control, nudge A and nudge A+B. This implies that to estimate the effect of nudge B these studies compared group A+B with A. In other words, the baseline they used was not “nudge free”. This represents 21% of our studies. A simple t-test reveals that testing a nudge against an “impure” baseline decreases the likelihood of finding a significant effect by 28 percentage points. This would tend to suggest that nudges become less effective when used in combinations with other nudges. Yet, more evidence is needed to better understand whether this is a general property of nudges or just an artifact of the choices made by researchers when designing their studies.

Empirical relationship with behavioral factors. The choice of nudges should be supported by the context and the behavioral factors that seem to prevent the adoption of practice. Nudges should be more effective on groups with given characteristics and more affected by the expected behavioral factors. Despite the key role of behavioral factors in motivating and supporting the use of nudges, their theoretical and empirical relationship is mostly understudied. Only four papers investigated the heterogenous effect of nudges along behavioral factors but only two found a significant interaction. One found that personalizing nudges reframing risks was more effective on people concerned about the environment. The other study found that making salient losses and benefits was more effective on those with higher pro-environmental concerns, stronger pro-social identities, and lower knowledge of the sustainable practice targeted.

The lack of papers investigating the moderating effect of behavioral factors on the effect of the nudges they study might be due to difficulties collecting enough data to carry out such analyses. Yet, future studies should endeavor to measure these factors to gain a better understanding of the mechanisms underpinning nudges. This should have relevant policy implications, for the identification of the type of people towards whom nudging should be targeted to maximize efficacy.

Sustainable forestry and nudges. Our review identified only nine studies examining nudges in the context of sustainable forestry, a notably small number compared to studies in agricultural settings. This scarcity may reflect multiple factors, including limited availability of suitable samples, relatively modest engagement from the scientific community on this specific application, or fundamental difficulties in applying nudge interventions to forestry contexts. The latter explanation appears particularly compelling given the temporal characteristics of forestry management. Forest management decisions typically unfold over time horizons spanning decades or even generations, creating a potential mismatch with the logic of nudge interventions, which are generally designed to influence decisions with more immediate consequences.

Consistent with this interpretation, we observed that even within the limited forestry literature, nudges rarely targeted core management decisions directly. Instead, interventions focused on adjacent or preparatory decisions such as acceptability of novel practices (e.g., ash recycling), receptiveness to eco-schemes, willingness to seek information about conservation programs, or knowledge and compliance with existing management regulations. This pattern raises an important methodological and conceptual challenge for the behavioral science community: what role can behavioral interventions meaningfully play in decision contexts characterized by extremely long temporal horizons? While nudges, as typically conceptualized through soft, choice-preserving interventions, may have inherent limitations in such contexts, forestry decisions nonetheless remain susceptible to cognitive biases and heuristics. This suggests a potentially fruitful frontier for research—developing behavioral policy approaches specifically tailored to long-term decision-making that may extend beyond conventional nudge frameworks while still leveraging insights from behavioral science.

Acceptability and effectiveness. We did not find any papers assessing the moderating role of acceptability and perceived effectiveness on the effect of nudges. Public acceptance is essential for both the ethical legitimacy and practical success of nudging interventions, as when nudges align with public

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preferences, ethical concerns diminish, increasing their overall acceptability (Reisch and Sunstein, 2016). Research on the general population indicates widespread support for nudges across countries, particularly when the purposes of such interventions are perceived as legitimate and aligned with citizens' interests or values (Sunstein et al., 2018; Sunstein and Reisch, 2019). However, approval rates vary depending on the type of nudge. While information-based interventions generally receive broad acceptance, default nudges tend to be less favored and sometimes disapproved (Reisch & Sunstein, 2016; Sunstein et al., 2018). This can be explained by the degree of deliberation involved in the intervention. "Deliberative" nudges requiring conscious decision-making, such as informative nudges ("boosts"), tend to be more accepted than those leveraging inertia or inattention and influencing automatic, non-deliberative decisions, such as default rules (Jung & Mellers, 2016; Reisch & Sunstein, 2016). Furthermore, approval rates vary across countries and population subgroups, suggesting the influence of cultural, societal, and individual factors. This highlights that a "one-size-fits-all" approach may be ineffective in designing nudging interventions (Hagman et al., 2015; Jung & Mellers, 2016).

Regarding the perceived effectiveness of nudges, there is very limited research on this topic (Cadario & Chandon, 2019; Gold et al., 2023). Available findings indicate that perceived effectiveness significantly predicts approval: individuals are more likely to support nudges they believe to be effective. However, people often misjudge the actual effectiveness of different behavioral interventions, leading them to reject certain nudges not due to opposition but due to misconceptions about their effectiveness. Notably, informing individuals about the proven effectiveness of nudges can increase their acceptance (Sunstein et al., 2018). Studies on perceived efficacy further suggest that transparent, deliberative nudges are generally perceived as more effective than opaque and non-deliberative ones, consistent with findings on acceptability.

While public acceptance of nudges is well-documented, less is known about farmers' acceptance and perceived efficacy of such interventions. Behavioral interventions increasingly target farm decision-making (Dessart et al., 2019), yet farmers' attitudes toward these policies are very little explored. To date, only one study has directly investigated farmers' acceptance of green nudges. Colen et al. (2024) surveyed 342 Swedish farmers to assess their approval of 15 nudging policies previously studied within the general European and Swedish populations (Reisch & Sunstein, 2016; Almqvist & Andersson, 2021). To enable comparison, the evaluated policies were general in nature and did not specifically target farm decisions. The study found consistently lower acceptance rates for nudging interventions among farmers compared to the general population. While farmers' socioeconomic factors may partially explain this result, it also suggests that self-interest also plays a role, especially when nudges relate to specific farming activities. Indeed, farmers' attitudes toward green nudges may differ from those of the general population due to their dual roles as citizens and economic actors impacted by agricultural policies (Vanio et al., 2021; Colen et al., 2024). As with the general public, farmers' support for nudging interventions also depends on the objectives of the policies and their alignment with personal motivations, values, and environmental concerns. Additionally, farmers' approval appears to be influenced by the perceived private benefits the policy may bring. They also find that farmers, like the general population, express low approval rates for default nudges, while showing higher acceptance of public education and information campaigns. This suggests that the mechanisms influencing nudge approval among farmers are like those observed in the broader population.

3.6. Conclusions

This literature review aims to systematically assess the role of green nudges in promoting sustainable agricultural and forestry practices, evaluating their effectiveness, underlying behavioral mechanisms, and potential applications. By analyzing 43 studies covering 80 different nudges, we identified patterns in the types of interventions used, their success rates, and their relevance across agricultural and forestry practices. The findings highlight that while some nudges, such as reminders and simplification strategies, are consistently effective, others—particularly social norm nudges and moral appeals—show variable results, often depending on contextual factors such as study design, sample size, and the specific practice being targeted.

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Our analysis also reveals that research on green nudges is geographically concentrated, with over 70% of studies conducted in Europe and North America. This limits insights into their applicability in other agricultural contexts, particularly in lower-income regions. Furthermore, while the literature extensively examines behavioral interventions for enrolling farmers in agri-environmental schemes or encouraging precision farming, other critical sustainability practices—such as integrated pest management, carbon farming, and improved nutrient management—remain understudied.

Notably, we find very little work on forestry and agro-forestry with only five papers on this topic. Besides, those studies do not directly focus on core forestry practices but rather on adjacent or preparatory decisions related to sustainable forestry. This gap might be explained by the limited relevance of green nudges to foster management decisions taking place over long time horizons. More research is needed to better understand where policies informed by behavioural insights could fit in this context.

One of the most significant research gaps is the lack of studies exploring the interaction effects between different nudges. While some interventions are tested in combination, few studies employ methodologies that allow for a clear disentangling of individual and cumulative effects. This limits our ability to determine whether combining nudges enhances or dilutes their effectiveness. Additionally, very few studies examine the role of behavioral factors—such as risk aversion, pro-environmental attitudes, and social conformity—in shaping nudge effectiveness. Understanding these psychological mechanisms would be crucial for designing more targeted and effective interventions.

Another key area requiring further exploration is the acceptability and perceived effectiveness of green nudges among farmers. While public acceptance is widely studied in other policy areas, only one study directly assesses farmers' approval of nudging interventions. The limited evidence available suggests that farmers may be more skeptical of certain nudges, particularly those that limit perceived autonomy, such as default options. Given that policy effectiveness depends not only on behavioral outcomes but also on stakeholder buy-in, future research should investigate how farmers perceive these interventions and whether providing transparency about their effectiveness could enhance adoption.

In conclusion, while green nudges offer a promising approach to promoting sustainability in agriculture and forestry, several gaps remain in the literature. Addressing these gaps—particularly by expanding research to diverse agricultural contexts, exploring the interactions between nudges, and understanding the behavioral and social factors influencing their success—is essential for developing more effective, evidence-based policy tools that support sustainable land management. The research presented in the next Section represents a first empirical attempt to fill the gaps highlighted above.

4. Multi-country BWS survey

4.1. Introduction

Agriculture and forestry are encountering significant challenges that underscore the urgent need for innovative solutions to facilitate the transition toward sustainable, climate-neutral, and technologically advanced systems. As the global population continues to grow, climate change introduces increasingly extreme and unpredictable weather patterns, posing substantial threats to agricultural productivity and the resilience of food and forestry production systems. Moreover, agriculture itself is a major contributor to environmental degradation, including greenhouse gas (GHG) emissions, soil erosion, water and air pollution, land degradation, and biodiversity loss. Additionally, deforestation remains a critical issue, with approximately 10 million hectares of forests lost annually, leading to diminished carbon sequestration, reduced biodiversity, soil degradation, and disruptions in water cycle regulation.

While the European Union has made significant progress in enhancing the sustainability of its agricultural and forestry sectors, considerable efforts are still required to meet the ambitious targets set by the European Green Deal (EGD). These include initiatives such as the Farm to Fork Strategy, the EU

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Biodiversity and EU Forest Strategies for 2030, the Fit for 55 packages, the Zero Pollution Action Plan, and the Circular Economy Action Plan (CEAP), as well as the 2023–2027 Common Agricultural Policy (CAP). As the EU's most extensive and long-standing policy, the CAP accounts for one-third of the EU budget and plays a crucial role in shaping the competitiveness of the agricultural and forestry sectors. However, evidence suggests that previous CAP reforms have had a limited impact on advancing climate change mitigation and adaptation efforts (Alons 2018, Pe'er et al. 2019, Haseler 2022) .

Sustainable agriculture and forestry have the potential to mitigate environmental degradation—particularly concerning soil, water, and biodiversity—while simultaneously ensuring economic viability and social equity. Despite these benefits, the adoption of sustainable practices and smart technologies in agriculture and forestry remains limited, largely due to policy frameworks that have overlooked the critical role of human behavior in driving adoption. Nudging, a behavioral science-based approach, has demonstrated effectiveness in increasing the take-up rate of pro-environmental and pro-social behaviors. A growing attention in the literature for the design and evaluation of green nudges in agriculture is documented in the previous part of this deliverable.

Green nudges have proven successful in promoting sustainable behaviors among consumers and farmers in a variety of settings and contexts. However, there remain several limitations and areas of further investigation. First, research indicates that the effects of nudges may be temporary, as individuals often revert to previous behaviors once external reinforcement diminishes, primarily due to a failure to internalize new behavioral patterns. Second, nudges often reach a relatively small effect size, due to the softness of the nudging approaches. Third, nudges operate by leveraging and exploiting behavioral biases in people. While it is proven that most people are affected by several behavioral biases (Stango and Zinman 2023), nudges may be effective only on segments of the population. Finally, population preferences, perceived effectiveness, and acceptability of nudging practices may also be responsible for their success. While nudging practices for sustainable consumption have found the support of the general population (Reisch and Sunstein 2016), the evidence on farmers and forest owners' nudge acceptability and perceived effectiveness is scarce. In particular, Colen et al. (2024) find that Swedish farmers have remarkably lower approval rates of nudging policies than the general public.

This Deliverable aims to deepen our understanding of the role of nudges in farmers and forest owners' decisions to implement sustainable practices. It investigates the role of behavioral biases, farmers and forest owners' perceived effectiveness and acceptability of nudges and how these relate to different socio-economic and behavioral traits. To do this, we developed an online survey in four Use Cases (UCs): Belgium, Finland, Italy and Lithuania. We target farmers in mixed farms in Belgium, forest owners in Finland, winegrowers in Italy and wheat farmers in Lithuania. In each UC, we identified one agricultural or forest management sustainable practice that is relatively under-developed, and which could be pushed using nudges. Then, we develop seven green nudges that could be implemented by the regional or national institutions to push farmers and foresters toward the adoption of sustainable practices. The seven nudges cover the most relevant categories identified in the literature, as presented in Section 3. Namely, we design contextualized nudges for the following categories: default option, timely reminder, reframing risks, social norm, making actions visible, moral appeals (emotional arousal), making salient losses and benefits (future prospects). Through a choice experiment, survey respondents are invited to rate nudges along two key dimensions: perceived effectiveness and acceptability. Respondents are also enquired about farm characteristics, current sustainable practices implemented, preferences and behavioral biases. This allows us to conduct a cluster analysis aiming at identifying what typology of farmers is more related to sustainable practice adoption and preference toward nudges.

We find that the adoption of sustainable practices varies across countries and is influenced by distinct socio-demographic and behavioral factors. In Italy, larger farm size predicts interest in the green multi-risk insurance, with economic concerns as a key barrier. Considering the intention to adopt green insurance as the social norm, risk-seeking attitudes and general environmental concerns have a positive impact on the intention to adopt itself. This suggests that nudges *reframing risks*, *social norms* or *reframing losses and benefits* nudges could facilitate behavioral change in this UC. However, results from the BWS survey

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suggest that *reminders, make action visible,* and *reframing losses and benefits* are among the nudges that are perceived as the most effective, while *social norm nudges* are perceived as one of the least effective and the least acceptable of the nudges.

In Belgium, prior engagement in sustainable practices predicts voluntary buffer strip adoption, with bureaucracy and economic concerns as barriers. Virtue signaling (desire to appear sustainable to consumers) positively influences adoption, implying that *visible sustainability labels* could enhance uptake. However, the BWS analysis indicates that *default nudges* and *reminders* are perceived as the most effective and acceptable in this sample.

In Finland, older forest owners are more likely to implement continuous cover forestry, with the characteristics of the forest being a barrier. Environmental concerns and belief that others are adopting the practice drive uptake. This indicates that *moral appeals* and *social norm nudges* could encourage adoption. However, the BWS survey indicates that social *norm nudges* are perceived among the least effective and acceptable. Instead, *default* and *reminders* are considered as the most acceptable and effective strategies.

In Lithuania, longer farming experience predicts crop rotation adoption. The belief that crops rotation is the norm positively influences adoption, meaning *social norm* campaigns may be effective even though it is perceived as one of the least effective and acceptable options by farmers. On the other hand, *reminders* are one of the nudge interventions that are perceived as the most acceptable and effective.

4.2. Methodology

4.2.1. Contexts and Samples

In this Section, we describe the different contexts, the sustainable agricultural practice that was proposed, and the target samples we consider in each UC.

Belgium

Intensive livestock production is widespread in Belgium and constitutes a significant share of agricultural output (26.2% of the total animal output), GDP, and employment (1.26 million cattle spread across 9,600 farms). Livestock farming is often closely linked to crop production, as many producers own or lease extensive fields to cultivate animal feed. In Belgium, a substantial proportion of farmers operate mixed farms, combining livestock and crop production.

Intensive livestock farming, while economically significant, presents multiple sustainability challenges that impact the environment and animal welfare. One major concern is the reduction of grazing in grasslands to control greenhouse gas (GHG) emissions, which raises ethical questions regarding animal welfare. Additionally, the expansion of monoculture crop production to support livestock feed demands contributes to biodiversity loss by replacing natural habitats with large, pesticide-dependent agricultural plots that require heavy machinery. Water pollution is another critical issue, as nutrient runoff from manure and fertilizers contaminates nearby water bodies, leading to eutrophication and ecosystem degradation. Soil erosion further exacerbates environmental strain, particularly in sloped areas where forage crops are planted in rows with bare, weed-free soil in between, increasing vulnerability to erosion. Moreover, the high energy consumption associated with intensive livestock farming, such as cooling milk and ventilating barns during hot summers, adds to its environmental footprint. Addressing these challenges is crucial to ensuring a more sustainable and responsible approach to livestock production.

To address some of these challenges—specifically biodiversity loss, soil erosion, and water pollution—public institutions have introduced buffer strips, a zone between the crops and watercourse, aimed at maintaining non-cultivated land along riversides. The Flemish government's scheme includes both a mandatory and a voluntary component. Under the mandatory scheme, farmers are required to:

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1. Refrain from cultivating crops within 1 to 5 meters of a watercourse.
2. Avoid applying pesticides within 1 to 5 meters of a watercourse.
3. Restrict fertilizer application within 5 to 10 meters of a watercourse.

Flemish legislation changed by the end of December 2024. The buffer strips are stricter now.

The voluntary component allows farmers to extend buffer strips between 1 and 12 meters, replacing crop cultivation with grass or flower strips. By integrating buffer strips into their operations, farmers help protect vulnerable landscape elements, such as watercourses, from pesticide and fertilizer leaching while simultaneously enhancing biodiversity on their land.

To support the voluntary buffer strips, the Flemish government provides financial compensation to farmers for revenue losses, offering subsidies per hectare. There are two types of subsidies: Eco-schemes which can be applied anywhere in Flanders and the Agromanagement agreements which can be only applied in specific regions. The compensation varies depending on the type of buffer strip, ranging from €945 to €2,058 per hectare.

Despite the voluntary scheme being in place for several years, its adoption rate remains relatively low: around 2,865 hectares spread across 4,574 farmers (Agentschap Landbouw en Zeevisserij – Landbouwcijfers).

In our survey, we selected voluntary buffer strips as the key sustainable practice to assess. The target population comprises cattle farmers who also cultivate arable land and have at least one plot adjacent to a watercourse.

Italy

Wine production holds great significance in Italian tradition and plays a pivotal role in the national agribusiness sector. In 2023, the industry generated a turnover of approximately €13.8 billion, representing 10% of the total value of agricultural production (ISMEA, 2024). With an average annual output of 47 million hectolitres, accounting for around 16.1% of global production, Italy ranks among the world's leading wine producers (OIV, 2024). Additionally, wine is the largest contributor to Italian agri-food exports, with a value of approximately €3.9 billion, representing 11% of the sector's total export value (ISMEA, 2024a).

Despite its economic and cultural importance, viticulture also generates negative environmental externalities that contribute to ecosystems degradation and climate change. Key categories of environmental impact of wine production include water use and quality, waste generation and management, energy consumption, greenhouse gas emissions, land use changes, soil quality, and biodiversity losses (Christ & Burritt, 2013). While wine production impacts the environment, its long-term viability is equally dependent on environmental conditions (Gabzdylova et al., 2009). Ecosystems degradation and climate change generate production risks that threaten the resilience of farming businesses and food systems in the EU, triggering recursive processes that are difficult to break. This is particularly concerning in the Mediterranean regions, identified as a major "hot spot" for climate change (Van Passel et al., 2017).

To address these challenges, the EU policy framework has recently set ambitious goals in terms of environmental sustainability via the Farm-to-fork strategy and the new CAP 2023-2027. Transition towards more sustainable farming systems is generally promoted within the CAP using financial subsidies via Agri-environmental and climate schemes (AECS) and eco schemes. However, public subsidization alone does not guarantee meeting the environmental objective proposed by the EU in terms of GHG emissions reduction and biodiversity enhancement (i.e. Paris Agreement, Effort Sharing Regulations, Biodiversity strategy 2030, ect.). Other complimentary financial interventions are needed from a public-private partnership perspective. An option is to top-up public funding with private funding from the private sector that needs to meet some of these goals themselves (i.e. facilitating conditions for access to credit, green insurances, etc.).

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In this UC, we propose the introduction of green insurances which link insurance benefits to the adoption of sustainable farming practices in an ESG perspective (Lefebvre et al., 2025). Green insurances are not marketed yet in Italy. Therefore, in addition to public funding to promote risk transfer in agriculture (Rippo & Cerroni, 2023), farmers who adopt more sustainable practices or meet specific environmental standards would benefit from favorable insurance conditions. The adoption of agricultural insurance among Italian winegrowers is limited. While wine is the most insured crop, the demand for insurance products is highly heterogeneous, leaving room for improvement in uptake (ISMEA, 2024b). Farmers' demand for agricultural insurance products, including new instruments like green insurance, can be boosted using behavioral interventions, such as nudging-based actions.

Finland

Finland has a unique forest ownership structure, with over 600,000 non-industrial private forest owners among a total population of approximately 5 million. This results in a highly diverse landscape of forest management practices, shaped by varying ownership profiles, economic interests, and levels of engagement in forest management activities. Private forest owners own around half of forestry land and play a critical role in decision-making regarding forest use and management, whether through direct involvement or via intermediaries such as forest advisors, managers, and service providers.

Forestry is a cornerstone of Finland's economy, with forest industry products accounting for 17 per cent of total national exports in 2024 (Finnish Customs, 2023). The sector provides employment to a significant portion of the population, employing 2.4% of the national workforce in 2021 (Luke, 2023). It supports rural livelihoods and supplies raw materials for industries such as paper, timber, and bioenergy production. However, the sustainability of these economic benefits is closely linked to forest management practices, making responsible forestry a key policy and environmental concern.

