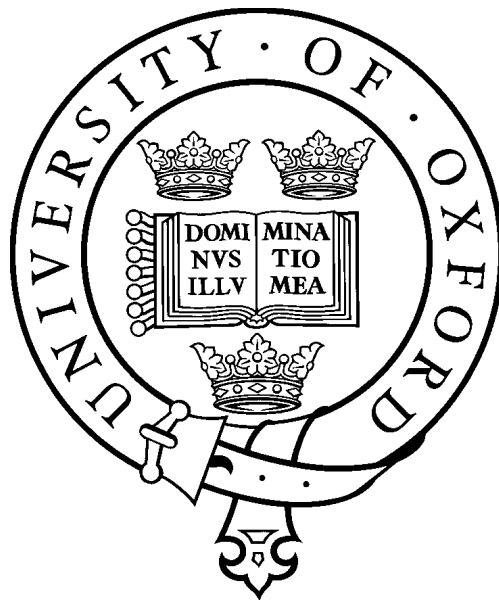


Behavioural aspects of sustainable agri-environmental change



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Abstract

Coupled climate and biodiversity crises have devastating consequences for agri-food systems. There is an urgent need for sustainable agricultural change globally. In Norway, horticultural farmers face the dual task of adopting mitigation and adaptation measures, both as individuals and as part of a collective response. This thesis employs a mixed-methods approach, drawing on fieldwork insights from semi-structured interviews, an experimental survey, and behavioural data to explore how farmers navigate these complex transitions. It examines the drivers and barriers shaping their decisions to adopt sustainable practices, offering novel perspectives on the interplay between individual motivations, relational values, and systemic change.

The first empirical chapter draws on semi-structured interviews in which I examine farmers' relational values, i.e. values that pertain to specific relationships with or via nature and how to live a good life. The results indicate that farmers' relational values influence their decisions, and that the values are interrelated with a web of actors in the agri-food system that shapes farmers' opportunities for enacting their relational values.

In the second empirical chapter I employ a survey incorporating video-based information interventions and experimentally manipulate narratives of cover crops, a sustainable farming practice, to focus on climate change mitigation or adaptation. I show that the adaptation framing increases farmers' support for large-scale agricultural mitigation policy, whereas I find no effect for the mitigation treatment. Neither treatment influenced farmers' adoption of cover crops.

Third, I use the survey data to examine predictors of farmers' intentions and their actual behaviour and the prevalence and nature of the gap between them. I demonstrate that predictors of intentions do not correspond to predictors of actual behaviour, and that only strong intentions (but not weak) predicted adoption. The chapter points to the need for mixed-method approaches and methodological advancements that overcome the reliance on measures of intentions and willingness to advance our understanding of behavioural change in the agricultural context.

Taken together, this thesis leverages interdisciplinary approaches to consider the complex relationships between various actors in the agri-food system, farmers' individual differences, and farmers' opportunities for action. It contends that while farmers are resourceful and adaptive, their abilities to implement change are often bound by systemic constraints, including the actions of other actors. These constraints can also prevent farmers from following up on their intentions to adopt sustainable farming practices. The research underlines the need for more nuanced perspectives that consider these interdependencies to improve understandings of and promote the adoption of sustainable agricultural practices. The thesis also provides new evidence that methodological approaches which incorporate longitudinal designs and behavioural measures are imperative to deliver insights to help address the interlinked challenges that must be overcome for sustainable agri-environmental change.

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Abbreviations

CDR	Carbon dioxide removal
CI	Confidence interval
COP	Conference of Parties
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GPS	Grøntprodusentenes samarbeidsråd (Green Growers' Cooperative Council)
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
NIBIO	Norsk Institutt for Bioøkonomi (Norwegian Institute for Bioeconomy)
NLR	Norsk Landbruksrådgivning (Norwegian Agricultural Extension Service)
OECD	Organisation for Economic Co-operation and Development
TPB	Theory of Planned Behaviour
UNFCCC	United Nations Framework Convention on Climate Change

1. Chapter 1: Introduction

We are facing unprecedented and interlocked challenges. Coupled climate and biodiversity crises, pollution, and a growing population that relies on natural environments for food and fibre place unsustainable pressures on and degrade our ecosystems. The global food system is among the key contributors to these challenges. Agriculture has enabled the development of human societies as we know them, but the intensity of modern agriculture now drives environmental decline. Indeed, the term ‘agri-environmental’ demonstrates how agriculture cannot be separated from environmental considerations. Policies are continuously developed and adapted to respond to these challenges. Many seek to promote the uptake of sustainable agricultural practices and minimise negative effects at the farm level. Such policies increasingly leverage insights from the behavioural sciences, recognising that farmers play critical roles in the sustainable transition, that they hold diverse preferences and beliefs, and that they must be willing to adopt such practices. Therefore, the goal of this thesis is to deepen our insights into the behavioural aspects of agricultural change, focusing on determinants of farmers’ decision-making. The remainder of the introduction further situates the work and presents the motivation behind the thesis.