A pressing environmental issue in Finnish forestry is the lack of management in some privately owned forests, leading to underutilized resources and decreased forest health. Between 2019 and 2023, over half of forestry land allocated to timber production was either a young or advanced seedling stand, or a thinning stand (Luke, 2024c). Natural regeneration felling accounted for less than one per cent of the total, while mixed-aged forests even less. This makes Finnish forests very even aged, with over 70 per cent of all forest stands less than 80 years old (Luke, 2024b). Additionally, widespread clear-cutting practices pose significant ecological risks, including biodiversity loss, soil degradation, water pollution, and disruptions in carbon sequestration. Out of all loggings conducted in 2023, 18.7% were conducted as clearcutting (Luke, 2024a). The removal of entire forest stands in clear-cutting alters habitats, increases erosion, and diminishes the resilience of ecosystems to climate change.

Continuous Cover Forestry (CCF) presents a sustainable alternative to conventional clear-cutting. This practice maintains a permanent forest cover by selectively harvesting trees rather than removing entire stands. CCF promotes natural regeneration, enhances biodiversity, and improves soil and water conservation. Deforestation—the permanent removal of forest cover resulting in land use change, typically for agriculture or development—is a major driver of carbon emissions and biodiversity loss. By avoiding large-scale clearances, CCF helps mitigate carbon emissions associated with deforestation and ensures long-term ecological stability.

Adopting CCF can offer multiple environmental advantages. It fosters habitat continuity for wildlife, reduces soil erosion, and maintains water quality by minimizing runoff and sedimentation. Moreover, continuous cover forests act as effective carbon sinks (Luyssaert et al. 2008), contributing to climate change mitigation. As a nature-based solution, CCF aligns with Finland's commitment to sustainable forestry . Despite these advantages, CCF currently only makes up around 3 per cent of all national loggings (Luke, 2024) and no systematic eco-scheme is available at local or national level. Survey results reveal that only 31 per cent of forest owners have been with CCF as a potential forest management practice (Suominen, 2023). This discourages the adoption of the practice, although some studies highlight that non-negligible population shares tested CCF or are willing to do so in the future (Karttunen, 2020).

In our survey, we selected CCF as the key sustainable practice to assess. The target population comprises forest owners with at least one hectare of owned forested land.

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Lithuania

The arable sector is a cornerstone of Lithuania's economy, significantly contributing to agricultural output and rural employment. As of 2022, Lithuania's total land area is approximately 6.53 million hectares, with agricultural land comprising about 3.38 million hectares (51.9% of the total land area). Arable land accounts for the largest share, covering approximately 2.3 million hectares (Lithuanian Statistical Office - OSP 2022).

Wheat remains the predominant grain crop in Lithuania. In 2023, the country produced approximately 4.5 million tons of wheat, underscoring its significance as a key export commodity. This high production volume highlights wheat's significance as a key export commodity, ensuring both food security and economic stability. The sector supports rural livelihoods, bolsters agricultural businesses, and contributes to the national GDP through domestic consumption and international trade.

Traditionally, Lithuanian farmers have relied heavily on monoculture practices, particularly in wheat cultivation. This approach offers advantages such as streamlined production processes, reduced machinery costs, and market stability. However, long-term wheat monoculture depletes essential soil nutrients, gradually reducing fertility and increasing reliance on synthetic fertilizers to maintain yields. The practice also fosters conditions conducive to the buildup of crop-specific pests and diseases, increasing farmers' dependency on pesticides. Additionally, excessive use of chemical fertilizers contributes to nutrient runoff, polluting water bodies and exacerbating eutrophication. Monoculture reduces biodiversity by limiting habitat diversity, negatively affecting local ecosystems and pollinators. Furthermore, such farming systems are highly vulnerable to climate change, as they lack the resilience needed to withstand extreme weather conditions such as droughts and heavy rainfall.

To address these challenges, Lithuania has implemented policies promoting crop rotation as a sustainable agricultural practice. Crop rotation is an agricultural technique where different crops are grown on the same field in sequential seasons. This practice enhances soil health, interrupts pest and disease cycles, and improves overall productivity. Widespread adoption of crop rotation provides multiple environmental and economic benefits, including improved soil health, reduced dependency on chemical inputs, and enhanced resilience to climate change. It helps maintain soil fertility by preserving nutrient levels and enhancing organic matter content. By disrupting pest and disease cycles, crop rotation reduces the need for pesticides, thereby lowering production costs and mitigating environmental risks. The practice also prevents soil compaction and erosion, improving water retention and reducing agricultural runoff. Additionally, diversified planting supports beneficial insects and microorganisms, promoting biodiversity and ecological stability. The inclusion of cover and nitrogen-fixing crops contributes to carbon sequestration, playing a role in climate change mitigation. Moreover, rotating crops enhances farm resilience to extreme weather events, ensuring long-term agricultural sustainability (Lal 2015, Bullock 1992).

Lithuanian agricultural policy mandates a four-crop rotation annually, requiring at least one soil-improving crop and a minimum of 10% of the land to be dedicated to protein crops. Consecutive planting of the same crop in the same field for two years is prohibited, and farmers must submit annual applications to qualify for support.

Farmers seeking subsidies under the "Crop Rotation" environmental support scheme must comply with specific crop diversification requirements. The rotation must involve at least four crops, with one being a legume. From 2025 onwards, no more than 50% of the declared area can be allocated to the primary crop in the rotation. While the same crop cannot be grown on the same land for two consecutive years, specific crops such as alfalfa and clover may be cultivated for up to four years but must not exceed 20% of the declared area from the second year onward. Additionally, at least 10% of the declared area must be allocated to legumes or legume-dominant crop mixtures. Applicants for the subsidy must submit an annual application declaring a minimum of one hectare of suitable agricultural land, with fields no smaller than 0.1 hectare. These commitments must last for four years, during which the declared area cannot be

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significantly altered by more than a 10% increase or decrease in size. The National Payment Agency is responsible for monitoring and ensuring compliance with these commitments.

By 2023, an estimated 25-30% of Lithuania's arable land was cultivated following crop rotation principles, reflecting an increasing shift toward sustainable farming practices, according to data from the Lithuanian Centre for Social Sciences Institute of Economics and Rural Development and records from the Agricultural Information Center. To further promote its uptake, the Lithuanian government provides financial incentives, with farmers receiving subsidies of 56,60EUR per hectare in 2024 for implementing crop rotation. In our survey, we selected crop rotation as the key sustainable practice to assess. The target population comprises forest owners with at least one hectare of owned forested land.

Table 7 summarizes the key information about context, sustainable practice, target population for each of the four UCs.

Table 7: Context and target population

	Belgium	**Finland**	**Italy**	**Lithuania**
Environmental issue	Water pollution, biodiversity loss, soil erosion	Intensive forest management, ecosystem services	Climate change impacts, intensive pesticide use, biodiversity loss	Biodiversity loss, intensive pesticide use
Sustainable practice	Buffer strips	Continuous cover forestry	Green insurance	Crop rotation
Presence of Eco-scheme	Yes	No	No	Yes
Target population	Dairy farmers	Forest owners	Winegrowers	Wheat farmers

4.2.2. Survey instrument

The survey is structured in several blocks.

In the first block, we assess farmers' and forest owners' preferences for green nudges that promote the adoption of sustainable practices. First, participants receive a description of the sustainable practice, which may be introduced as “new” and compared to the prevailing alternative. They are then asked whether they currently implement the practice and, if not, the main reasons for non-adoption. Second, we present seven types of nudges: default option, timely reminder, risk reminders, social information, visibility, emotional arousal, and future prospects. Rather than using the term “nudge,” we define these as “actions that could promote the adoption of sustainable practice” and illustrate them with examples. The nudges were tailored to different contexts in collaboration with local partners while maintaining a consistent core structure. Appendix Table A details these adaptations across different UCs. Third, we use the Best/Worst Scale (BWS) strategy (Finn & Louviere, 1992; Marley & Louviere, 2005) to gauge farmers' and forest owners' preferences regarding nudge acceptability and perceived effectiveness. Participants review a series of seven choice cards, each displaying a pre-determined set of nudges. They must select the most and least acceptable/effective nudge on each card. To reduce the response burden, each participant is randomly assigned to evaluate either acceptability or perceived effectiveness.

In the second block, we gather information about respondents’ preferences, values and behavioral biases. We ask questions aimed at measuring: virtue seeking, trust in science, self-efficacy, risk and time preferences, loss aversion, innovation openness, influence of social norm, environmental identity/values, confirmation bias, beliefs about peers’ sustainable behavior.

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In the third block, we enquire about the adoption of other sustainable practices, besides the one proposed at the beginning. The list of sustainable practices was established in coordination with the local partners. Farmers/forest owners could report whether they were currently adopting the practice and their willingness to adopt it in the future.

In the final block, we collect basic individual socio-demographics and farm characteristics. We enquire about respondent gender, age, education, experience in the agricultural sectors, whether the business was inherited, beliefs about whether the business will be continued by a family member, and land size.

The survey was programmed in Qualtrics and could be accessed by phone, tablet, or computer. The link and QR code to start the survey was incorporated in emails, newsletters, and meetings by the local partners to maximize the outreach in the target groups. The survey duration was estimated to be around 25 minutes. The actual median completion time is 28 minutes. Respondents were incentivized to participate in the survey. In the survey description, we highlighted that 40 randomly selected respondents would be awarded a prize worth 25 euros. The nature of the prize differed from country to country.

Data collection started on November 13th, 2024, and ended on January 30th, 2025. Ethic clearance was received by University of Trento IRB (code 2024-082ESA).

In what follows, we provide the details of the contact sources, the recruitment strategy and the response rate in each UC.

4.2.3. Sample recruitment

Sample recruitment was managed by the local partners and was implemented differently from UC to UC. In general, local partners extracted the list of contacts from institutional sources and internal resources. In some cases, survey participation was promoted through social media channels and public events. In the typical approach, farmers and forest owners were contacted by email. The email included a brief description of the study purpose, the importance of participation and the link to the survey. One or more reminders were delivered in the following weeks.

In what follows, we provide details about the way the samples are contacted and recruited in each UC.

Belgium

Farmers' contacts source is the Flemish Agency for Agriculture and Fisheries. Thanks to the institutional collaboration between the Agency and the project partner ILVO, farmers' email addresses were obtained from the agency. To comply with ILVO's internal data protection requirements, the survey was adapted.

The target group consisted of dairy farmers who also cultivate arable land and have at least one plot adjacent to a watercourse. Farmers fitting into one of the following categories were selected: - Dairy cattle - Combination of arable farming and dairy cattle - Livestock combination: breeding and dairy cattle - Dairy farming and arable farming combination - Livestock combination: mainly dairy cattle. This filtering process identified 3,039 farmers who met the criteria. From this group, 2,342 unique email addresses were obtained from the agency. The respondents were divided into two groups in accordance with ILVO's protocol, established in collaboration with the Flemish Agency for Agriculture and Fisheries, to mitigate survey fatigue. If sufficient responses were obtained from Group 1, Group 2 would not be contacted. Group 1 included 1,914 farmers who received an initial email on November 27, followed by two reminders sent on December 10 and December 17. Group 2 included 428 farmers who received an initial email on December 10, followed by one reminder on December 17. They were sent an invitation to participate via email, which included an information sheet outlining the study objectives and relevant details, and the link to the online survey. In parallel, Borrennatuur, the other local partner, reached about 550 farmers through the newsletter, in December.

Overall, 288 farmers initiated the survey, 198 gave their consent to proceed, 129 answered the BWS, and 81 eventually completed it.

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On December 18, 2024, the Flemish Government enacted legislation on buffer strips, which came into effect on January 1, 2025. This new legislation had direct implications for our survey. Specifically, the "background information," including the two illustrative images provided to respondents, became outdated. For example, the regulations on pesticide application for certain crops near watercourses have become stricter, increasing the buffer distance from 1-3 meters to 3-5 meters. As a result, the choices described at the beginning of the survey were no longer completely accurate. For this reason, we decided to stop data collection in early January 2025 and stop sending reminders.

Italy

The target group for the survey in the Italian UC consisted of winegrowers. Potential participants were recruited through the contact network provided by the National Association of Agricultural Insurance Consortia (ASNACODI Italia), PRUDENT's local partner, and 12 regional consortia. A total of 3,138 farmers were contacted in three rounds of email communication, on November 13, December 2 and December 23. They were sent an invitation to participate via email, which included an information sheet outlining the study objectives and relevant details, and the link to the online survey. To improve participation, follow-up actions were conducted after each email round. Specifically, incomplete survey responses were identified, and reminder emails were sent to encourage respondents to complete the questionnaire. When telephone contact details were available, participants were personally called by either the research team or representatives of the local consortium to remind them to complete the questionnaire. Moreover, the survey was promoted during one in-presence and one online event.

Overall, 384 farmers initiated the survey, 227 gave their consent, 164 answered the BWS, and 152 eventually completed it.

Finland

Forest owners contact information are provided by the Metsäkeskus (the Finnish Forest Centre), which ensures open access to contact information for research as regulated by the National Forest Data Act. This allowed the European Forest Institute, our local partner, to obtain a list of 5,000 email addresses of registered forest owners. The list was skimmed to comply with the following screening criteria: forest owners within the region of North Karelia, having at least 1 hectare of owned forested land, excluding death estates. The filtering led to 4,681 available contacts. The total number of first contacts was 2,790, of which 2,591 were valid. EFI sent forest owners an invitation to participate via email, which included an information sheet outlining the study objectives and relevant details, and the link to the online survey. General reminders were sent to all, and specific reminders were sent to forest owners who started but did not finish the survey.

Overall, 283 forest owners initiated the survey, 161 gave their consent, 101 responded to the BWS, and 95 eventually completed it.

Lithuania

Lithuanian farmers are reached through AgriFood Lithuania's list of contacts. A total of 10,000 invitation emails were sent through the AgriFood Lithuania newsletter from November onwards. Out of these, 4,500 were direct farmer contacts, while the remaining emails were sent to various organizations working with farmers. Moreover, the local partners participated in five farmers' events where they proposed and promoted the survey completion.

Overall, 101 farmers gave their consent, 78 answered the BWS, and 76 eventually completed it.

In total, 687 farmers and forest owners gave their consent to participate in the survey: 198 in Belgium, 161 in Finland, 227 in Italy and 101 in Lithuania. From this, 59% of the respondents finished the survey, leaving us with a complete sample of 404 observations: 81 in Belgium, 95 in Finland, 152 in Italy and 76 in Lithuania.

Table 8 summarizes the recruitment effort and shows the number of contacts reached, the channel and the number of surveys completed. Considering the overall number of initial contacts, 18,071, and the final

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number of surveys completed, the study response rate was 2.2%. Due to the survey length, not all respondents who started the survey reached the end. In particular, 472 respondents completed the initial block related to the BWS, while 404 (86%) completed the entire survey

Table 8: Survey recruitment and responses

Country	N. of first contacts	Channel	N. of initiated surveys	N. of BWS completed	N. of completed surveys
Belgium	2,342	Emails + newsletter	198	129	81
Finland	2,591	Emails	161	101	95
Italy	3,138	Events + emails	227	164	152
Lithuania	10,000	Events + emails	101	78	76
Total	**18,071**		**687**	**472**	**404**

4.2.4. Variables description

In Tables 9 and 10, we describe how the variables we use in the analysis have been operationalized, starting from the question posed in the survey. Table 9 presents individual and business characteristics. The key variable of interest is the adoption of the sustainable practice presented at the start of the survey. Respondents can adopt the practice with or without the support of an eco-scheme, when available. The propensity to adopt the practice is then operationalized with a binary variable taking the value of one if the practice is implemented, and zero otherwise. We characterize farmers and forest owners by several individual and business characteristics. Individual characteristics include the usual socio-demographics: gender, age (only in some countries), education, experience with farming or forestry activity. As business characteristics we ask the size of land owned, whether the business was inherited, and the beliefs about whether it will be continued. Finally, we ask whether respondents implement or are willing to implement in the future other agricultural or forestry sustainable practices. The list of practices is UC-specific; hence we generate two variables representing the share of sustainable practices adopted or to be adopted, out of the total practices proposed. We are interested in measuring the potential behavioral factors that may affect the non-adoption of sustainable practice and that can be leveraged using green nudges. The selection of factors is informed by the literature review in Section 2. We follow internationally accepted validated scales to measure the following factors: confirmation bias, trust in science, innovation openness, risk and loss aversion, relevance of the social norm, virtue seeking, self-efficacy, environmental concerns. The operationalization of each variable is presented in Table 10.

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Table 9: Operationalization of individual and business characteristics

Characteristic/factor	Survey question	Survey scale	Variable operationalization
Sustainable practice adoption	Do you implement [SUSTAINABLE PRACTICE]? 1) Yes, with eco-scheme (if applies) 2) Yes, without eco-scheme (if applies) 3) No	Multiple choice question	Coded as 1 if chose "Yes, with eco-scheme (if applies)" or "Yes, without eco-scheme (if applies)", 0 if "No"
Inherited business	"Was your business inherited? 1) Yes 2) No 3) I do not want to answer"	Multiple choice question	Coded as 1 if chose "Yes", 0 if "No" and "NaN" if "I do not want to answer" is selected.
Years of experience	"How many years have you been involved in farming? 1) Less than 5 years 2) Between 5 and 10 years 3) Between 10 and 20 years 4) More than 20 years"	Multiple choice question	Coded as a categorical variable ranging from 1 (less than 5 years) to 4 (more than 20 years).
Gender	"Indicate you gender: 1) Male 2) Female 3) Other"	Multiple choice question	Coded as 1 if chose "Male" and 0 if chose "Female"
Education	"Indicate the highest level of education you have achieved: 1) Primary school 2) Middle school / high school 3) Bachelor's degree 4) Master's degree 5) PhD"	Multiple choice question	Coded as a categorical variable ranging from 1 (primary school) to 5 (PhD).
Size of land owned	"Utilized agricultural area (UAA) of your holding, in hectares:"	Open-entry box	Continuous variable
Belief business will be continued	"Do you think your activity as a farmer will be continued in the future by a family member? 1) Yes 2) No 3) I do not know 4) I do not want to answer"	Multiple choice question	Coded as 1 if "Yes" is selected, 0 if "No" or "I do not know" is selected, and "NaN" if "I do not want to answer" is selected.
Ratio of other sustainable practices already implemented	For each sustainable practice (list depending on the country): 1) I have implemented it 2) I will implement it in the future	Multiple choice question	Ratio of practices reported as already doing (1 is selected) over the number of practices assessed (from the list asked for each country.
Ratio of other sustainable practices planned in the future	For each sustainable practice (list depending on the country): 1) I have implemented it 2) I will implement it in the future	Multiple choice question	Ratio of practices reported as willing to implement in the future (2 is selected) over the number of practices not already implemented (from the list asked for each country).

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Table 10: Operationalization of behavioral factors

Characteristic/factor	Survey question	Survey scale	Variable operationalization
Confirmation bias	"I tend to pay less attention to information that does not align with what I already think."	1 (strongly disagree) - 7 (strongly agree	Coded as a continuous score (1-7)
Trust in science	"How much trust do you have in: "Scientists""	1 (do not trust at all) - 7 (trust completely)	Coded as a continuous score (1-7)
Innovation openness	"I am open to innovation in my farm."	1(strongly disagree) - 7 (strongly agree)	Coded as a continuous score (1-7)
Risk aversion	"Indicate how willing you are to expose yourself to the risks in the following domains, on a scale from 1 (not willing at all) to 7 (very willing). 1) Production risks (e.g. adoption of an innovative practice) 2) Market and prices risks (e.g. fluctuation of sales prices) 3) Financing risks (e.g. repaying credit and loans)"	1 (not willing at all) to 7 (very willing)	Coded as the average between the three metrics - continuous score (1-7)
Loss aversion	"Indicate how much you think about potential losses and gains when making an investment in your farm, on a scale from 1 (not at all) to 7 (very much). 1) Potential losses 2) Potential gains"	1 (not willing at all) to 7 (very willing)	Coded as the difference between the number reported for losses and the number reported for gains such that a positive value indicates a focus on losses and a negative value indicates a focus on gains- continuous score (-6 - 6)
Belief UC practice is the norm	"Most farmers in my area would be interested in adopting multi-risk green insurance."	1 (not willing at all) to 7 (very willing)	Coded as continuous - continuous score (1-7)
Influenced by norms	"My farm management is similar to that of farmers working in my area." "My decisions about farm management are influenced by decisions of other farmers working in my area."	1 (not willing at all) to 7 (very willing)	Coded as the average between the two questions - continuous score (1-7)
Virtue seeking	"My decisions about farm management are influenced by my desire to appear virtuous in the eyes of consumers"	1 (not willing at all) to 7 (very willing)	Coded as continuous score (1-7)
Self-efficacy	"Not having the skills to use a new technology holds me back from adopting it."	1 (not willing at all) to 7 (very willing)	Coded as continuous score (1-7)
Patience	"I am willing to forgo a benefit today in order to get a greater benefit in the future."	1 (not willing at all) to 7 (very willing)	Coded as continuous score (1-7)
Environmenta concern	"I am concerned about environmental issues in my area (e.g. pollution, overuse of resources) and their consequences." "Immediate action is necessary to combat climate change, and biodiversity and ecosystems degradations."	1 (not willing at all) to 7 (very willing) 1 (not willing at all) to 7 (very willing) 1 (not at all) to 7 (very much)	Coded as the average between the three questions - continuous score (1-7)

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	"Indicate how important environmental goals are to you when managing your farm."		