1.1. Human dimensions of climate change

The joint crises of climate change and biodiversity decline threaten human and non-human life. Paradoxically, these crises result from the ways in which humans and social systems have developed over time. Modern societies organise around natural resource extraction and exploitation. Virtually all aspects of life—how we move around, build and heat our homes, and eat—involve fossil fuel combustion, deforestation, land use change, and other activities that emit greenhouse gases into the atmosphere and deplete natural environments. The rising

atmospheric greenhouse gas concentrations form a blanket around Earth that increases temperatures and provokes more frequent and severe extreme weather events including heat waves, droughts, and heavy precipitation (Stott et al., 2016). Degraded environments and livelihoods that depend on them are in turn left more vulnerable to these events (Webb et al., 2017). The coupled climate and environmental crises are thus inextricably linked with human existence. Global assessments demonstrate the urgent need for transformative change across scales for climate change mitigation and adaptation, from individual behaviours to collective action in private and public sectors (IPCC, 2022; Pascual et al., 2017; Pörtner et al., 2021).

Because the environment, social systems, and individual actions are deeply interconnected, scientists and experts agree that advancing collective action to implement solutions relies on the behaviours of many individuals (Amel et al., 2017; Gavrilets & Richerson, 2017; World Bank, 2014). Many human behavioural changes could contribute to reducing emissions (i.e. climate mitigation) and addressing vulnerabilities and expected impacts (i.e. climate adaptation), that when aggregated can significantly influence projected climate change (Beckage et al., 2022; Steg, 2023). Individuals can thus significantly influence the severity of climate change through their actions (Gifford et al., 2011; Gifford & Nilsson, 2014; Nisa et al., 2019). Yet human behaviour can be slow to change, and we lack the ability to reliably predict how behavioural change today influences change at societal levels tomorrow (Bak-Coleman et al., 2021). Considerations of how to produce such changes have piqued the interest from the scientific community. For example, environmental psychologists have conducted research to understand how to promote pro-environmental behaviours since the middle of the 20th century (Hines et al., 1987). Since then, empirical insights from across the behavioural and social sciences have taught us that human behaviours result from complex interactions

between the individual and their environment: individual values, preferences, and beliefs influence, and are influenced by their surrounding social norms, regulatory frameworks, and other political and economic conditions (Bamberg & Möser, 2007; Gifford & Nilsson, 2014; Nyborg et al., 2016; Whitmarsh et al., 2021).

We are now well into the 21st century and fast approaching critical climate change targets set for 2030. Climate and environmental problems are as pressing as ever. Given the key role individuals play in advancing large-scale change it is important to further understand the context-specific factors that motivate their actions (Amel et al., 2017). Moreover, integrating these behavioural insights into sustainability research and policy implementation remain as urgent challenges (Constantino et al., 2021). Recent contributions increasingly call for more attention to be given to interdisciplinary perspectives in order to advance our understanding of how to conceptualise sustainable transitions, the context-dependent process of behaviour change, and how to scale up change from individuals to collectives (Beckage et al., 2022; Folke et al., 2021; Geels et al., 2023; Schill et al., 2019). Drawing on different strands from across the behavioural and social sciences that thus far have remained separate could offer new insights and enable sustainable trajectories (Eyster et al., 2022; Naito et al., 2022; Stålhammar & Thorén, 2019).

The agricultural context epitomises the challenge of coupled climate and biodiversity crises, possessing a duality of both influencing and being influenced by them (IPCC, 2022; Masson-Delmotte et al., 2019). Agriculture is the main driver of biodiversity decline and a major source of greenhouse gas emissions, yet also the most vulnerable economic sector to climatic and natural conditions, for example through seasonal fluctuations, temperature variation, and

water stress (IPCC, 2022; Konapala et al., 2020). Farmers are at the front lines of these challenges. Their farm management must continuously account for crop and soil health, pest management, weather fluctuations, and seasonal change. Increasingly they must also respond to droughts, floods, and other challenges that threaten their livelihoods and agricultural productivity (Anderson et al., 2020; Masson-Delmotte, 2019). To do so farmers have various farming practices at their disposal, such as conservation tillage, planting hedgerows, implementing agroforestry, cover crops, and nutrient management, to mention a few (Gosnell et al., 2019). These can offer mitigation or adaptation benefits, or both, thereby making food systems more resilient and reducing environmental impacts. The importance of farmers' decisions therefore cannot be understated.