4.3. Results

4.3.1. Sample description

Social-demographic profile by country

Overall, the most common profile of respondents in our sample is a man with a high school diploma who inherited their businesses and has been farming or managing their forest for more than 20 years. Table 111 presents the socio-demographic profile of respondents for each country.

In Belgium, we find the highest rate of inherited business (95% of the sample), the largest proportion of male respondents (94%), and the lowest number of respondents believing a family member will continue their businesses (26%). The sizes of Belgian farms are relatively more homogenous than in the other countries: the average size (69 ha) is the closest to the median size (55 ha). For data privacy matter, we could not collect information on respondents' age.

Finland is quite peculiar as the sample is composed of forest owners. Besides, it is the second after Lithuania with the smallest proportion of inherited business (here a forest, 55%). This sample is also more educated than Italy and Belgium, with the median respondent holding a bachelor's degree. The share of respondents believing that someone in their family will continue managing their forest is the highest (75%). On average, the size of forest in the sample is 106 ha. The average respondent is 64 years old.

In Italy, there is the highest share of male respondents after Belgium (92%). The peculiarity of the Italian case lies in the heterogeneity in the sizes of farms. The median Italian winegrower owns a farm of 19 ha, but the average winegrower owns 96 ha. The average respondent is 50 years old.

Lithuania differs from the other countries with a sample balanced in terms of gender (51% of male respondents). Lithuania is also characterized by the smallest share of inherited businesses compared to the other countries (36%). The median Lithuanian farmer also exhibit less experience than the other countries (between 10 and 20 years of experience) and a higher education level compared to Belgium and Italy (bachelor's degree). For data privacy matters we could not collect information on respondents' age in all countries.

To assess the extent to which our sample is selected or rather representative of the target populations of interest, we compare the basic socio-demographics with national or regional level statistics. This is relevant for the external validity of the findings. In Table 12, we show that our study sample is not fully representative of the target populations in each UC. However, the direction of misalignments varies across UCs. For instance, the Belgian respondents are more male and have fewer land than the average regional population, while the median level of education is the same. In Finland, we have more female respondents with less forest than the national average, while age appears aligned. In Italy, we have more female respondents and larger size of land, while the median level of education appears higher than the national average. The Lithuanian sample appears quite similar to the national average in terms of gender composition and owning more land.

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Table 11: Social-demographic profile of respondents

	Belgium (n=129)	Finland (n=101)	Italy (n=164)	Lithuania (n=78)	Total (n=472)
Inherited business					
Proportion	95%	55%	72%	36%	66%
Years of experience					
Median	>20 yrs	>20 yrs	>20 yrs	10 to 20 yrs	>20 yrs
Male					
Proportion	94%	82%	92%	51%	82%
Age					
Mean	/	64 years old	50 years old	/	56 years old
Median	/	65 years old	52 years old	/	57 years old
Education					
Median	Up to high sch.	Bachelor's degree	Up to high sch.	Bachelor's degree	Up to high sch.
Size of land owned					
Mean	69 ha	106 ha	96 ha	151 ha	118 ha
Median	55 ha	49 ha	19 ha	58 ha	42 ha
Belief business will be continued					
Proportion (in %)	26%	75%	33%	32%	41%

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Table 12: Social-demographic profile of the target group

	Belgium	Finland	Italy	Lithuania
Male				
Proportion	76-80%	57.5%	68.5%	55%
Age				
Mean	56	61	58	NA
Education				
Median	Up to high sch.	NA	Up to secondary sch.	NA
Size of land owned				
Mean	27.6 ha	31.3 ha	10.5 ha	70-78 ha

Notes: for Belgium, data are from Agentschap Landbouw en Zeevisserij (2024a, 2024b) and refer to all farm businesses in 2022 in the Flanders; for Finland, data are from Natural Resources Institute Finland (2022-23); for Italy, data are from CREA (2024); for Lithuania data are from Lithuanian Statistical Office (2022) and Eurostat (2020).

Behavioral profile of UCs

Figure 9 depicts how the average farmer or forest owner in each country compares to the average of the whole sample along key behavioral factors.[4]

First, Italian farmers tend to exhibit a lower confirmation bias, i.e., a lower preference for information confirming what they think, compared to the average. They also tend to believe that the target practice is the norm (i.e., that other farmers find green multi-risk insurance interesting). They are also more concerned about the environment, more open to innovation in their farms, and find scientists more trustworthy than the average.

Belgian farmers tend to believe less that the target practice is the norm (i.e., that farmers around them are implementing voluntary buffer strips). They are also less concerned about environmental issues, less keen on taking risks, and find scientists less trustworthy than the average of our sample. They also exhibit weaker self-efficacy, namely, they are less confident about their ability to perform new tasks when they do not have all the skills necessary to execute them.

Finnish forest owners also exhibit weaker beliefs that the target practice is the norm (i.e., that farmers around them implement continuous cover forestry). They appear to be slightly less concerned about environmental issues, less open to innovation in their parcels, less willing to take risks compared to the average of the sample. They report a weaker influence of their desire to appear virtuous on the actions they take in their forests. Finally, they are more confident about their ability to perform new tasks, even if they do not have the skills necessary to execute them.

Finally, Lithuanian farmers show stronger beliefs that the target practice is the norm (i.e., that farmers around them implement crop rotation). They also report a stronger preference for information confirming what they already know. Compared to the average of the sample, they are more concerned about the environment, more averse to losses, more risk seeking, and find science more trustworthy. They also

4 Behavioral factors have been normalized to the entire sample mean and standard deviation to allow for comparability across factors and countries.

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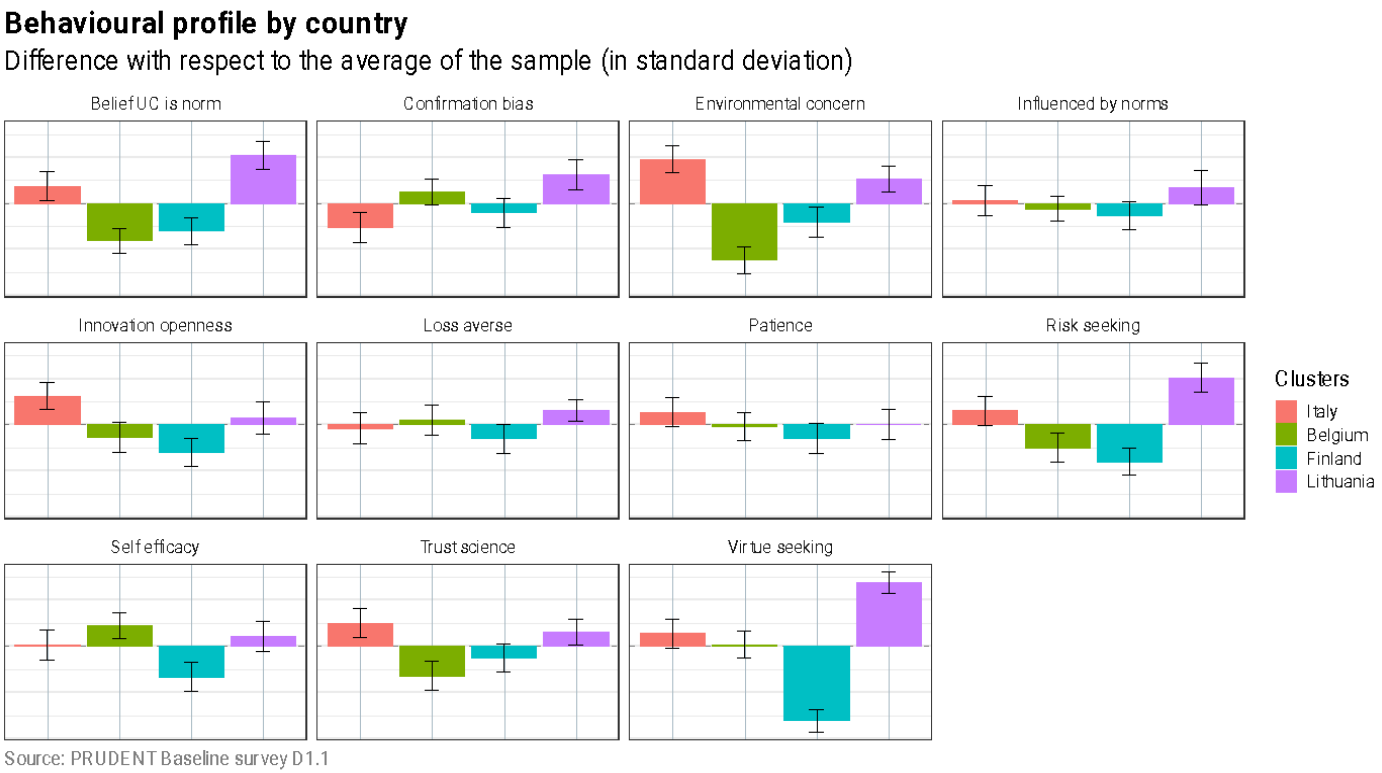
indicate a stronger influence of their desire to appear virtuous in the eyes of consumers when making decisions in their farms.

Figure 9: Behavioral profile by country



Adoption of the target sustainable practice

Adoption of the target sustainable practice is assessed at the beginning of the survey, after its explanation. Farmers and foresters could report whether they are currently implementing the practice or not (or no longer). In the case of the existence of eco-schemes, they report whether they are enrolled or not. In the Italian case, since the practice is related to a hypothetical green insurance that is not currently available in the market, farmers express their interest. Figure 10 shows that, overall, the sustainable practices proposed are relatively widespread among sample respondents, as about 54% declared to implement them to some extent. Shares are particularly high in Lithuania with 61% of respondents implementing the practice. The interest in the green insurance product is high in Italy with 72% of respondents declaring some interest. Buffer strips in Belgium are adopted by about 39% of respondents, while about one third of Finnish foresters declared to implement continuous cover forestry (35%).

In what follows, we present specific statistics for each UC, together with the main reasons why respondents do not implement the sustainable practice. The most relevant reasons for non-adoption are related to economic constraints, lack of knowledge about implementation or the eco-scheme compensation, lack of interest, and the bureaucratic burden.

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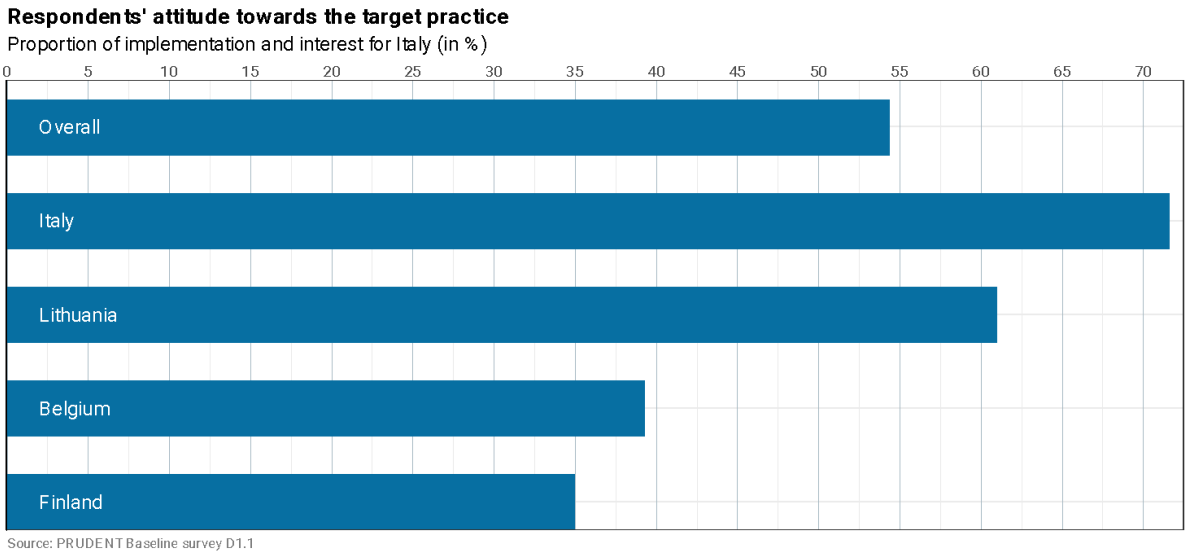
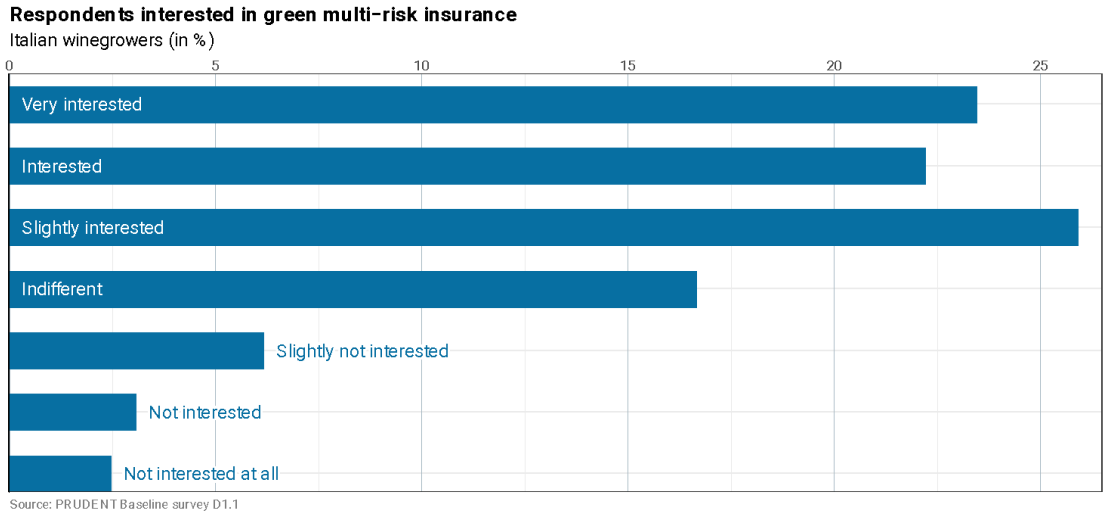
Figure 10: Interest for the target sustainable practice adoption



Italy

As shown in Figure 11, around 72% of Italian winegrowers declare being slightly interested, interested or very interested in adopting a green multi-risk insurance. Most of the rest of the sample is simply indifferent (16.7%). Only a small portion of our sample (11.7%) of Italian winegrowers declare being slightly not interested, not interested or not interested at all.

Figure 11: Interest in green multi-risk insurance (ItalianUC)



As shown in Figure 12, among the reasons cited for not being interested in the green insurance product, economic matters come first (42%), followed by a lack of knowledge about implementation (21%). Delays in subsidy payment is the most frequent reason advanced by those selecting “other” in the questionnaire.

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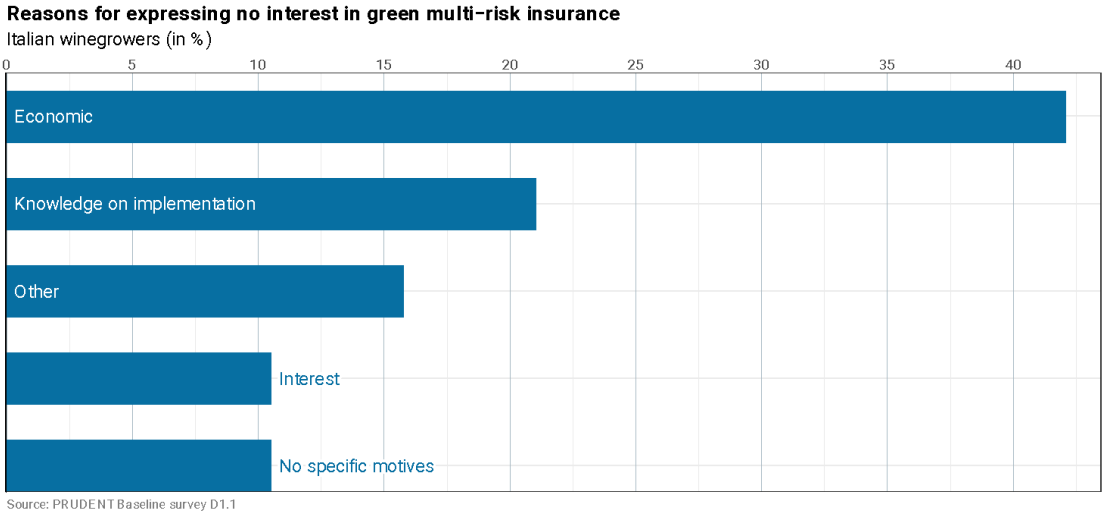
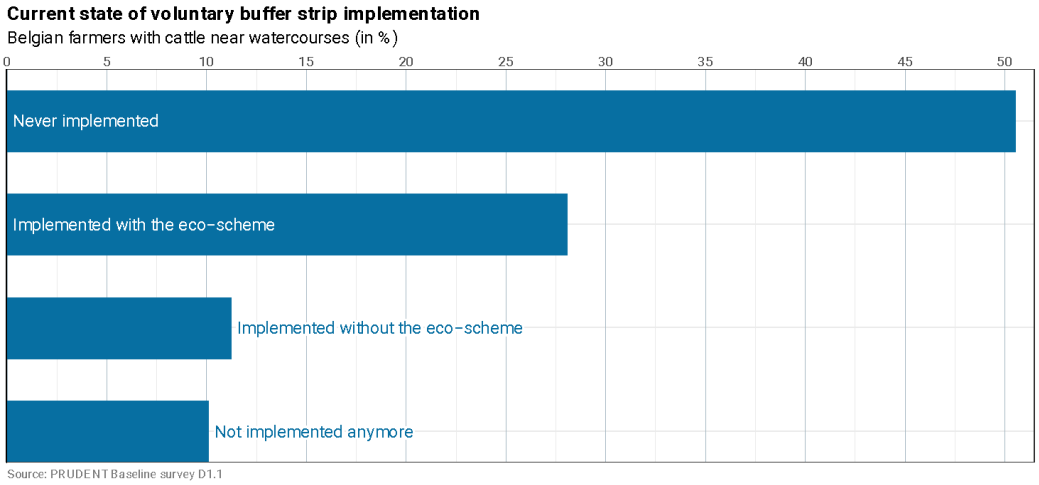
Figure 12: Reasons for no interest in green multi-risk insurance (Italian UC)



Belgium

As depicted in Figure 13, in Belgium, almost 51% of our sample have never implemented voluntary buffer strips near watercourses. Still, a large share (39%) of respondents declare that they are implementing it. Namely, 28% declare implementing voluntary buffer strips with the help of the eco-scheme, and 11% without the eco-scheme. A small portion (10%) declare having stopped doing voluntary buffer strips.

Figure 13: Adoption of buffer strips (Belgian UC)



Those who stopped implementing voluntary buffer strips and those having never implemented it motivate their decision by the high bureaucratic load (35%), the lack of economic incentives (28%), and other motives (28%). These other motives include the negative impact buffer strips have on production (through contamination to cultivated lands or decrease in the size of land cultivable), the lack of suitability to the farms' situation, lack of time, and fear of fines if the buffer strips are not properly implemented (Figure 14).