To ensure efficient food production and to protect livelihoods, policy in the agri-food-climate-biodiversity nexus must facilitate both effective mitigation and adaptation, thereby promoting sustainable agri-environmental change. To do so policies often target farmers' production methods to encourage adoption of sustainable farming practices (Defra, 2021; Dessart et al., 2021; European Commission, 2020). Farmers' management decisions and support for agri-environmental policy thus have important implications for their own livelihoods, the food provision for the whole of society, and climate mitigation and adaptation. How exactly do farmers make these decisions? How do their values and beliefs influence their actions? How can policy be shaped to support them? These questions are of society-wide importance, and better understanding them can help advance multiple sustainable change goals.

1.2. Research motivation and questions

This thesis is motivated by such questions and the need to advance our knowledge of interconnections between human behaviour and environmental outcomes. Such cross-cutting issues require interdisciplinary approaches and solutions. In this thesis I combine empirical methods and draw on different perspectives from the behavioural and social sciences to examine urgent agricultural sustainability challenges. To make the work feasible I focus on distinct aspects of human behaviour that have been conceptualised as central for sustainability transitions. Specifically, I draw on perspectives from relational thinking and environmental psychology, strands which have grown increasingly relevant in recent years but to date have remained relatively separate. I use agriculture and farmers' decision-making as a case study, with Norway as the geographic focus and horticultural farmers as the population of interest. The main research questions addressed in the thesis are summarised in Table 1.1. The outline of the remainder of the thesis and the research objectives are as follows. In **Chapter 2**, I outline the theoretical approach of the thesis. In doing so I non-exhaustively review relevant literature and identify and situate the research questions that the thesis addresses. Specifically, I focus on the concept of relational values—values that refer to the meaningfulness of relationships between humans and nature; individual perceptions and beliefs regarding climate change mitigation and adaptation; and the gap between intentions to act and actually performing behaviour. In **Chapter 3**, I explain the methodological approach used in the thesis. **Chapters 4-6** are conceptualised to address the research questions. They are intended as stand-alone papers that are published or will be published in academic journals. I first consider how relational values, a concept which emerged to offer more nuanced understandings of human-nature relationships, can be employed in the context of farmers' decision-making and identify leverage points for sustainable change (**Chapter 4**). I then examine predictors of farmers'

preferences and beliefs pertaining to agricultural mitigation and adaptation—which could be perceived as substitutes and therefore there is a plausible and potentially harmful trade-off at the individual level of decision-making. I use cover crops as an example sustainable farming practice (**Chapter 5**). Thereafter, in **Chapter 6** I address the gap between farmers’ stated values and intentions on the one hand and their actual behaviour on the other, given the need for more empirical evidence on this relationship and when intentions turn into actions. Finally, in **Chapter 7** I consider the main findings from the thesis and its cumulative insights based on the previous chapters. I also discuss the implications for sustainable agricultural change and propose avenues for future research based on the limitations of the research. Taken together, the thesis seeks to contribute to the literature illuminating the diverse behavioural aspects of farmers’ pro-environmental decisions and adoption of sustainable farming practices, and how such insights can help evaluate and further develop agri-environmental policies.

Table 1.1. Summary of the research questions addressed in this thesis.

Thesis Chapter	Paper	Research Question
4	1	How do farmers’ relational values inform their experiences, priorities, and farm management decisions? How do other actors in the agri-food value chain interact with their relational values?
5	2	How does learning about cover crops as a strategy for climate change adaptation and mitigation influence farmers’ support for large-scale mitigation policy and adoption of cover crops?
6	3	Of what magnitude is the intention-behaviour gap? 2) Are the predictors of intentions also predictors of behaviour? 3) Which predictors explain whether intentions turn into behaviour?

2. Chapter 2: Literature review

To contextualise the research questions in this thesis I start by exploring the need for a nuanced understanding of human behaviour to address climate change, focusing on the agricultural context. I draw on interdisciplinary literatures to account for the complexities underlying behaviour in general and farmers' decisions to adopt sustainable practices in particular, in order to identify knowledge gaps and develop further insights into processes of change in the agri-environmental context. I specifically address three facets of literature that are relevant for understanding the objectives of this thesis. First, in Section 2.2 I consider the current understanding of how human behaviour influences agri-environmental change based on a values perspective and specifically focus on how relational values influence farmers' behaviour. Second, in Section 2.3 I turn to the psychological sciences which emphasise a diverse set of variables including individuals' perceptions and beliefs, social influence, and contextual factors to understand behaviour and how to change it. Third, and finally, in Section 2.4 I focus on the prevalent gap between people's professed values and intentions and their actions, and the urgent need to better understand how and when values and intentions translate into actual behaviour to advance sustainable change.

The chapter thus keeps with the scope of the thesis presented in the introduction. It identifies specific research gaps throughout the text to inform the research objectives and questions of the thesis. The full literature review relevant to each research question is contained in the respective empirical chapter. Although I have attempted to avoid repetition there is some inevitable overlap in wording and concepts between the contents of this chapter and the empirical chapters.

2.1. Agricultural change needs behavioural change

The agricultural sector is uniquely situated at the crux of the sustainability challenges that define the 21st century. While growing populations require efficient food production, agricultural productivity is threatened by the rapidly evolving consequences of climate change, biodiversity loss, and a host of social, economic, and political threats. Agriculture is simultaneously a key contributor to these very crises, as the main driver of biodiversity loss and responsible for one quarter of global greenhouse gas emissions worldwide (IPCC, 2022; Masson-Delmotte et al., 2019). Without widespread change in the agricultural sector, human activities will continue to transgress planetary boundaries (Clark et al., 2020; Springmann et al., 2018). The gravity of these challenges has brought agricultural production methods, land use, supply chains, and consumption patterns to the top of political agendas worldwide (European Commission, 2021; FAO, 2022; UNFCCC, 2023). While agricultural policies vary in their scope, attempts to instigate change in the agricultural sector often target farmers. As will be further explored below, these attempts have so far had limited effects. Thus, farmers are explicitly recognised as critical actors in the context of agricultural change as the ones who must directly respond to challenges and implement necessary changes (Gosnell et al., 2019; Mills et al., 2017), and more knowledge is required on how to effectuate these changes.

Parallel to this recognition, scientists and professionals also acknowledge that implementing singular technological fixes and engineered solutions, often retrofitted, could not adequately or sustainably address the problem (Eriksen et al., 2021; Nightingale et al., 2020). Instead, behavioural change by various stakeholders and changes to the regulatory environment would be required (Barnes et al., 2019; Brown et al., 2021). For example, in industrial farming systems farmers often grow the same crop year after year—monocropping—for reasons including

efficiency and access to machinery, and they rely on inputs such as chemical fertilisers to stimulate growth and on pesticides to protect their crops. However, monocropping reduces soil organic matter, leads to erosion, and increases the risk of pests and disease (Rühlemann & Schmidtke, 2015). Chemical inputs such as synthetic fertilisers emit large amounts of greenhouse gases at the production stage and are associated with soil degradation, biodiversity decline, and adverse impacts on human health (Bünemann et al., 2006). To prevent these adverse effects, farmers could adjust their farming methods by incorporating one or more alternative practices depending on their production system. For example, they could introduce crop rotations to alternate the types of crops grown in consecutive years or introduce agroforestry which integrates trees or shrubs in farming systems. They could also use cover crops to prevent the soil from lying bare between rotations, that offer co-benefits of reducing soil erosion and sequestering additional carbon, or they could adjust their nutrient management practices including inputs of e.g. synthetic fertilisers and/or pesticides (Bünemann et al., 2006; Rasmussen et al., 2024). These decisions, however, are contingent on a range of economic, social, and attitudinal influences, the effects of which strongly depend on individual farmers' contexts and that often involve trade-offs between different and often conflicting objectives (Brown et al., 2021; Sutherland et al., 2012). While this thesis recognises the importance of economic incentives, it focuses on that of behavioural factors. For example, farmers who are more concerned about climate change tend to report stronger willingness to implement climate mitigation and adaptation practices (Arbuckle et al., 2013; Mase et al., 2017; Swart et al., 2023), whereas certain farmers are more motivated by the economic benefits that may accompany such changes (Davidson et al., 2019). How strongly a farmer is connected to other farmers and believe they are taking action can also influence their

behaviours (BenYishay & Mobarak, 2019; Bijman et al., 2014; Petersen-Rockney, 2022; Villamayor-Tomas et al., 2019). I will explore these factors in-depth in Section 2.3.

The critical point is that while farmers must be experts on many things, including agronomic conditions, crop varieties, and business management, they do not possess complete information or absolute cognitive control, and they do not always pursue rational optimisation of their own (monetary) benefits (Brown et al., 2021; Dessart et al., 2019; Mills et al., 2017; Urbina & Ruiz-Villaverde, 2019). As such, while considering the impact of economic incentives is necessary, adopting a nuanced perspective that considers a broad range of factors that influence farmers' behaviour—beyond economic considerations—is critical to explicate how to influence sustainable change in the agri-environmental context. This includes the wider system that farmers operate in, which interacts with individual preferences and shapes the opportunities that individuals have for action.