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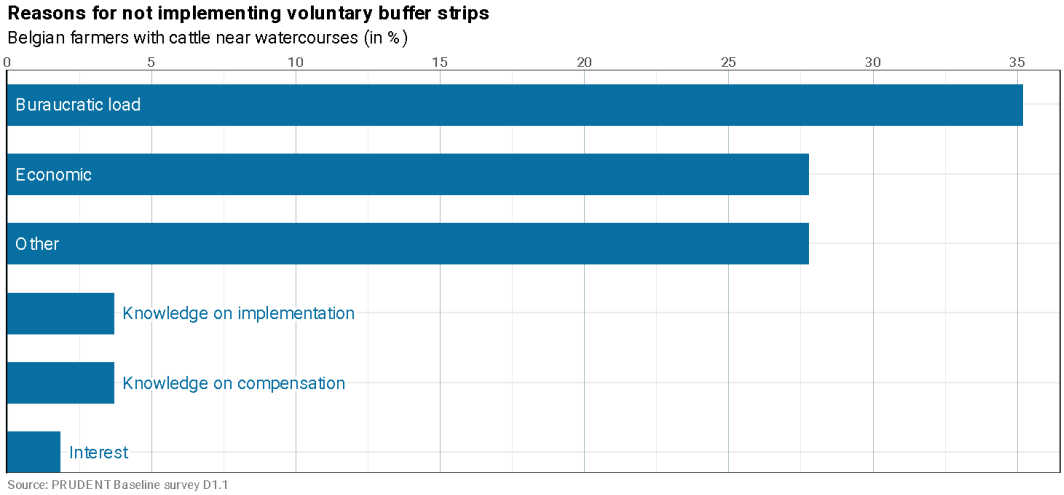
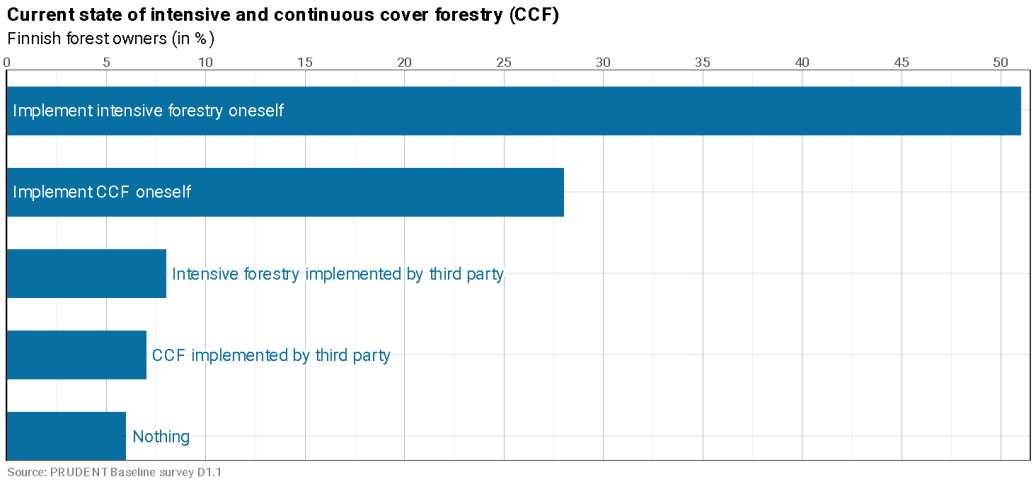
Figure 14: Reasons for no interest in buffer strips (Belgian UC)



Finland

As shown in Figure 15, in Finland, 59% of forest owners declare implementing intensive forestry practices on their parcels, either themselves (51%) or with the help of a third party (8%). Around 35% of Finnish forest owners declare implementing continuous cover forestry, either themselves (28%) or with the help of a third party (7%). Finally, a small share of forest owners declares doing nothing on their parcels (6%).

Figure 15: Adoption of continuous cover forestry (Finnish UC)



Among the barriers to continuous cover forestry, the characteristics of the forest come first (59%), followed by economic considerations (20%) are the most cited. The 11% of forest owners reporting other reasons indicate a fear of worsening the state of their forests, lack of time, and the opportunity cost of switching to a new practice (Figure 16).

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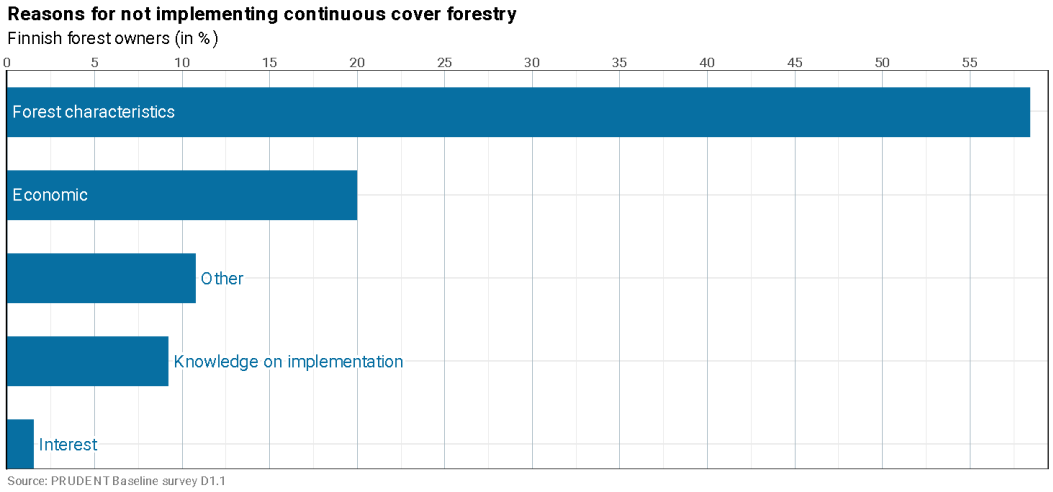
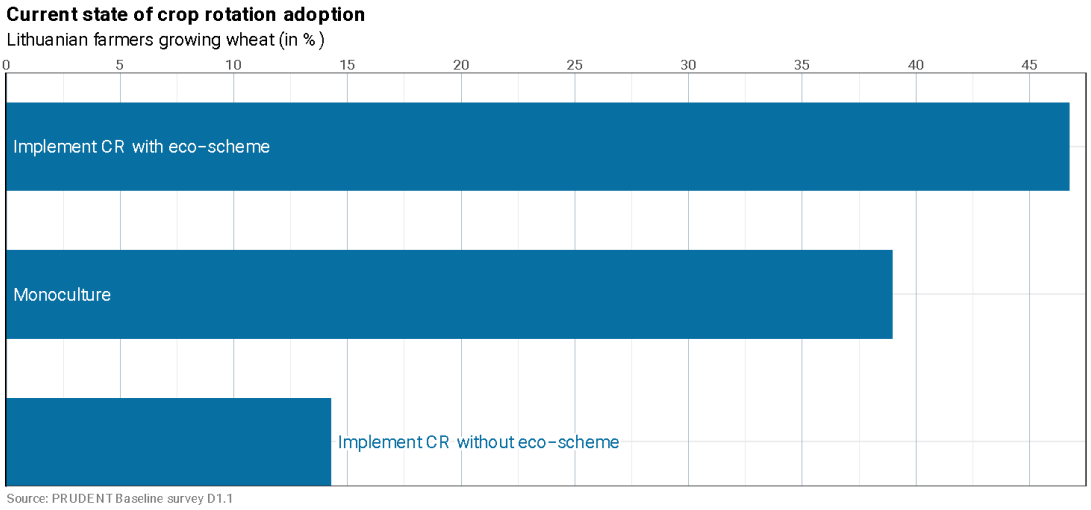
Figure 16: Reasons for no interest in continuous cover forestry (Finnish UC)



Lithuania

As shown in Figure 17, in Lithuania, 61% of our sample declared implementing crop rotation, either with the help of the eco-scheme (47%) or without (14%). The rest of the sample implement monoculture on their lands (39%).

Figure 17: Adoption of crop rotation (Lithuanian UC)



As shown in Figure 18, the majority of respondents (53%) reported other reasons that those we suggested for not implementing crop rotation, most of them were related to having committed to another project for young farmers. Around 17% of those doing monoculture reported a lack of interest in crop rotation, 17% reported a lack of knowledge on implementation, and 10 % reported economic reasons. The difficulty in accessing necessary input was the least chosen reason for not implementing crop rotation (3%).

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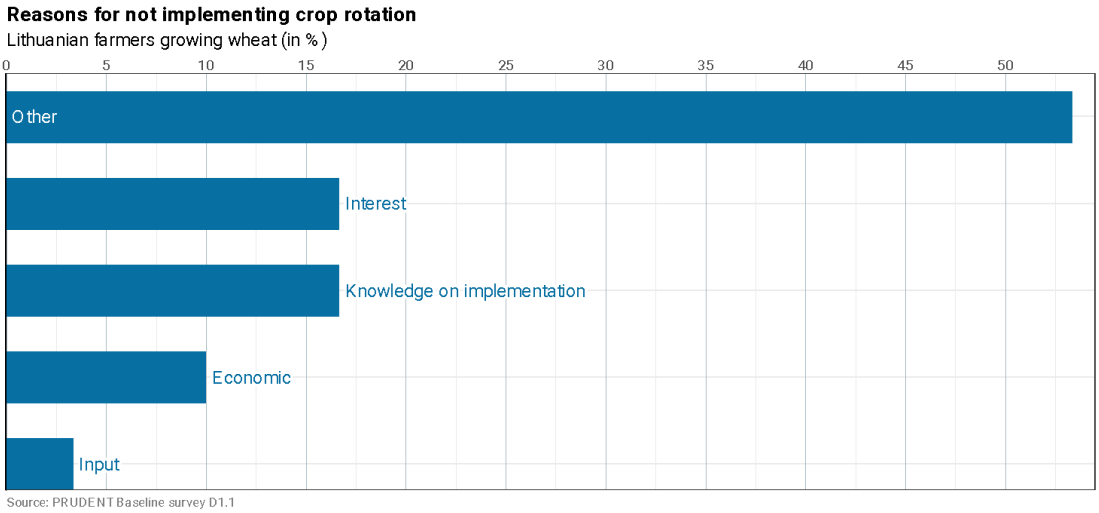
Figure 18: Reasons for no interest in crop rotation (Lithuanian UC)



4.3.2. Nudge perceived acceptability and effectiveness

To elicit preference for the nudges, we employed a Case 1 Best-Worst Scaling (BWS) experiment (Finn & Louviere, 1992; Marley & Louviere, 2005). Case 1 BWS works as follows: respondents are shown a series of choice sets, each including a subset of items, and are asked to select the best (most accepted or effective) and the worst (least accepted or effective) item in each choice set. This approach enables us to measure each nudge's relative position to other nudges in terms of acceptability or perceived efficacy.

BWS has several advantages compared to other rating and ranking methods. First, BWS forces respondents to make trade-offs between nudges (Lusk & Briggeman, 2009). Second, it avoids scalar inequivalence, enabling interpersonal and cross-cultural comparisons (Steenkamp & Baumgartner, 1998). Finally, BWS mitigates response biases such as acquiescence bias (Schwartz & Bardi, 2001), edge avoidance (Rubinstein et al., 1997), and middle effect bias (Attali & Bar-Hillel, 2003), ultimately providing better results than other rating methods (Lee et al., 2007; Lagerkvist, 2013). BWS has been widely applied across research fields such as healthcare (Flynn et al, 2007), food consumption and marketing (Lusk and Briggeman, 2009; Cohen, 2009; Cerroni et al., 2022). Applications in agricultural policy include Caputo and Lusk (2020), Wolf and Tonsor (2013), and Stone, Costanigro, and Goemans (2018).

In the BWS, each respondent was asked to select the most and least acceptable (or effective) nudge in 7 different choice sets, each including a subset of 4 nudges. This is a Balanced Incomplete Block Design (BIBD) (Louviere et al., 2015) in which each item appears 4 times across the 7 choice sets and co-occurs with other nudges twice (Newman & Briggeman, 2016; Widmar et al., 2017). The order of the choice sets and the nudges within each choice set was randomized across respondents. Additionally, we adopted a between-subject design with two groups responding to only one set of questions either related to nudge *Acceptability* or *Perceived Efficacy*. This was done to reduce cognitive burden.

Specifically, respondents in the *Acceptability* group were asked to evaluate the most and least acceptable nudges, where an acceptable nudge was defined as "an action that you have nothing against." Respondents in the *Perceived Efficacy* group were asked to evaluate the nudges that they consider most and least effective in promoting the adoption of the sustainable practice, where an effective nudge was defined as "an action that prompts you to change your behavior" (adapted from Gold et al., 2023). Respondents were randomly assigned to one of these groups. Figures 19 and 20 illustrate an example of a choice set for the *Acceptability* and *Perceived Efficacy* groups.

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Figure 19: BWS choice set in the Acceptability group – translated example from the Belgian survey

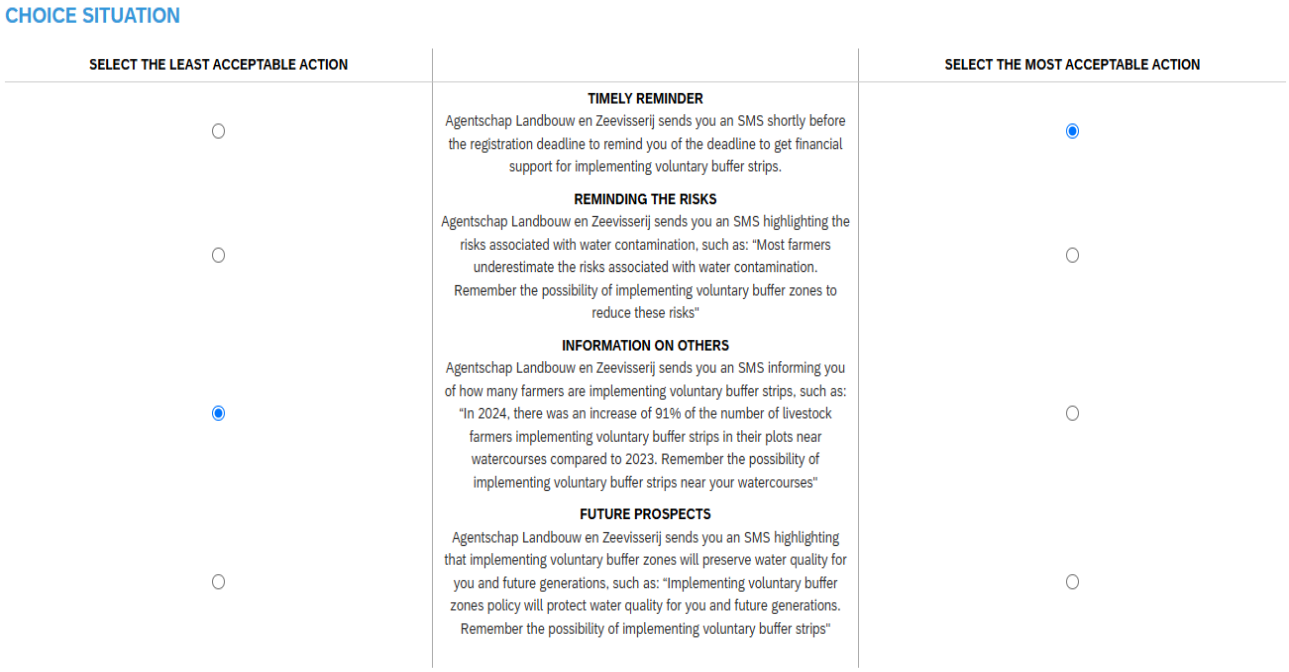
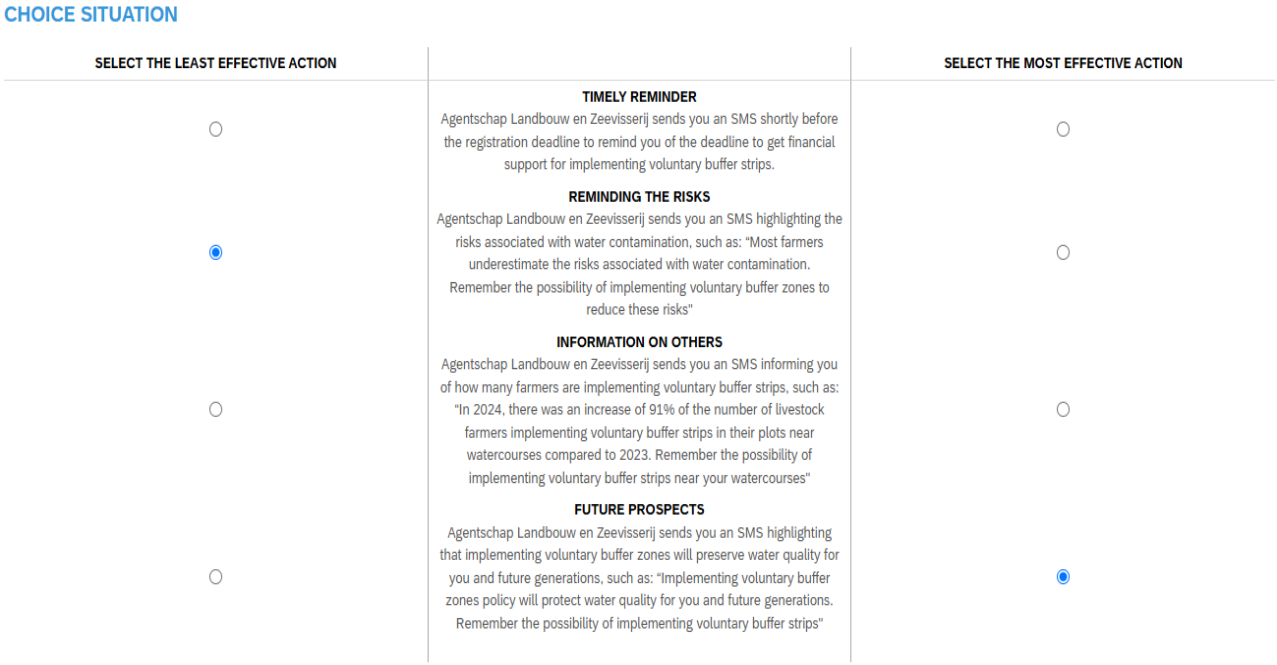


Figure 20: BWS choice set in the Perceived Efficacy group – translated example from the Belgian survey



Standardized scores calculation

From respondents' choices made in the BWS section, we calculated both individual and aggregate best-minus-worst (B-W) standardized scores. For each nudge, the individual standardized score was calculated as:

$$Std\ BW_{in} = \frac{B_{in} - W_{in}}{r} \qquad (1)$$

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where B_{in} and W_{in} represent the number of times respondent n selected item i as the most and least accepted (or effective), respectively, and r indicates the number of times i appears across all choice sets. This score ranges from -1 to 1, with higher values indicating stronger preference for the item.

The aggregate standardized score was then calculated by summing individual scores. Let B_i and W_i be the total number of times item i was selected as the best (most acceptable/effective) and worst (least acceptable/effective), respectively, across all N respondents (i.e., $B_i = \sum_{n=1}^{N} B_{in}$ and $W_i = \sum_{n=1}^{N} W_{in}$). The aggregate standardized score was calculated as:

$$Std\ BWi = \frac{Bi - Wi}{N \cdot r} \qquad (2)$$

Like the individual score, this metric ranges from -1 to 1, and allows for comparisons across different sample sizes. The aggregate scores were used to rank nudges for each country, providing an initial assessment of cross-country differences in preferences.

Table 13 presents the variables included in the model used for estimation along and their operationalization.

Table 13: Operationalization of variables for the BWS

Variable	Survey question	Survey scale	Description	Variable operationalization
Default	Select the least / most acceptable action in this column Or Select the least / most effective action in this column	Best-Worst choice (1 item selected as most and 1 as least accepted/ effective)	Indicates if the item was chosen as the most or least accepted/effective, or not chosen	Coded as 1 if most accepted/effective, −1 if least accepted/effective, 0 in not chosen
Reminders	Select the least / most acceptable action in this column Or Select the least / most effective action in this column	Best-Worst choice (1 item selected as most and 1 as least accepted/ effective)	Indicates if the item was chosen as the most or least accepted/effective, or not chosen	Coded as 1 if most accepted/effective, −1 if least accepted/effective, 0 in not chosen
Information on risks (reframing risks)	Select the least / most acceptable action in this column Or Select the least / most effective action in this column	Best-Worst choice (1 item selected as most and 1 as least accepted/ effective)	Indicates if the item was chosen as the most or least accepted/effective, or not chosen	Coded as 1 if most accepted/effective, −1 if least accepted/effective, 0 in not chosen
Information on others (social norm)	Select the least / most acceptable action in this column Or Select the least / most effective action in this column	Best-Worst choice (1 item selected as most and 1 as least accepted/ effective)	Indicates if the item was chosen as the most or least accepted/effective, or not chosen	Coded as 1 if most accepted/effective, −1 if least accepted/effective, 0 in not chosen
Make it visible (visibility of actions)	Select the least / most acceptable action in this column Or Select the least / most effective action in this column	Best-Worst choice (1 item selected as most and 1 as least accepted/ effective)	Indicates if the item was chosen as the most or least accepted/effective, or not chosen	Coded as 1 if most accepted/effective, −1 if least accepted/effective, 0 in not chosen
Emotional arousal (moral appeals)	Select the least / most acceptable action in this column Or Select the least / most effective action in this column	Best-Worst choice (1 item selected as most and 1 as least accepted/ effective)	Indicates if the item was chosen as the most or least accepted/effective, or not chosen	Coded as 1 if most accepted/effective, −1 if least accepted/effective, 0 in not chosen

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Future prospects (salience of benefits)	Select the least / most acceptable action in this column Or Select the least / most effective action in this column	Best-Worst choice (1 item selected as most and 1 as least accepted/ effective)	Indicates if the item was chosen as the most or least accepted/effective, or not chosen	Coded as 1 if most accepted/effective, −1 if least accepted/effective, 0 in not chosen

Estimation procedure

Data were then further analyzed using a maxdiff model, which assumes that respondents evaluate all possible item pairs in each choice set and select the pair that maximizes the difference between the chosen items in terms of acceptability or perceived efficacy (Finn & Louviere, 1992). Formally, if there are J items in each choice set t, the number of possible pairs is $J(J-1)$. Under the random utility framework (McFadden, 1974), the observable level of acceptability (effectiveness) of the item j is defined as λ_j, while the unobservable level of acceptability (effectiveness) of the item j for respondent i is given by $I_{ij} = \lambda_j + \varepsilon_{ij}$, where ε_{ij} is the random error term. The probability that respondent i selects item j as the most acceptable (effective) and item k as the least acceptable (effective) in a choice set t equals the probability that the difference in utility of these items (I_{ij} and I_{ik}) is greater than all the other $J(J-1)-1$ possible differences in the choice set. Assuming ε_{ij} is iid with a Gumbel (Extreme value type 1) distribution, then this probability takes the Multinomial Logit (MNL) form:

$$P_{ijkt} = \frac{e(\lambda_{ijt} - \lambda_{ikt})}{\sum_{l=1}^{J} \sum_{m=1}^{J} (\lambda_{ilt} - \lambda_{imt}) - J} \qquad (3)$$

The estimated λ_j represents the relative importance of the item j over one of the other items, normalized to zero for identification purposes. The normalized item in this study was *social norms*, which we set as the baseline as it is the least accepted and perceived as least effective nudge, based on the rank resulting from the standardized B-W aggregated score in the pooled sample.