2.1.1. Environmental sociology

Perspectives rooted in environmental sociology investigate the intersection between society and the environment and the social construction of environmental problems to understand how to transition to a sustainable future (Hannigan, 2022). These perspectives emphasise that individuals' everyday decisions are rooted within, and thus shaped by, social and political contexts (Pellow & Nyseth Brehm, 2013; Schill et al., 2019). For example, practice theory diverts focus away from individual decision-making and draws attention to how actions are embedded within social practices (Hargreaves, 2011; Reid & Ellsworth-Krebs, 2019; Shove, 2010). In this view, individuals are not the centre of study but rather those who carry out the tasks and activities which are defined by societal institutions (Hargreaves, 2011). These include

informal institutions such as societal norms and values, which can strongly influence individuals (Bicchieri, 2017; Inglehart & Baker, 2000). Relational perspectives, which also shift focus away from the individual as the subject of enquiry, conceptualise actions as consisting of and being iteratively shaped by diverse relationships, processes, and actors (humans and non-humans), all of which exist and occur at various levels and time points (Chan et al., 2016; Gosnell et al., 2019). Specifically, a relational approach posits that environmental values can emerge from salient relationships that humans have with or via nature (Chan et al., 2018). This contrasts with conventional conceptions of human-nature relationships, which tend to assume that people possess properties or traits, such as environmental values, that are associated with attitudes about e.g. environmental actions (Dunlap, 2008; Sagiv et al., 2017). A relational perspective instead posits values not as traits but as a bidirectional bond in that it describes the ways in which humans value their relationship with nature. It considers individuals as existing in networks and their actions as facilitated or constrained by social, financial, and political institutions in order to further identify leverage points for sustainable trajectories (Chan et al., 2020). It thus brings forward values as indirect drivers of change, that despite being recognised as important have received distinctly less attention on how they influence environmental decisions (Chan et al., 2020; IPBES, 2022). This is an important avenue for research because interventions that address direct drivers of change, i.e. the processes that directly influence nature, land use change, biodiversity, climate change, etc. (Díaz et al., 2015), are often resisted since current socioeconomic and regulatory environments constrain people's opportunities for action (Ehrlich & Pringle, 2008).

These perspectives from the social sciences in general and environmental sociology in particular have advanced our knowledge of the processes that underlie sustainable change.

However, they do not offer a complete understanding, and they do not comprehensively account for the role of the individual in social change processes.

2.1.2. Insights from psychology

The psychological sciences have advanced our knowledge of how human behaviour is integral to the causes and solutions to climate change (Clayton et al., 2015; Whitmarsh et al., 2021). For example, a body of literature rooted in dual-process models of human behaviour that acknowledges limits to mental capacity and the prevalence of cognitive biases have demonstrated that interventions can change individual behaviours by harnessing these limitations (Gilovich et al., 2002; Kahneman, 2003; Tversky & Kahneman, 1974). Instead of relying on people's conscious considerations, interventions that for example frame messages, increase the salience of desired behaviours, leverage emotional appeals, or use default settings can effectively change behaviour (Byerly et al., 2018; Ferrari et al., 2019; Thaler, 2000). In turn, as many individuals change their behaviour it could scale up and result in abrupt and widespread changes in the wider population (Andreoni et al., 2021; Winkelmann et al., 2022). For example, Fehr and Schurtenberger (2018) demonstrate that fundamental psychological mechanisms, such as an intrinsic desire for fairness, the desire to reciprocate others' behaviour, and to maintain a self-image as prosocial, could drive individuals to conform with social norms even when doing so conflicts with their material or economic self-interest.

In the agricultural context, policies often leverage economic incentives to encourage farmers' adoption of environmental management practices. In Europe, the Common Agricultural Policy focuses on agri-environmental schemes, i.e. voluntary contracts to implement a set of management practices usually at field or farm scales with environmental and/or biodiversity

benefits (Barreiro-Hurle et al., 2023; M. Díaz & Concepción, 2016; European Commission, 2020a). Similarly in the UK, farmers are paid to implement sustainable farming practices, e.g. through the Sustainable Farming Incentive (Defra, 2021). A prevalent view that monetary profits is a main motivator for production decisions has led to this economic focus for policy interventions (Batáry et al., 2015; Brown et al., 2021; Pe'er et al., 2019). However, farmers' decisions to adopt sustainable farming practices are far more nuanced than these policy rationales assume, which could help explain their limited success. For example, despite legislation and financial incentives targeting EU farmers' practice changes to address nitrate pollution and a goal to reduce nutrient losses to the environment by 50% by 2030, the average nitrate concentration in EU groundwaters did not decline from 2001 to 2021 (EEA, 2023; European Commission, 2020a). Decisions often depend on a range of socio-psychological and contextual factors including individuals' motivations and values, social orientations and networks, farm structure, in addition to economic factors and policy designs (Bartkowski & Bartke, 2018; Brown et al., 2021; Dessart et al., 2019; Fehr & Schurtenberger, 2018; Levin, 2014; Swart et al., 2023). For example, managing the risk of transitioning to new farming practices can be challenging if it is necessary to learn novel forms of production, purchase new inputs or machinery, or if there are limited economic fallback mechanisms (Zurek et al., 2022). One recent focus has been on strategies for closing yield gaps, or the difference between the realised yield and the maximum possible yield in a particular location, that interact with both climate mitigation and adaptation through alleviating pressures on land, water, and food production (Mueller et al., 2012). Yet closing this gap requires inputs such as water and fertiliser that might not be locally available and that may have negative environmental externalities (Davis et al., 2017; Zurek et al., 2022). It also requires the necessary knowledge, skills, and motivation. In sum, the analysis of individual decision-making has advanced from

the neoclassical economic theories of “rational” agents acting to maximise self-interest to now consider a broader set of influences on individual preferences and behaviour.