MNL assumptions imply independence within alternatives and homogeneous preferences across respondents. Since we expect heterogeneity, the estimated parameters λ_j were modeled as following a multivariate normal distribution with means and standard deviations to be estimated. Therefore, the probability in (3) is extended to a Random Parameter Logit (RPL) model, which was estimated using the maximum simulated likelihood with 100 Halton draws (Train, 2009). A RPL was estimated for each country by group (*Acceptability* and *Perceived Efficacy*). S_j OBJ j OBJ were calculated as follows:

$$S_j = \frac{e^{\hat{\lambda}_j}}{\sum_{k=1}^{J} e^{\hat{\lambda}_l}}. \qquad (4)$$

This provides a more intuitive interpretation of the RPLs results, as preference share S_j reflects the relative acceptability (or perceived efficacy) of item j compared to all other items and can be interpreted as the forecasted probability that item j is selected as the most accepted (effective).

Results

The results from the standardized Best-Worst (B-W) aggregated scores are presented in Figure 21 for acceptability and Figure 22 for perceived efficacy.

They indicate that reminder-based nudges are the most consistently accepted across countries, with particularly high acceptance and perceived efficacy scores in Lithuania (0.49 and 0.34, respectively) and relatively stable scores ranging from 0.15 to 0.22 in the other countries in both dimensions. Conversely,

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among the lowest-scoring nudges across all four countries are social norms interventions, which consistently receive negative scores, indicating that descriptive norm-based nudges are less preferred compared to other interventions.

The scores also reveal notable cross-country differences. An interesting result is observed for the default nudge, which is the most accepted (0.21) and perceived as the most effective (0.24) in Belgium. A similar pattern is found in Finland, with a positive and high acceptance score (0.26) and a moderate efficacy score (0.14). In contrast, Italy and Lithuania exhibit opposite preference for this nudge, with much lower, negative scores.

Figure 21: Standardized B-W aggregated scores for acceptability by country

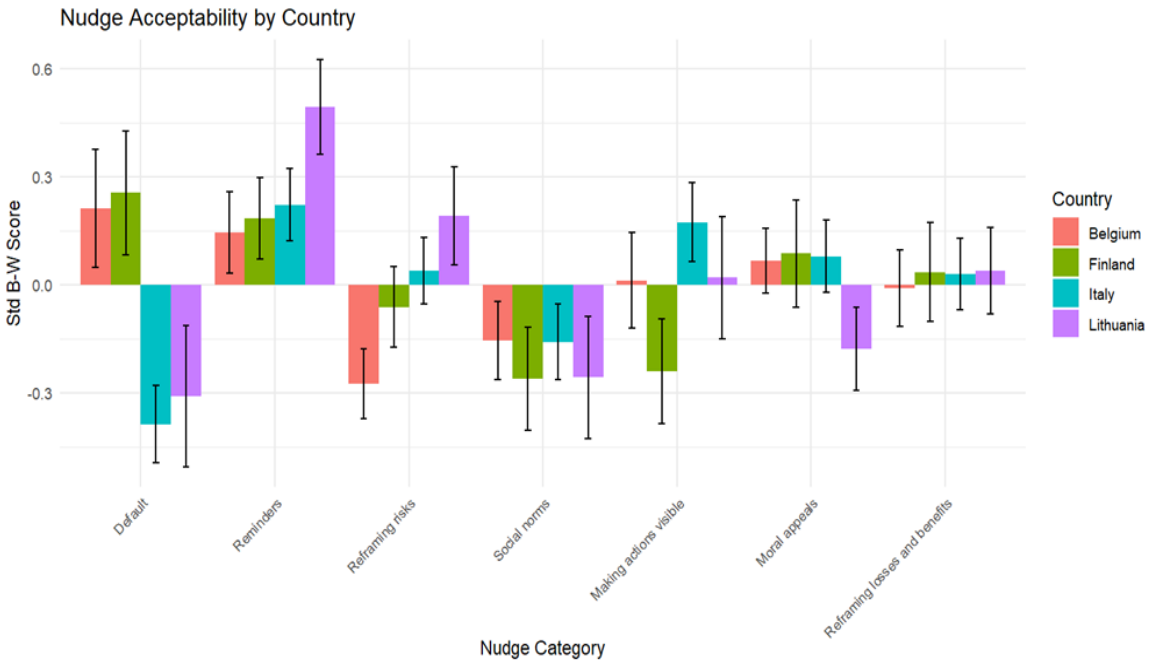

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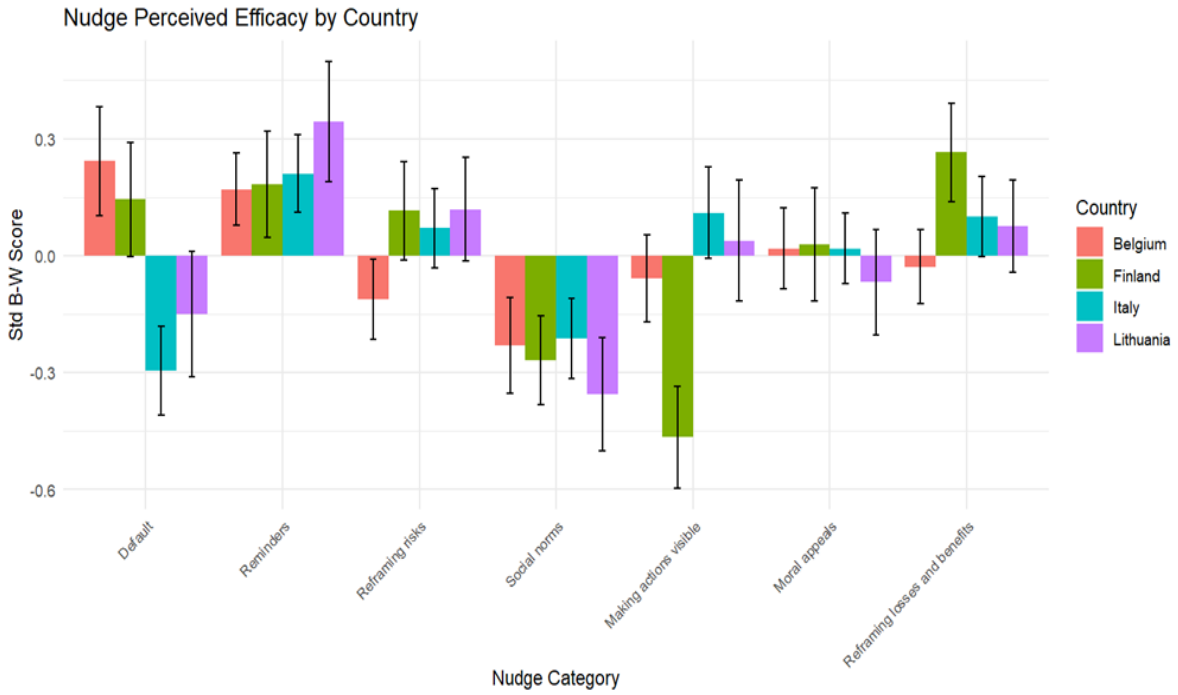
Figure 22: Standardized B-W aggregated scores for perceived efficacy by country



Preferences for other nudges are less consistent, varying across dimensions and countries. Reframing losses and benefits and moral appeals are generally perceived as relatively "neutral" across all countries, with few exceptions. The "making action visible" nudge exhibits strong variation, being positively received in Italy (0.17 acceptability, 0.11 efficacy) but less preferred compared to other nudges in Finland (-0.24 acceptability, -0.47 efficacy). Similarly, the "reframing risks" nudge shows moderate variation across countries.

The preference shares estimated from the RPL model reinforce the findings from the standardized B-W aggregated scores. In the pooled sample (Figure 23), reminders are the most preferred nudge for both acceptability (27%) and perceived efficacy (22%). Notably, the probability of choosing reminders as the most acceptable nudge is almost double that of the second-ranked nudge, "making actions visible" (15%), while the gap with the second-ranked nudge (reframing losses and benefits) in the perceived efficacy dimension is smaller. Preference shares for the default nudge (11% acceptability, 13% efficacy) remain relatively low overall, but as country-specific results will show, preferences for this nudge vary widely across countries. As expected, social norms-based nudges rank low in both dimensions. Preference for middle-ranked nudges generally display small differences in shares, suggesting a less clear hierarchy beyond the top and bottom-ranked interventions.

Overall, we notice that nudge acceptability and perceived efficacy are relatively similar across nudge categories.

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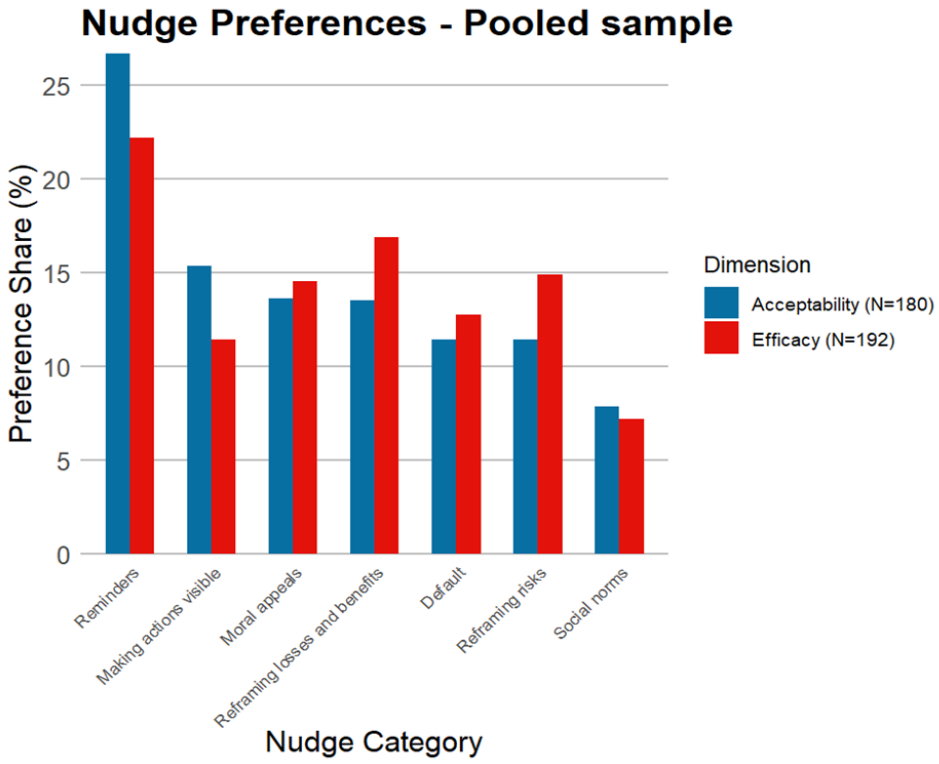
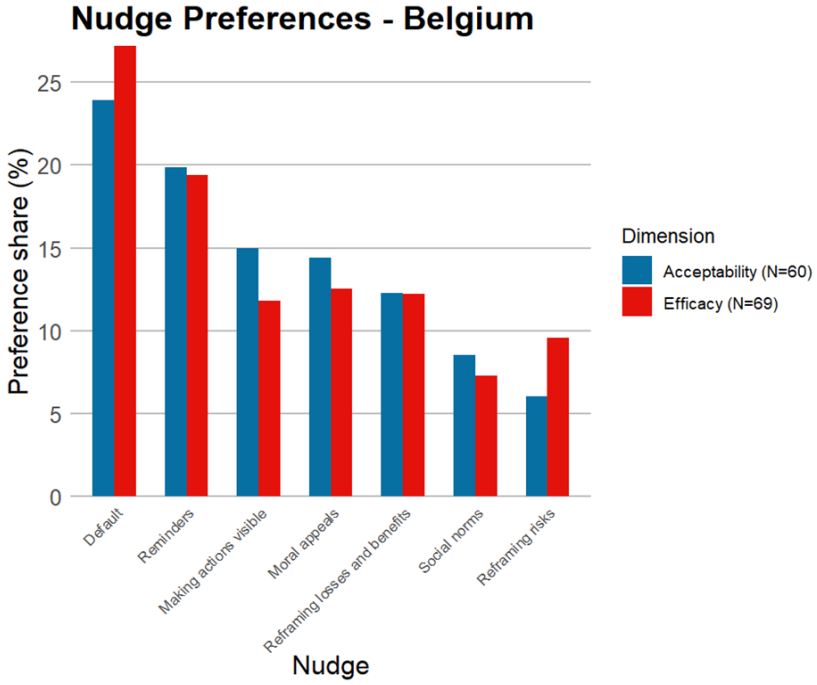
Figure 23: Nudges' preference shares – Pooled sample (N = 472)



Aligning with the pooled sample, the results from Belgian farmers (Figure 24) show that reminders are well-received, while nudges involving social norms remain among the least preferred. Notably, in contrast with the pooled sample the default nudge stands out as the most acceptable and effective intervention by several percentage points.

Figure 24 : Nudges' preference shares – Belgium (N = 129)



In Italy (Figure 25), reminders hold the top position (25% acceptability, 24% efficacy), while default is the least preferred nudge (3% acceptability, 5% efficacy), along with social norms (8% in both dimensions).

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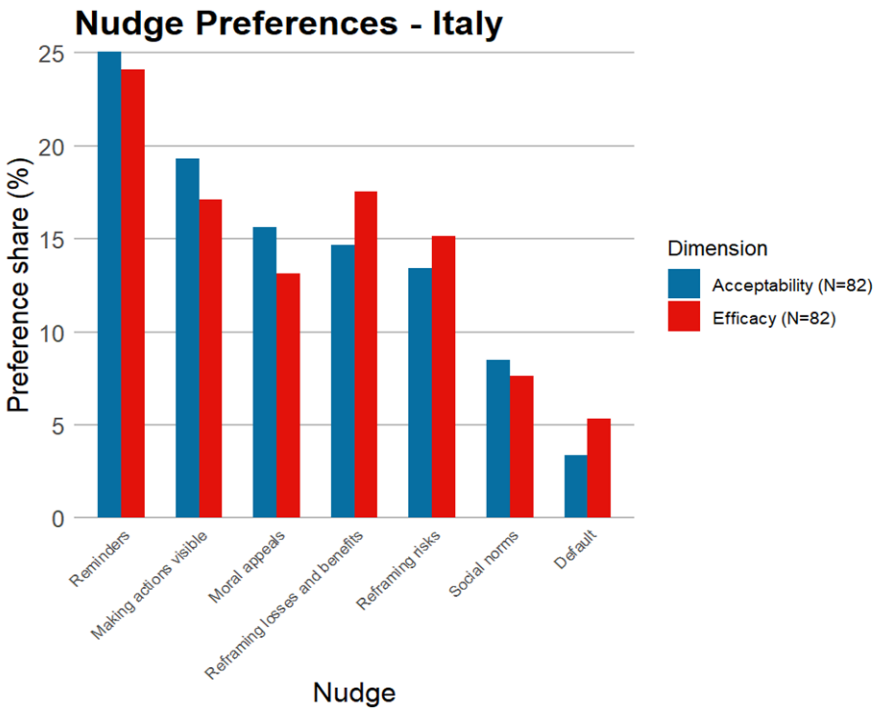
Compared to other countries, Italy shows more moderate differences in nudge preferences, except for the lowest-ranked nudges – particularly the default nudge – which have very low preference shares.

Figure 25: Nudges' preference shares – Italy (N = 164)



Finland (Figure 26) is the country where the ranking varies the most between acceptability and perceived efficacy. Default nudges are highly accepted (42%), with a preference share several percentage points higher than other nudges, yet they are perceived as less effective (14%). The opposite pattern emerges for reframing losses and benefits (11% acceptability, 27% efficacy) and reframing risks (9% acceptability, 20% efficacy). Consistent with previous findings, preference shares for reminders are relatively high in both dimensions (17% acceptability, 19% efficacy), while social norms-based nudges are among the least preferred intervention.

Lithuanian farmers (Figure 27) show a clear preference for reminder-based nudges (57% acceptability, 32% efficacy), marking the highest preference share across all countries and nudges. Reframing risks and losses and benefits follow at significantly lower levels. Similar to Italy, default nudges are the least acceptable (3%) and second-least effective (8%). Unlike Finland, the Lithuanian sample shows a stable preference pattern across the two dimensions, at least in terms of ranking.

The preference shares results align with and reinforce the findings from the standardized BWS scores. Reminder-based nudges are widely accepted across different contexts, while social norms-based nudges tend to be the least preferred. However, preferences for other nudges are less consistent, and cross-country differences suggest the influence of contextual factors. This is particularly evident for the default nudge, which is strongly preferred in Belgium and Finland but ranks lowest in Italy and Lithuania.

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Figure 26: Nudges' preference shares – Finland (N = 101)

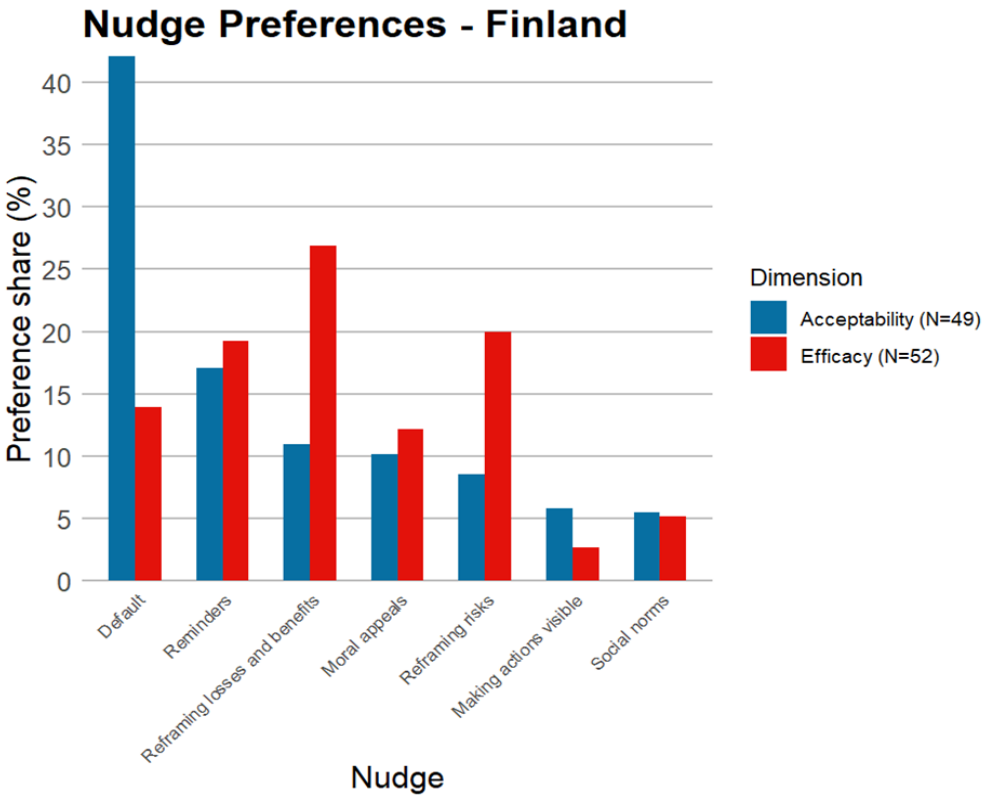
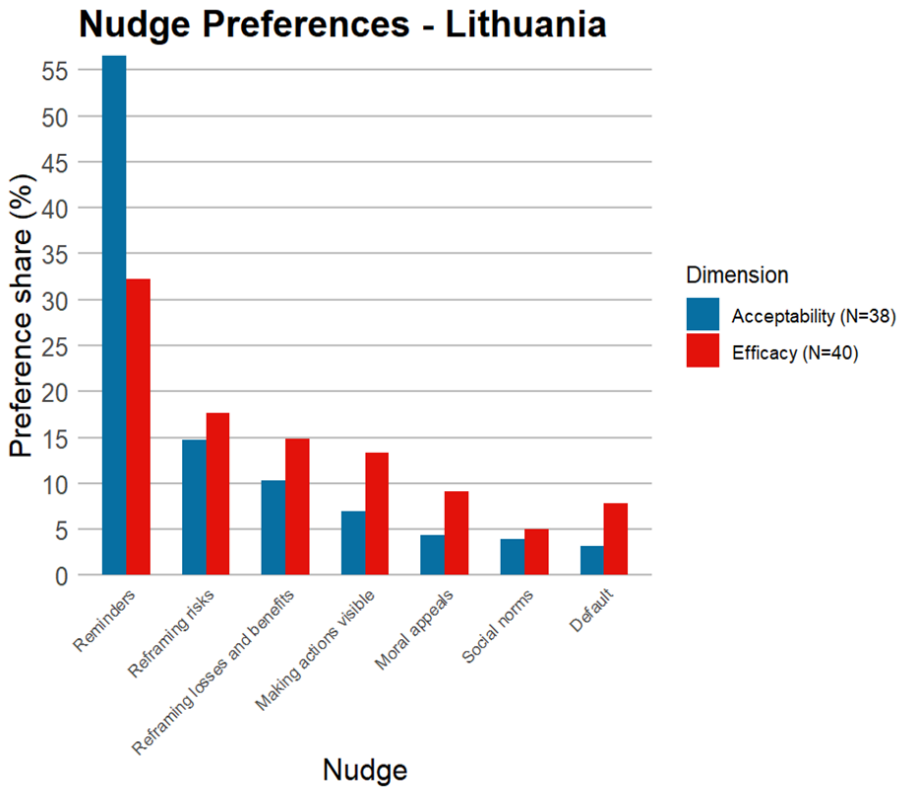


Figure 27: Nudges' preference shares – Lithuania (N = 78)



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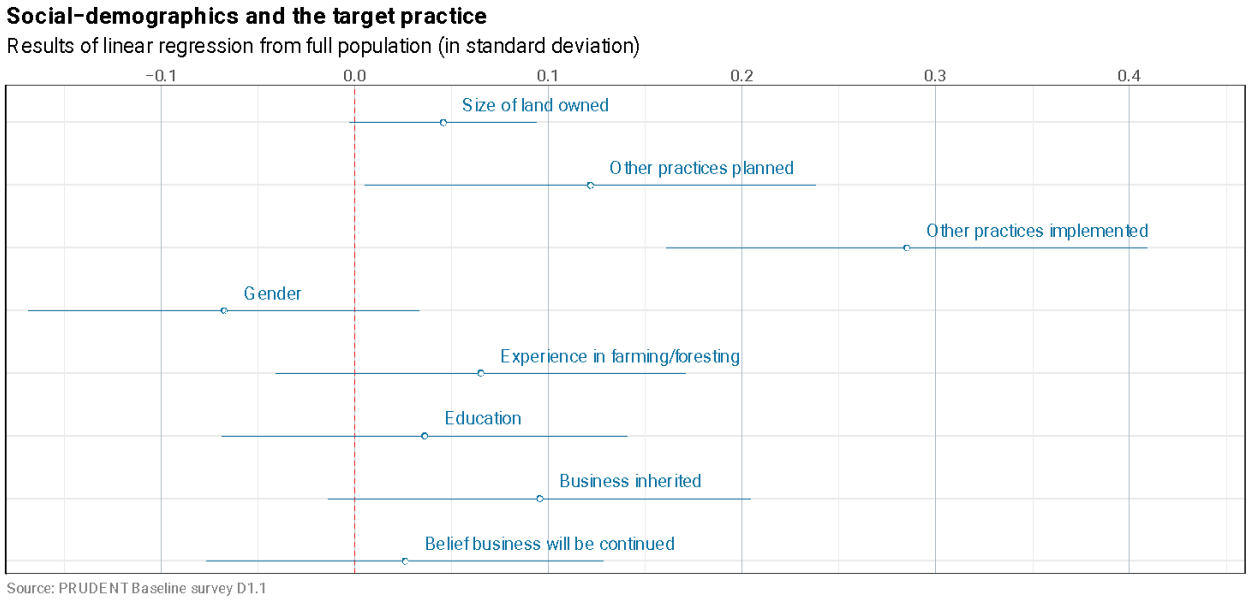
4.3.3. Segmentation analysis

In this section we explore the determinants of the adoption of the targeted sustainable practice. This is done through a simple linear probability model where the dependent variable is a binary for sustainable practice adoption and the independent variables are the set of socio-economic characteristics and the set of behavioral factors. The first set includes: size of land owned, other sustainable practices planned, other sustainable practices implemented, being male, experience in the business, education level, inherited business, belief that the business will be continued. The second set includes: Virtue seeking, trust in science, self-efficacy, risk seeking, patience, loss aversion, innovation openness, norms influence, environmental concerns, confirmation bias, and beliefs that the sustainable practice is the norm.

The model controls also include country-specific dummies, to absorb country-specific variability. Factors are expressed in different scales. To allow the comparability of the different factors' role, we transform all variables in standard deviation by subtracting the sample mean and dividing by the sample standard deviation. In the figures that follow, we graphically present the different coefficients' point estimates with 95% confidence intervals. This allows us to conduct traditional hypothesis testing: we reject the null that the coefficient is statistically different from zero when the confidence interval does not overlap with zero.

As Figure 28 shows, looking at the main predictors across countries, we notice that already implementing other sustainable farming practices and planning to implement more predict the likelihood of being in favor or having adopted the target practice. It also seems that the larger the size of the land owned and having inherited one's business facilitates the adoption of the target practice (or make it more appealing in the Italian case). Yet, for these last two social-demographics, coefficients are marginally statistically significant.

Figure 28: Correlations between social-demographics and adoption or interest in the target practice



Among the behavioral factors, the belief that the target practice is the norm, and environmental concerns predict the fact that respondents will have implemented or are in favor of the target practice. In what follows, we break down this analysis country by country (Figure 29).

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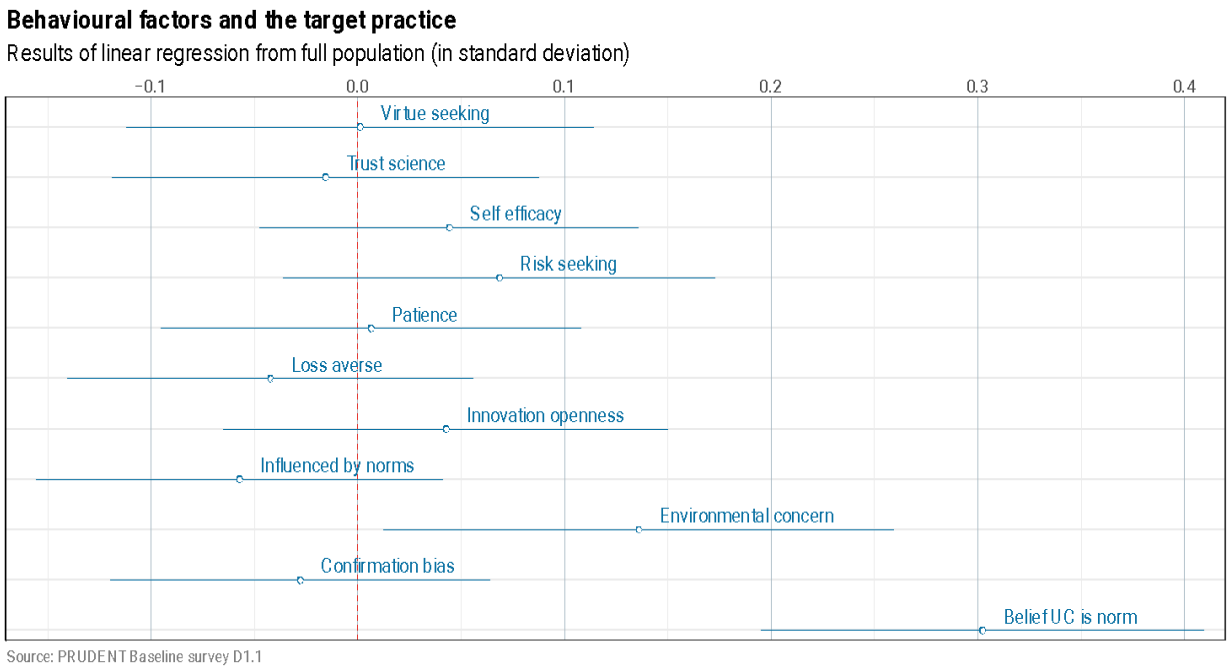
Figure 29: Correlations between behavioral factors and adoption or interest in the target practice



Italy

In Italy, the only social-demographic factor predicting a positive attitude towards the adoption of green multi-risk insurance is the size of the land owned (Figure 30). We find that the larger the size of the land owned, the less likely respondents are to report economic motives as a barrier to the adoption of multi green insurance policy. We find a similar correlation, albeit weaker, between the size of lands and reporting a lack of knowledge on the implementation. *This indicates that larger farms may have better access to the skills and means to implement green insurance policies in a way that is economically beneficial for them.*

As for the full sample, the belief that most farmers in one's area would be willing to adopt a green multi-risk insurance predicts one's own attitude towards green insurance. Being more open to risks and being more concerned about environmental degradation also predicts a stronger interest in green multi-risk insurance policies. The influence of other factors is not statistically significant (Figure 31). *This suggests that the use of social norm nudges, moral appeals and nudges playing on the salience of risks might be appropriate strategies to foster the adoption of green insurance policies.*

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Figure 30: Correlations between social-demographics and interest in the multi green insurance policy in Italy

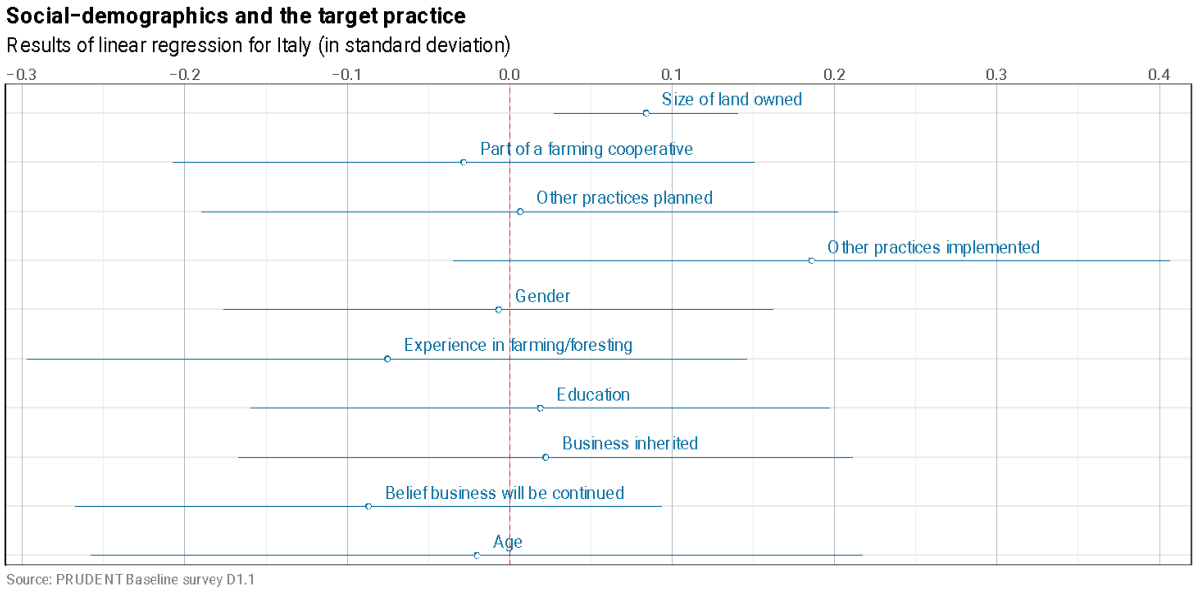
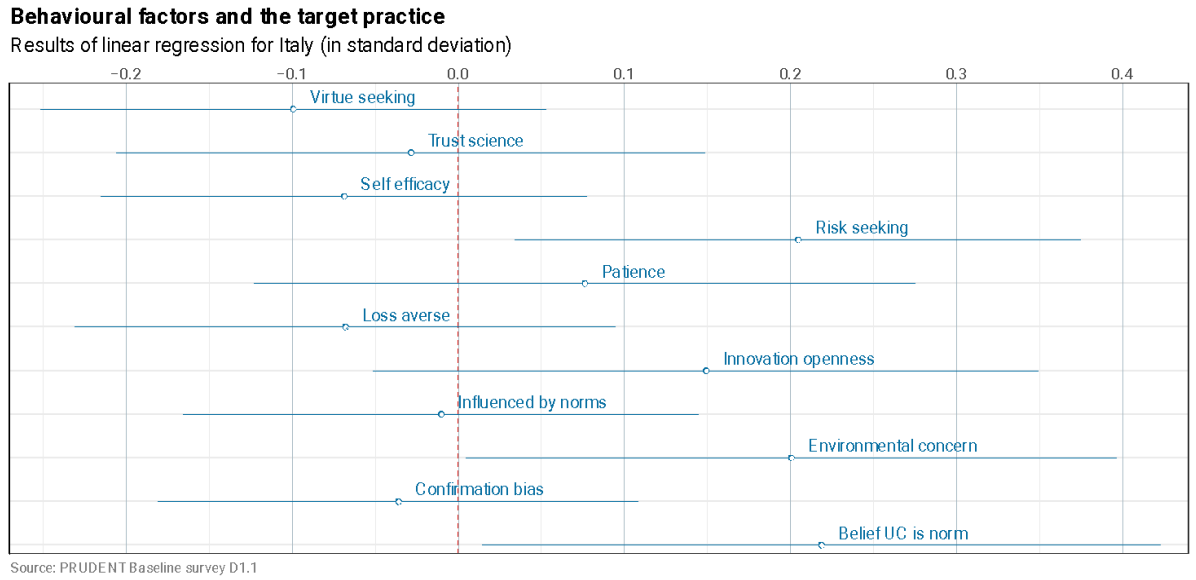


Figure 31: Correlations between behavioral factors and interest in the multi green insurance policy in Italy



Belgium

Among Belgian farmers, having already implemented other environmentally sustainable practices predicts the adoption of voluntary buffer strips. The influence of other social-demographic variables is not statistically significant. We excluded the variables capturing whether the business was inherited and the belief that the business will be continued due to a lack of variations. There is a negative correlation between reporting having implemented other practices and declaring that economic motives impede the adoption of voluntary buffer strips. There are no correlations between having implemented other practices and declaring that a high bureaucratic load impedes the adoption of voluntary buffer strips (Figure 32). *This indicates the presence of learning-by-doing positive spillovers of adopting other sustainable practices on farmers ability to manage economic challenges associated with voluntary buffer strips.*

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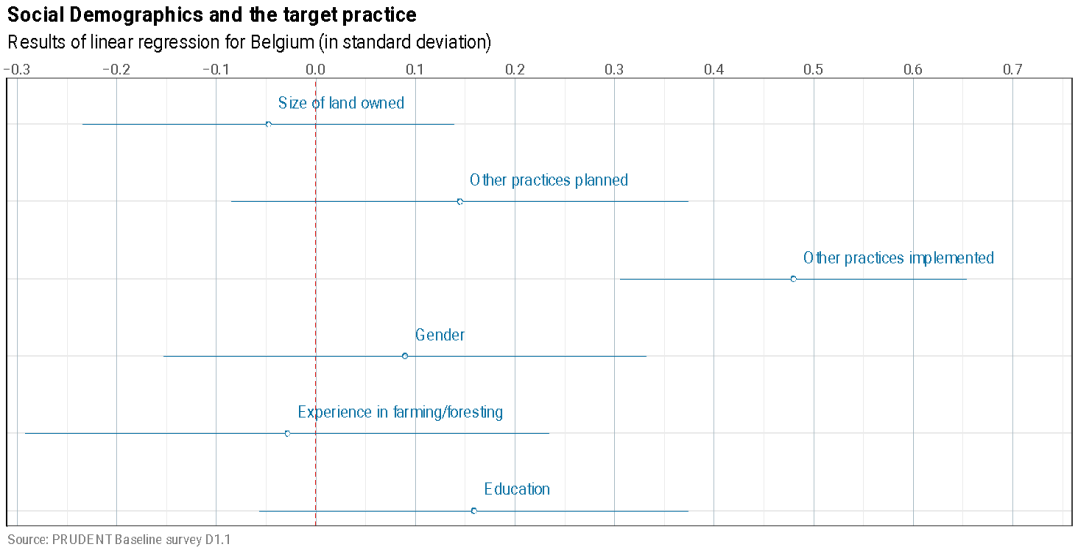
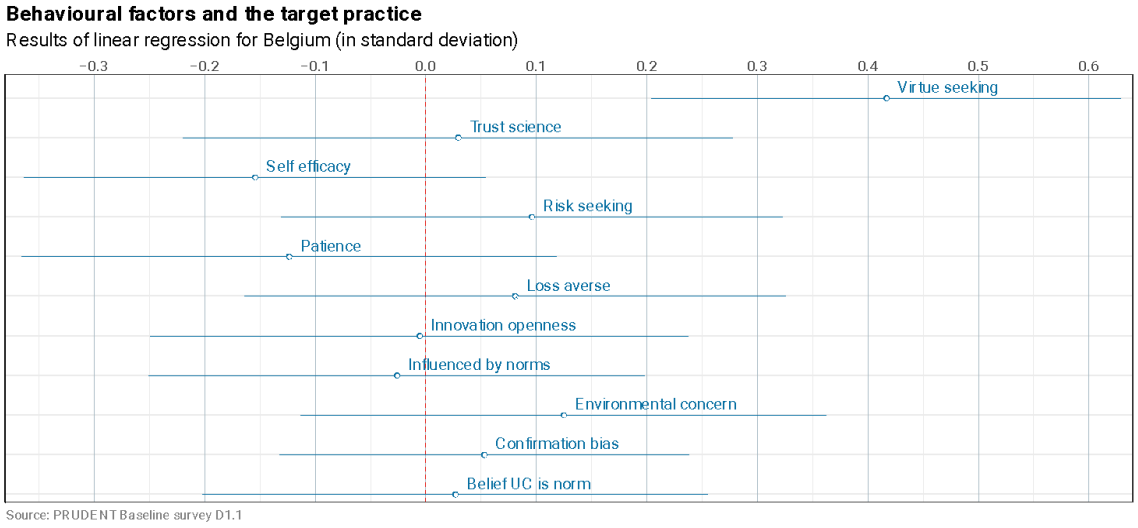
Figure 32: Correlations between social-demographics and adoption of voluntary buffer strips in Belgium



The behavioral factors predicting the adoption of voluntary buffer strips is the desire to appear virtuous in the eyes of consumers (Figure 33). *This indicates that the use of labels to make the adoption of voluntary buffer strips visible would be a viable strategy to promote their adoption.*

Figure 33: Correlations between behavioral factors and adoption of voluntary buffer strips in Belgium



Finland

In Finland, the age of respondents predicts the adoption of continuous cover forestry. In other words, older forest owners are more likely to implement continuous cover forestry (Figure 34). In this regard, we observe a small and weak negative correlation between being older and reporting economic motives as a reason for not implementing continuous cover forestry. There is no correlation between the age of Finnish forest owners and reporting that the characteristics of one's forest impede the adoption of continuous cover forestry. *This would indicate that older Finnish forest owners may be more experienced to manage the economic challenges associated with continuous cover forestry or are less constrained by economic concerns.*

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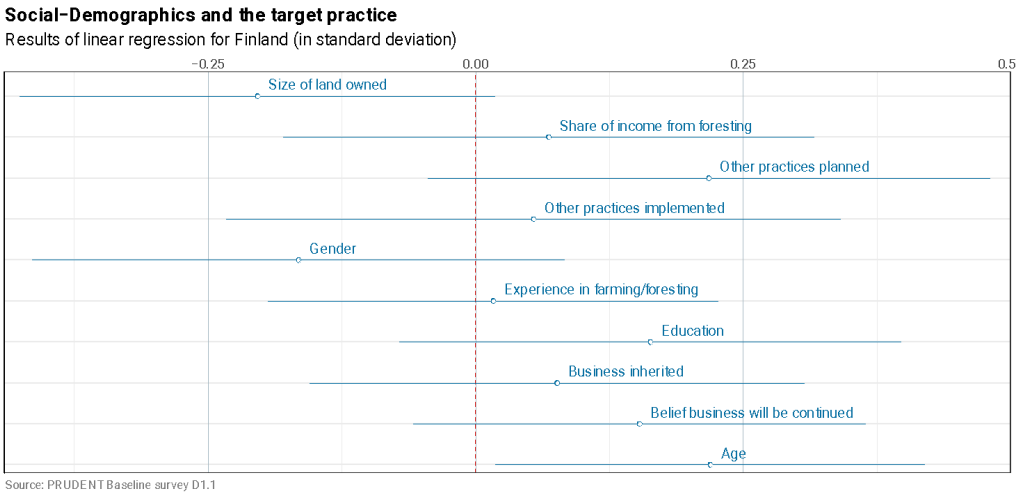
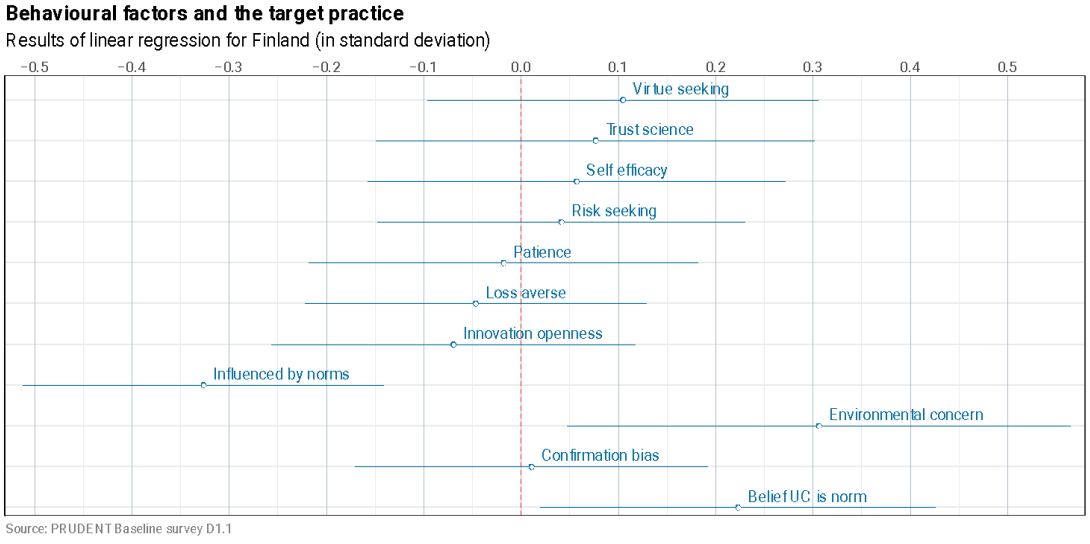
Figure 34: Correlations between social-demographics and adoption of continuous cover forestry in Finland



Being concerned about the environment and believing that most forest owners in one's area implement continuous cover forestry positively predict that one is implementing continuous cover forestry. On the other hand, reporting being influenced by what others are doing negatively predicts the implementation of continuous cover forestry (Figure 35). *A viable nudge to foster the adoption of continuous cover forestry would therefore be to raise awareness of environmental issues related to intensive forestry or use a dynamic social norm nudge emphasizing an increasing trend of adoption of continuous cover forestry*.