The sections above demonstrate some of the diverse perspectives regarding drivers and barriers for behavioural change, each with their respective strengths and limitations. Given the complexity of human behaviour, this thesis recognises that a stronger integration of different perspectives can help advance action on climate change (Nielsen, Clayton, et al., 2021; Schipper et al., 2021; Steg, 2023; Whitmarsh et al., 2021). In particular, it emphasises that these insights need to be incorporated—urgently and carefully—into approaches that aim to influence farmer’s decisions (Batáry et al., 2015; Huber et al., 2024). The thesis thus draws on interdisciplinary insights, particularly (but non-exhaustively) from the social sciences including environmental sociology and psychology, to argue that a more nuanced understanding of the factors that influence and predict human behaviour (hereafter termed “predictors”) in general and that of farmers in particular can help advance sustainable agri-environmental change. This thesis will not go into documenting the difference between farmers and other decision-makers regarding these behavioural mechanisms. Instead, it will review some of the recent evidence of what matters particularly in the context of farmers’ behaviour and their decisions to adopt sustainable farming practices, as specified above. I first consider the role of values.

2.2. The values behind behaviours

Across theories of human behaviour, values represent a key construct that is often intuitively linked with behaviour and conceptualised as predicting it (Bouman et al., 2021; Gould et al., 2023; Schwartz, 2012; Steg, 2023). From a psychology perspective values are understood as relatively stable traits that reflect foundations of the goals that people strive for in life and are

conceptualised to influence attitudes and beliefs and help direct attention toward value-congruent information (Schwartz, 2012). For example, strong conformity values motivate behaviour that aligns with social expectations, and achievement values can prompt people to demonstrate personal capability and success. Given their role in both individual lives and societal outcomes, researchers and practitioners have for long sought to better understand how values influence decisions and actions (Inglehart & Baker, 2000; Ives & Kendal, 2014; Schwartz, 2012). A range of valuation perspectives have been put forward along with related methodological challenges and discrepant results depending on contexts, underlining the need for more work in this area (Chan et al., 2018; Pratson et al., 2023). In 2022 the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), a UN organisation that summarises scientific information for environmental policy, published the “Values Assessment” to evaluate the diverse values and valuation perspectives of nature. Specifically, it offers a “guidance to navigate pathways for reconciling people’s good quality of life with life on Earth and advancing the intertwined economic, social and environmental dimensions of sustainable development in a balanced manner” (IPBES, 2022). The Values Assessment thus welcomes and elaborates on diverse valuation perspectives and on multiple values of nature and associated benefits, their role in judgements of the importance of nature in particular contexts, and in policy design.

2.2.1. Relational values

To further understand human-nature relationships the concept of *relational values* has recently been put forward. Its emergence is rooted in the ecosystem services perspective and a growing consensus that pro-environmental behaviours such as conservation and land stewardship, or lack thereof, stem from various relationships between humans and nature

(Eyster et al., 2022; West et al., 2018). Relational values thus represent a “third kind” of values that expands on the dichotomy previously dominating the discourse: instrumental (valuing nature for people’s sake) and intrinsic (valuing nature for its own sake) values (Chan et al., 2018; Deplazes-Zemp, 2023; Himes & Muraca, 2018). Relational values refer to the meaningfulness of people’s interactions with nature, specifically defined as “preferences, principles, and virtues associated with relationships, both interpersonal and as articulated by policies and social norms” (Chan et al., 2016, p. 1462). Three characteristics separate relational values from other value concepts. First, rather than centring on the value of things or outcomes, relational values are based on the recognition that relationships with nature are fundamental to people’s sense of well-being and identity. Second, they are embedded within culture and (re)produced through behaviours (Allen et al., 2018), and thus more context-specific than other types of values (Himes & Muraca, 2018). Finally, the relational values concept emphasises the dynamic and bidirectional relationships between humans and nature, and does not rely on a priori traits or properties of humans (Chapman & Deplazes-Zemp, 2022).