Figure 35: Correlations between behavioral factors and adoption of continuous cover forestry in Finland



Lithuania

In Lithuania, having a longer experience in farming positively predicts the implementation of crop rotation. There seems to be a weak positive correlation between implementing crop rotation and planning to implement other sustainable practices. Other social-demographic factors do not have a statistically significant influence (Figure 36). There is no correlation between a longer experience in farming and reporting economic and knowledge barrier to the adoption of crop rotation. However, we observe that planning other practices is negatively correlated with reporting knowledge barriers to the adoption of crop rotation. *This might indicate knowledge spillovers between sustainable farming practices.*

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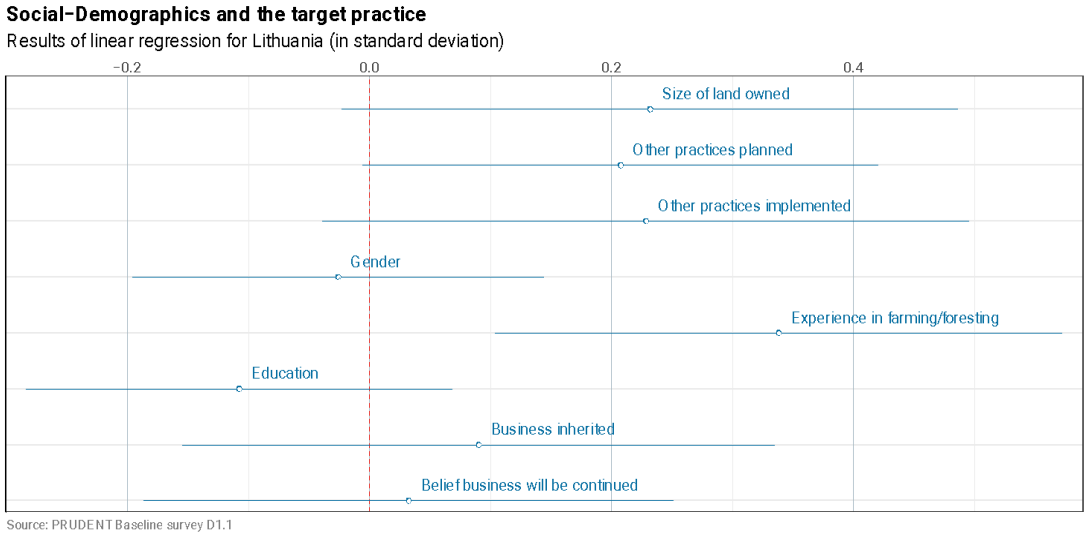
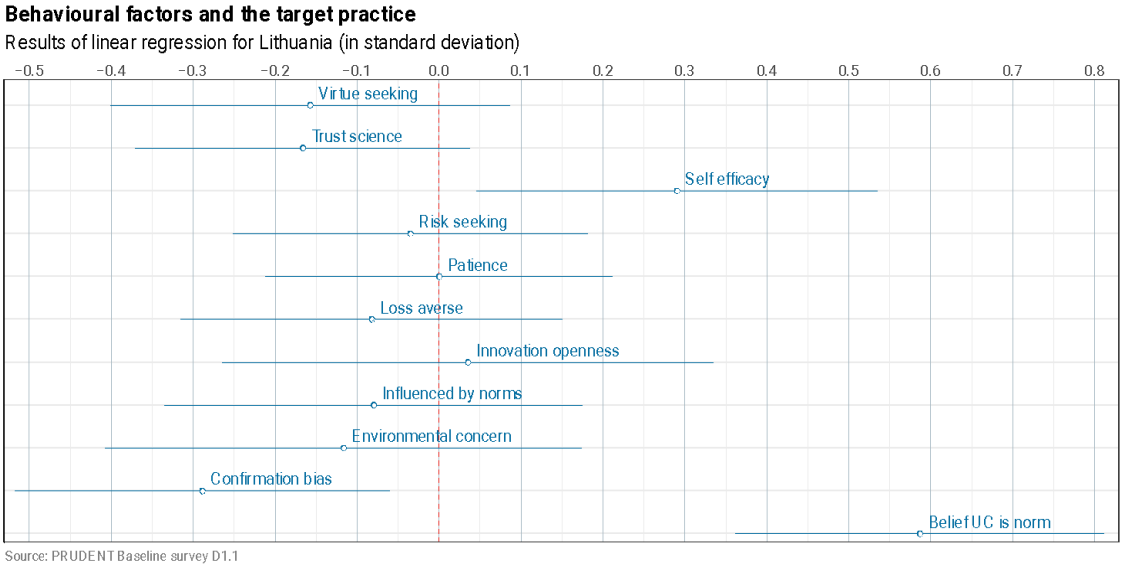
Figure 36: Correlations between social-demographics and adoption of crop rotation in Lithuania



Holding a stronger preference for information aligning with their beliefs decreases the likelihood that Lithuanian farms implement crop rotation. On the other hand, believing that crop rotation is the norm positively influences the likelihood of implementing crop rotation (Figure 37). Surprisingly, we find that respondents reporting a lower level of self-efficacy, i.e., feeling uncomfortable using a technology they do not are skilled in using, are also more likely to implement crop rotation. *These results suggest that the use of social norm nudges might be appropriate to foster crop rotation but might also fail as ignored by those suffering from a strong confirmation bias. Using simplification nudges might also facilitate the adoption of crop rotation.*

Figure 37: Correlations between behavioral factors and adoption of crop rotation in Lithuania



Clustering analysis

Using social demographic and behavioral variables, we grouped respondents into two clusters based on hierarchical clustering. Hierarchical clustering consists of a bottom-up approach regrouping observations that are the most similar. For this exercise, we used Ward's method (Ward, 1963). Namely, the algorithm starts by pairing observations that are the most similar using the squared Euclidian distance as a metric. The optimal number of pairs is the one that minimizes the total within-cluster variance. Then the algorithm proceeds iteratively by pairing again clusters with one another in a way that minimizes the total within-

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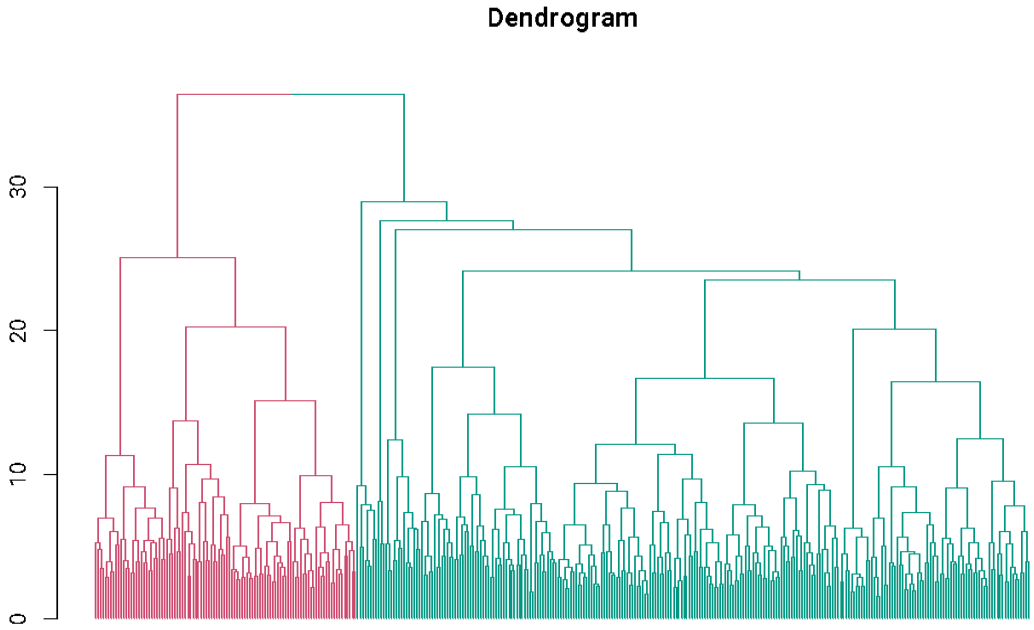
cluster variation until all observations are regrouped in one cluster. This approach produces trees, called dendrograms, that are used to determine the desired number of clusters. In our case the dendogram is shown in Figure 38. One should note that, to perform this analysis, we have scaled the data as some variables were expressed in different units. We have also excluded information on the country of origin of respondents as not doing so induced the algorithm to trivially cluster respondents by country.

Figure 38: Dendogram of the hierarchical clustering approach applied to the dataset of farmers and forest owners



The higher the split occurs, the more dissimilar the observations are. Looking at the dendogram, we see that splitting our sample into two clusters would yield two relatively equally populated groups compared to having more clusters. The clustering analysis reveals two groups. The first of 262 respondents (henceforth G1) is characterized by a stronger belief that the target practice is the norm compared to the second of 102 respondents (henceforth G2). G1 exhibits higher environmental concerns than G2, higher innovation openness, more patience, less risk aversion, and higher trust in scientists. G1 is also more likely to make decisions to signal virtue than G2. These differences are plotted in Figure 39.

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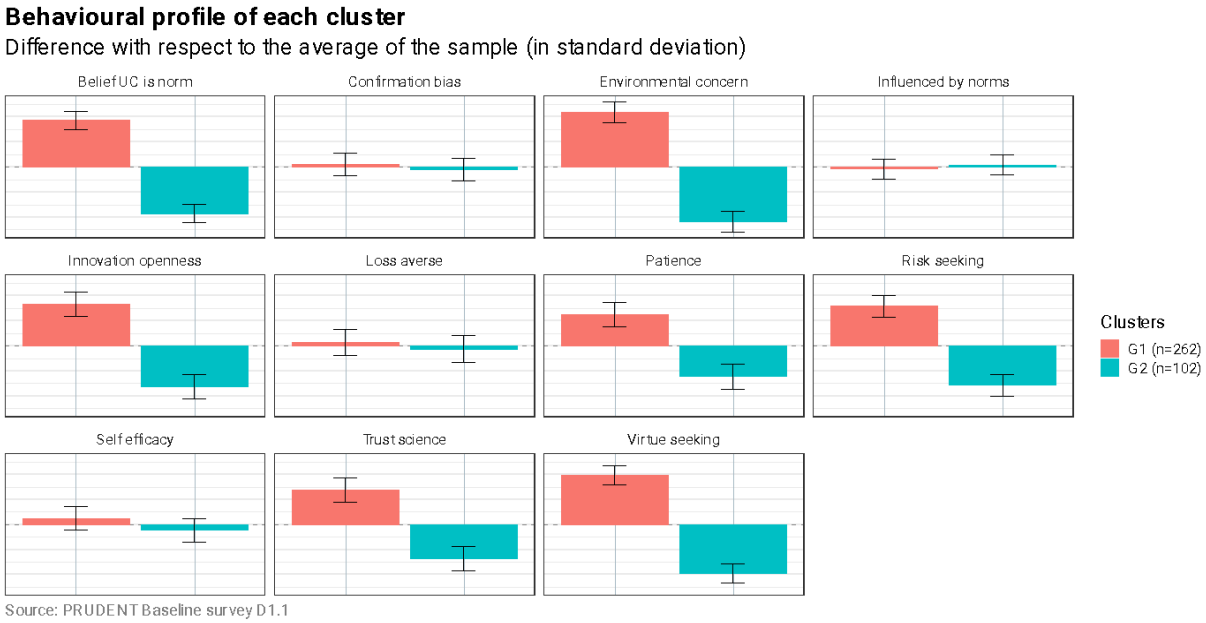
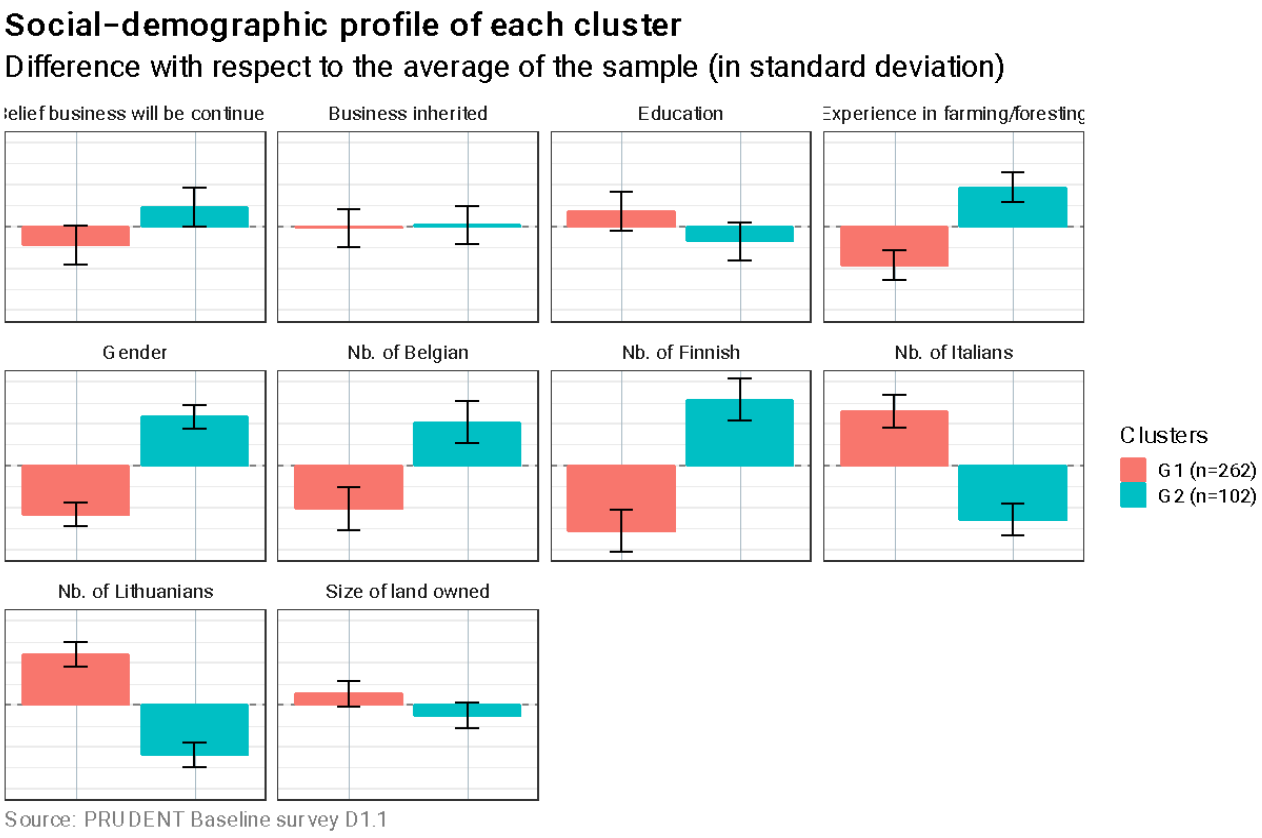
Figure 39: Difference in behavioral factors between the two clusters



In terms of socio-economic characteristics, G1 is less experienced in farming or forestry than G2 and has a larger share of female respondents. G1 has also less Belgian and Finnish respondents than G2 but has more Italians and Lithuanians (Figure 40).

Figure 40: Differences in social demographics between the two clusters



Running a simple probability linear model, we find that being in G2 decreases the likelihood of having implemented or being interested in the target practice by 58 percentage points. This result remains the same when adding country fixed effects. Doing the same analysis country by country reveals that this

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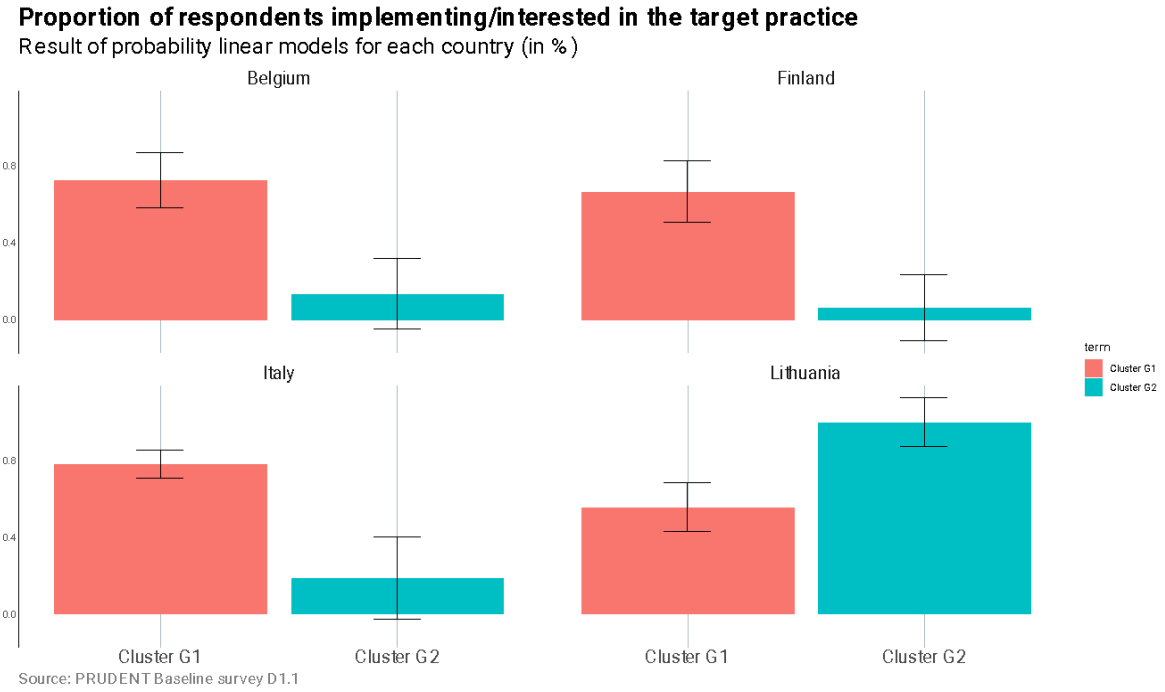
effect is driven by Italians (-59 pp), Belgian (-59 pp) and Finnish respondents (-60 pp). This effect reverts for Lithuanian farmers, with an increase in the likelihood of implementing crop rotation by 44 percentage points for G2 compared to G1. This apparent paradox might be explained by the peculiarity of the Lithuanian case: younger famers seem to be less likely to implement crop rotation compared to more experienced ones and G2 contains more experienced respondents. Figure 41 below presents these differences.

Figure 41: Adoption/interest rate of the target practice by cluster and by country



Relationship between clusters and the perceived effectiveness and acceptability of nudges

In this last section, we investigate whether differences in the acceptability and perceived effectiveness of nudges exist between the two clusters we identified. Figure 42 reveals three patterns between clusters and the acceptability of nudges. First, respondents in G1 tend to find the use of *default nudges* as less acceptable compared to the other nudges. This is the contrary for those in G2. Second, respondents in G2 tend to perceive nudges *reframing risks* as less acceptable while G1 seems indifferent. Third, both G1 and G2 find *reminders* more acceptable and *social norm* nudges less acceptable than the other nudges.

Figure 43 shows relationships between clusters and the perceived effectiveness of nudges. Consistently with the cluster-acceptability relationship, G1 and G2 perceive *reminders* as more effective and *social norm nudges* as less effective than the other nudges. On the other hand, while G1 find *default* nudges to be less effective, G2 perceive them as more effective. Here again, this is the same pattern as the one observed for acceptability. We also observe that group G1 perceives *reframing losses and benefits* as more effective while G2 does not find it more or less effective than the other nudges. Conversely, G2 perceive *making actions visible* as less effective while G1 does not find it more or less effective than the other nudges.