Thus, the concept offers a novel perspective focusing on the importance of desirable and meaningful relationships and values that are more than just instrumental, i.e. they are non-substitutable and stem from or are about relationships (Chapman & Deplazes-Zemp, 2022; Himes & Muraca, 2018; Pratson et al., 2023). Proponents of the concept argue that it could help identify and examine salient relationships that construct environmentally relevant motivations and behaviour (Chan et al., 2018; Eyster et al., 2022, 2023). The bidirectional and co-created nature of relational values makes them useful for simultaneously examining both humans and non-human components of nature, such as species or landscapes, to find solutions (Eyster et al., 2022). The concept also highlights that social relationships can work as

information dissemination and enable or facilitate environmental behaviour, which, then, is situated and co-produced rather than limited to those who hold specific environmental priors (West et al., 2018). Consider for example protected areas. Without the concept of relational values, protected areas must justify their existence in instrumental or intrinsic terms. They would thus either need to serve human interests in some way, e.g. by providing ecosystem services, or be instated for their own sake (Kleespies & Dierkes, 2020). Relational values, however, add the option that the protected areas are established due to e.g. traditional or cultural relationships that humans have with the specific place as well as their appreciation for and responsibilities toward it, that cannot be substituted by another place (De Vos et al., 2018).

It should also be noted that the concept has been subject to critique. In particular, scholarship that does not properly define the concept or engage specifically with the three characteristics could result in a vague and 'messy' concept that loses theoretical meaning (Kenter et al., 2019). In a review of relational values research, Pratson et al. (2023) identified 312 unique relational values across 72 studies. The authors caution that the diverse interpretations of the relational values concept and the ways it is (not) defined pose risks of it being so broad and inclusive that it loses meaning (Pratson et al., 2023). For the concept to serve its intended purpose of explicating human-nature relationships, research should be grounded in the core characteristics of the concept and consider how it could accompany or expand on other methods (Eyster et al., 2023; Pratson et al., 2023).

Relational values thus capture nature and its constituents as conduits for meaningful lives (see Figure 2.1). Commonly cited relational values include responsibility, care, connection to place, and stewardship, principles which often cannot be substituted and that link to well-being and

“doing what is right” (Hill et al., 2021; Pratson et al., 2023). As empirical evidence suggests highly complex interlinkages between values and behaviour in the context of environmental management (Fish et al., 2016; Vatn, 2009), a relational values lens can help develop a more nuanced understanding of human-nature relationships.

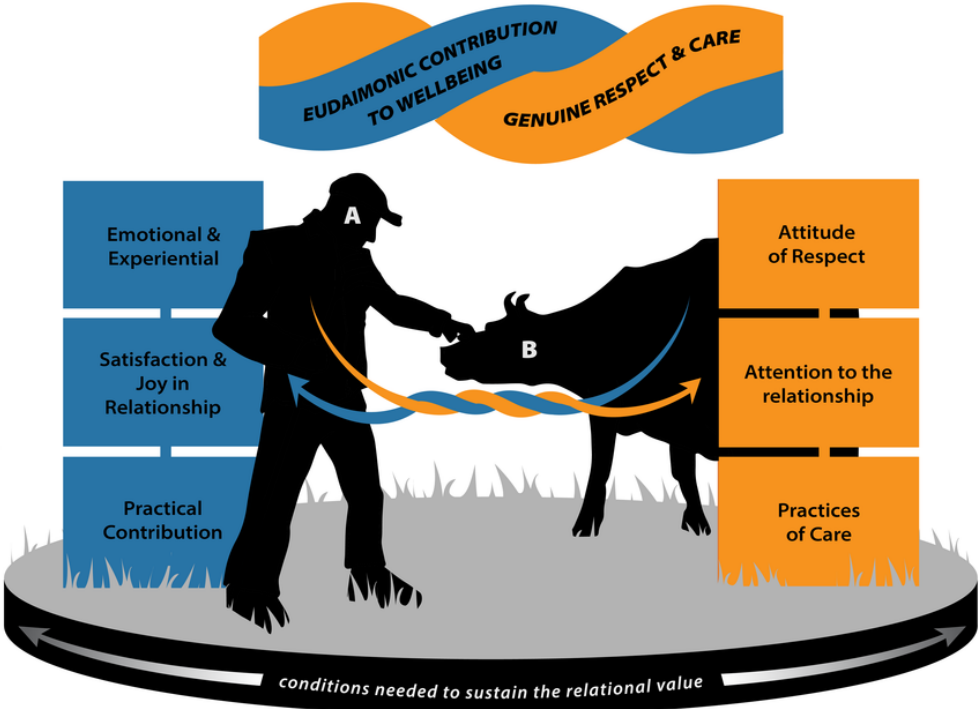


Figure 2.1. Example of how relational values reflect the responsibilities and relationships humans have with nature, here illustrated with six core components in the context of Swiss farmers. The interwoven arrows signify the interrelatedness of each direction between the valuer (farmer, A) and the valued entity (cow, B) to the extent that they cannot be fully separated. The grey foundation represents the biophysical, economic, political, and other conditions needed to sustain the relational values (adapted from Chapman & Deplazes-Zemp, 2022).