Overall, these relationships point out two main takeaways. First, G1, characterized by stronger pro-environmental attitudes seem to favor nudges explicitly encompassing information related to the environment. On the other hand, G2 favors nudges facilitating the decision process. This interpretation is confirmed when regrouping nudges in three categories, following Jesse and Janach (2021)'s broader classification presented in Section 3 of this report. Figures 44 and 45 display these relationships. G2 finds nudges facilitating the decision process (reminders and defaults) more acceptable and effective while finding nudges providing environmental information (reframing risks, losses and benefits) as less

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acceptable. G1 finds nudges facilitating the decision process as slightly more effective than the other nudges (this effect being driven by reminders), and nudges providing environmental information as more effective. Both groups seem to find social appeals less effective (social norms, moral appeals, making action visible), and G2 seems to even find them less acceptable.

Figure 42: Barplots showing for each nudge how acceptability differs by cluster

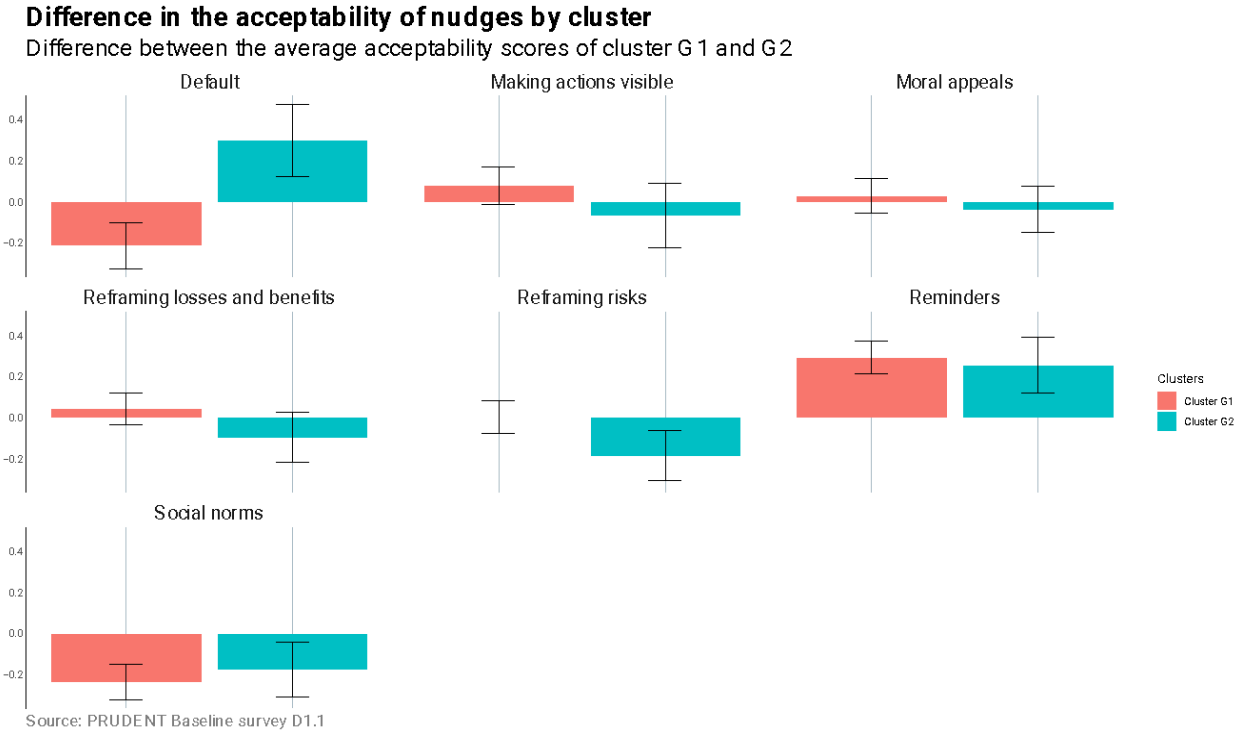

Figure 43: Bar plots showing for each nudge how perceived effectiveness differs by cluster

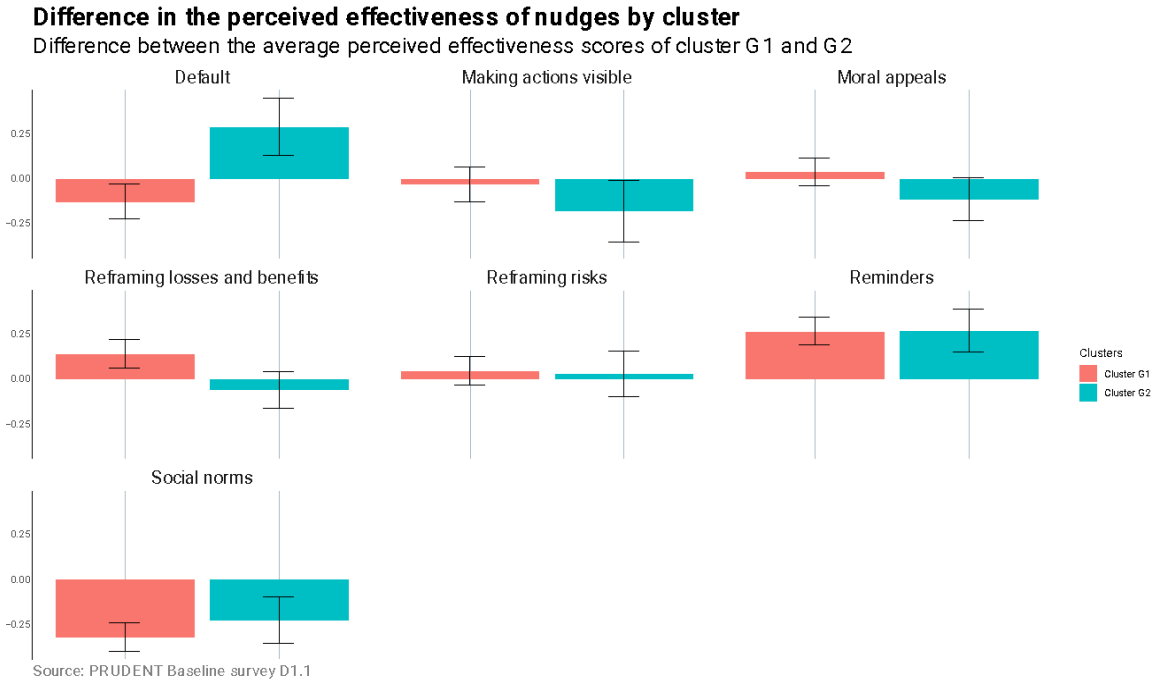

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Figure 44: This graph displays the perception each cluster has of nudge categories in terms of their acceptability

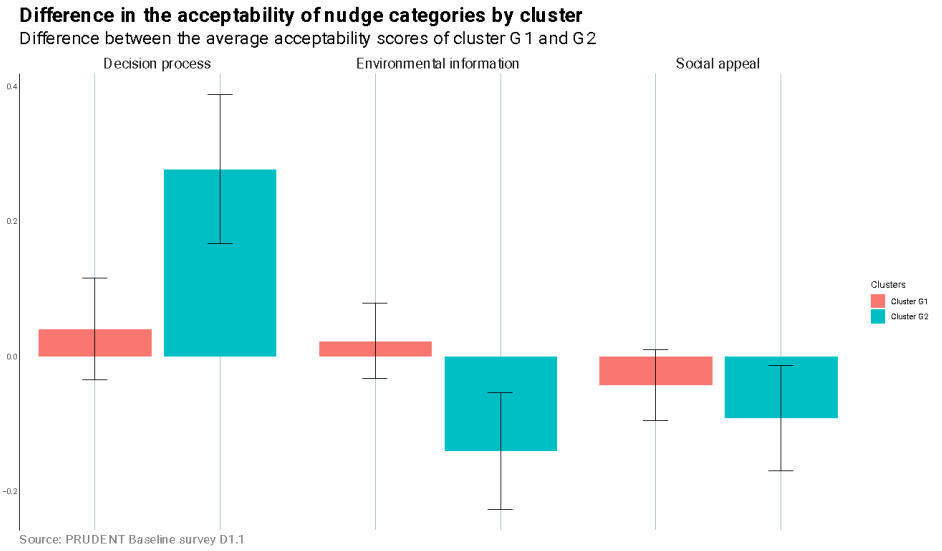
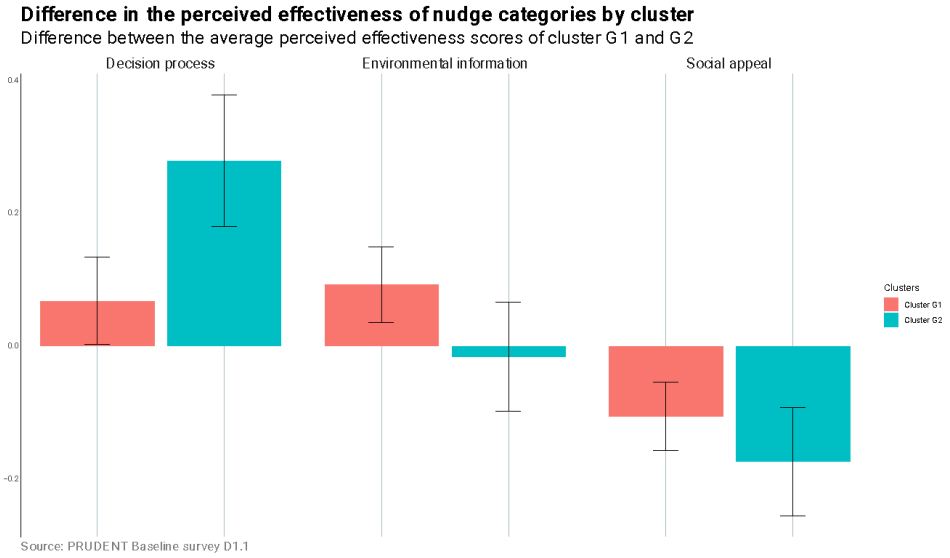


Figure 45: This graph displays the perception each cluster has of nudge categories in terms of their effectiveness



4.3.4. Discussion

Our analysis spans four European countries, Belgium, Finland, Italy and Lithuania, and different business targets, namely mixed farmers, forest owners , winegrowers and wheat farmers. We find that, besides country and business differences, some common behavioral and socio-economic patterns exist that predict the propensity to implement sustainable practices and preferences towards nudges. To extend the geographical coverage and practice variety, we actively presented the study design to colleagues in other countries. Following this outreach effort we have managed to get letters of agreement (see Annexes 1 and 2) with two research teams in Switzerland and Spain. Another agreement is under definition in France. The study will be replicated in all three contexts, by launching the same survey instrument, after being adapted to the local context. This will contribute to increasing the generalizability of our results on the effectiveness and acceptability of nudges to promote more sustainable farming practices in Europe.

In particular, the three new cases are:

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Switzerland: Agroscope will replicate our experiment focusing on planting new fruit and nut trees (e.g., walnut, cherry, and apple trees) on pastures and meadows. The survey will be delivered as a standalone survey to farmers in Switzerland. Data collection will be carried out on-line and is expected to be ready by March 2025 and their data will be pooled into the scientific paper that we expect to draft on this topic.

Spain: The Polytechnic University of Cartagena will replicate our experiment focusing on deficit irrigation, underground irrigation systems and cover crops with a sample of fruit growers in Murcia (Southeastern Spain). The survey will be embedded in a larger survey regarding preferences for support schemes to promote those three farming practices. Data collection will be carried out in person and is expected to be ready by March 2025 and their data will be pooled into the scientific paper that we expect to draft on this topic.

France: we are discussing with INRAE about the practice to be tested and the farmers' recruitment strategy.

4.4. Conclusion

Through a multi-country survey covering Belgium, Finland, Italy, and Lithuania, we have identified key behavioral and socio-demographic factors that influence farmers' and forest owners ' decisions. Our findings reveal that adoption rates vary significantly across countries due to economic, informational, and structural barriers. In Italy, interest in green multi-risk insurance was high, with 72% of respondents expressing some level of interest. In Belgium, 39% of farmers reported implementing voluntary buffer strips, while in Finland, 35% of forest owners practiced continuous cover forestry. Lithuania had the highest adoption rate, with 61% of wheat farmers implementing crop rotation. Self-reported barriers to the adoption of these practices reveal both structural and behavioral differences, emphasizing the need for targeted behavioral interventions tailored to each country's context.

To examine how behavioral interventions are perceived by our respondents, we employed a Best-Worst Scaling (BWS) experiment to assess farmers' and forest owners ' perceptions of different green nudges in terms of acceptability and perceived effectiveness. This method allowed us to rank nudging strategies. Additionally, we conducted segmentation and clustering analyses to identify distinct cross-national profiles of farmers and forest owners based on their behavioral traits, preferences, and socio-economic characteristics. These insights provide a more nuanced understanding of which nudging approaches are likely to be most effective for different groups.

Reminders emerged as the most consistently accepted and effective nudge across all countries, whereas social norm-based interventions were among the least preferred. However, country-specific variations highlight the importance of tailoring nudging strategies to local contexts. For instance, default nudges were highly accepted in Belgium and Finland but ranked among the least preferred in Italy and Lithuania. These differences emphasize that while behavioral interventions can be effective, a one-size-fits-all approach is unlikely to yield optimal results.

Moreover, our findings demonstrate that individuals who are already engaged in sustainable practices, have larger landholdings, or have inherited their business are more likely to adopt additional sustainability measures. Behavioral factors such as risk aversion, environmental concern, and the perception that a practice is the social norm also play significant roles in shaping decision-making.

The Best-Worst Scaling results resonate with the patterns we identified in the literature review conducted in this report. Indeed, in the review, we find that reminders and simplification strategies tend to be the most effective behavioral interventions, while social norm nudges often yield mixed or limited effects. This seems to indicate that our respondents' *perception* of the effectiveness of these strategies can be informative of their *actual* effectiveness. Another lesson we can draw from comparing the Best-Worst Scaling results with the literature review is that scholars' perception of what could be an appropriate nudge is not perfectly aligned with the realities of the ground. Indeed, social norms, considered as the least acceptable and least effective nudges, are by far the most studied despite a success rate below 50%. On

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the other hand, reminders, considered as one of the most acceptable and most effective nudges, appear to be a very promising approach with a high success rate.

Together, our empirical findings and the literature review emphasize the importance of designing nudging interventions that account for both behavioral barriers to the strategy promoted and the structural conditions of agricultural and forestry decision-making.

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6. Appendix

Table 1: Description of nudges in each UC

ITALY	BELGIUM	FINLAND	LITHUANIA
DEFAULT The insurance intermediary initially offers you to take out a green multi-risk insurance policy. You must actively say no if you do not want a green multi-risk insurance policy.	**DEFAULT** When you log in to your annual farmer registration, your plots near watercourses are already registered as voluntary buffer strips within the eco regulations or management agreements. You must actively opt out if you do not want to be registered.	**DEFAULT** Forest management agencies initially suggest you to engage in continuous cover forestry. You must actively say no if you do not want to practice continuous cover forestry.	**DEFAULT** The National Payment Agency automatically register as applying for support under the "Crop Rotation" system within the environmental schemes beneficial to climate, environment, and animal welfare. You must actively opt out if you do not want to be registered as doing crop rotation.
REMINDERS The insurance intermediary sends you an SMS, shortly before the deadline, reminding you can take the green multi-risk insurance, such as: “Remember that you can take out a green multi-risk insurance until [date].”	**REMINDERS** Agentschap Landbouw en Zeevisserij sends you an SMS shortly before the registration deadline to remind you of the deadline to get financial support for implementing voluntary buffer strips	**REMINDERS** Forest management agencies send you an SMS shortly before [intensive commercial forestry harvest timing] to provide you information on how to implement continuous cover forestry.	**REMINDERS** The National Payment Agency sends you an SMS shortly before the registration deadline to remind you to get financial support for implementing crop rotation.
REFRAMING RISKS The insurance intermediary sends you an SMS highlighting the risks associated with adverse events, such as: “Most farmers underestimate the risks associated with adverse events. Remember the possibility of taking out a green multi-risk insurance policy."	**REFRAMING RISKS** Agentschap Landbouw en Zeevisserij sends you an SMS highilghting the risks associated with water contamination, such as “Most farmers undersestimate the risks associated with water contamination. Remember the possibility of implementing voluntary buffer zones to reduce these risks.”	**REFRAMING RISKS** Forest management agencies send you an SMS highlighting the risks of intensive commercial forestry, such as: “Most foresters underestimate the risks of storm or insect damage. Remember the possibility of implementing continuous cover forestry to reduce these risks.”	**REFRAMING RISKS** The National Payment Agency sends you a SMS highlighting the risks associated with monoculture, such as: “Most farmers underestimate the risk of soil nutrient depletion, increased pest and disease pressure linked to monoculture. Remember the possibility of implementing crop rotation to reduce these risks.”
SOCIAL NORMS The insurance intermediary sends you an SMS informing you of how many farmers are taking this the green multi-risk insurance, such as: "To date, 75% of insured Italian farmers have already shown interest in taking out green multi-risk insurance. Remember the possibility of taking out green multi-risk insurance."	**SOCIAL NORMS** Agentschap Landbouw en Zeevisserij sends you an SMS informing you of how many farmers are implementing voluntary buffer strips, such as: “In 2024, there was an increase of 91% of the number of livestock farmers implementing voluntary buffer strips in their plots near watercourses compared to 2023. Remember the possibility of implementing voluntary buffer strips near your watercourses.”	**SOCIAL NORMS** Forest management agencies send you an SMS informing you of how many forest owners are practicing continuous cover forestry, such as: “To date, 30% of forest owners already practice continuous cover forestry. Remember the possibility of implementing continous cover forestry in your forest.”	**SOCIAL NORMS** The National Payment Agency sends you a SMS informing you of how many farmers are implementing crop rotation, such as: “To date, 25-30% of arable lands are already cultivated managed with crop rotation. Remember the possibility of implementing crop rotation in your farm.”
MAKING ACTIONS VISIBLE Upon taking out a green multi-risk insurance policy, you receive an environmental sustainability certification for your company, enabling you to promote your business to	**MAKING ACTIONS VISIBLE** Upon implementing voluntary buffer strips, you receive an environmental sustainability certification for your company, enabling you to promote your business to	**MAKING ACTIONS VISIBLE** Upon practicing continuous cover forestry, you receive an environmental sustainability certification for your forest, enabling you to	**MAKING ACTIONS VISIBLE** Upon implementing crop rotation, you receive an environmental sustainability certification for your company, enabling you to promote your business to

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consumers and partners in the supply chain.	consumers and partners in the supply chain.	promote your activity to everyone.	consumers and partners in the supply chain.
MORAL APPEALS The insurance intermediary sends you an SMS to highlight that farmers are at the forefront of environmental protection, for example, conservation of semi-natural landscapes and habitats, such as: "As a farmer, you are at the forefront of the protection of the environment, through the preservation of semi-natural landscapes and habitats that are traditional of our country. Remember the possibility of taking out a green insurance policy to help you develop and strengthen this role."	**MORAL APPEALS** Agentschap Landbouw en Zeevisserij sends you an SMS to highlight that farmers are at the forefront of environmental protection, for example, conservation of semi-natural landscapes and habitats, such as: "As a farmer, you are at the forefront of the protection of the environment, through the preservation of semi-natural landscapes and habitats that are traditional of our country. Remember the possibility of implementing voluntary buffer strips to strengthen this role by preserving watercourses."	**MORAL APPEALS** Forest management agencies sends you an SMS to highlight that forest owners are at the forefront of environmental protection, for example, conservation of semi-natural landscapes and habitats, such as: "As a forest owner, you are at the forefront of the protection of the environment, through the preservation of semi-natural landscapes and habitats that are traditional of our country. Remember the possibility of implementing continuous cover forestry to strengthen this role by preserving biodiversity."	**MORAL APPEALS** The National Payment Agency sends you an SMS to highlight that farmers are at the forefront of environmental protection, for example, conservation of semi-natural landscapes and habitats, such as: "As a farmer, you are at the forefront of the protection of the environment, through the preservation of semi-natural landscapes and habitats that are traditional of our country. Remember the possibility of implementing crop rotation to strengthen this role by preserving nutrient soil quality."
MAKING SALIENT LOSSES AND BENEFITS The insurance intermediary sends you an SMS highlighting that choosing a green multi-risk insurance policy will protect you and your legacy for future generations, such as: "Taking out a green multi-risk insurance policy will protect your farm against adverse events and preserve your legacy for future generations. Remember the possibility of taking out a green multi-risk insurance policy."	**MAKING SALIENT LOSSES AND BENEFITS** Agentschap Landbouw en Zeevisserij sends you an SMS highlighting that implementing voluntary buffer zones will preserve water quality for you and future generations, such as: "Implementing voluntary buffer zones policy will protect water quality for you and future generations. Remember the possibility of implementing voluntary buffer strips."	**MAKING SALIENT LOSSES AND BENEFITS** Forest management agencies send you an SMS highlighting that choosing continuous cover forestry today will protect the revenue stream from your forests and your legacy for future generations, such as: "Adopting continuous cover forestry will preserve your future revenue stream and the legacy of your forests for future generations. Remember the possibility of adopting continuous cover forestry."	**MAKING SALIENT LOSSES AND BENEFITS** The National Payment Agency sends you a SMS highlighting that implementing crop rotation will preserve soil quality for you and future generations, such as: "Implementing crop rotation policy will protect your farm against the depletion of soil quality and your preserve soil as your legacy for future generations. Remember the possibility of implementing crop rotation."

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