However, thus far the literature predominantly focused on identifying and describing relational values as they pertain to individuals. It is increasingly recognised that various actors and contexts can facilitate the expression of some values while restricting others (Bataille et al., 2021; Gould et al., 2023; Hoelle et al., 2022). In the context of agriculture, there are research gaps pertaining to how farmers’ relational values interact with other actors (e.g. farm advisors,

policymakers) and the outcomes for their decisions (Gould et al., 2023; Sagiv et al., 2017). To advance agricultural change, the utility of the concept in policy and practice could thus be furthered by elaborating on how different actors, policies, and economic drivers influence the relationships that farmers develop with and via nature, and the outcomes for their behaviours. As such, to contribute to this gap in the literature, this thesis focuses on the following research question in Chapter 4 (Paper 1):

Research question 1: How do farmers' relational values inform their experiences, priorities, and farm management decisions? How do other actors in the agri-food value chain interact with the relational values?



The literature reviewed above suggests that the relational values concept can help identify novel perspectives and understandings of human-nature relationships in general and of farmers' decision-making in particular. Given the complexity of interlinked climate-biodiversity and agri-environmental challenges and the role of human behaviour within them, it is however clear that one perspective alone cannot fully account for farmers' decisions, let alone behavioural change at a larger scale (Eyster et al., 2023; Gould et al., 2023). As alluded to above, farmers must also navigate a wide array of factors and have many possible on-farm strategies on hand that can contribute to sustainable change. Before turning to consider contributions from the psychological sciences to better understand these decision processes, it is therefore useful to first elaborate on the strategies that farmers have at their disposal for agri-environmental change.

2.3. The relationship between agricultural mitigation and adaptation

The numerous strategies available to farmers for addressing climate change can be divided into two dominant groups: mitigation and adaptation. Climate change *mitigation* involves reducing greenhouse gas emissions and enhancing greenhouse gas sinks, for example via rewilding and afforestation (IPCC, 2021). Mitigation thus addresses the source of the problem and ultimately reduces the magnitude of future climate change, requiring collective efforts to produce society-wide benefits. The other strategy revolves around responding to climate change, i.e. *adaptation*, by preparing for, adjusting to, and dealing with expected and ongoing negative consequences of climate change (IPCC, 2022). Such consequences are inevitable due to historical emissions, and adaptation efforts can be undertaken at the individual level for private benefits. There are thus differences in how mitigation and adaptation actions impact individuals: whereas for both actions the cost of implementation falls on the individual, large-scale mitigation efforts result in society-wide and collective benefits that are often intangible and long-term in scope, whereas adaptation efforts more generally result in individual-level and more tangible benefits (Dolšak & Prakash, 2018; Eriksen et al., 2015; Nightingale, 2016). Critically, these strategies are not mutually exclusive. To prevent future runaway climate change and to respond to the already committed level of climate change due to historical emissions, both strategies are indispensable (Calvin et al., 2023).

However, initial efforts to address climate change primarily focused on mitigation and largely ignored adaptation. Some researchers and practitioners argued this to be a suitable focus given the urgent need to reduce emissions and not wanting to divert attention to something that seemed less critical such as adaptation (Pielke et al., 2007). It is now undisputed that both strategies are needed, which is particularly evident in a context like agriculture that is both a

source of emissions and vulnerable to the impacts of climate change. Moreover, implementing appropriate climate change mitigation and adaptation strategies requires individual farmers to act, as well as their endorsement of policies and programs to further facilitate large-scale emissions reductions and adaptation initiatives (Arbuckle et al., 2013; Brügger et al., 2015; Haden et al., 2012). If the farming community does not endorse these programs and instead prioritises other matters, such as maintaining intense, high-input production systems, the programs will likely be unsuccessful in delivering the intended changes to move towards sustainable agricultural systems.

Indeed, the literature started considering what predicts the actual uptake of mitigation and adaptation practices in agriculture. This is a critical research focus because mitigation and adaptation in agriculture is of interest to farmers and the public alike. The climate-driven risks that confront farming communities and that will continue to confront them in the coming decades will only increase in severity and frequency. To ensure efficient food production and prevent the most destructive consequences of climate change, urgent action across scales and sectors to mitigate emissions and to adapt to the impending impacts will be necessary (IPCC, 2022; Masson-Delmotte, 2019; United Nations Environment Programme, 2023). Therefore the required changes in agriculture should not fall as burdens on individual farmers, underlining a pressing need for well-designed, inclusive institutional arrangements that support their uptake (Batáry et al., 2015; Brown et al., 2021; Mills et al., 2021).

Most studies have focused on either agricultural mitigation or adaptation, and only more recently have they been considered together (Arbuckle et al., 2015; Jørgensen & Termansen, 2016; Moerkerken et al., 2020; Niles et al., 2016). Moreover, this literature remains divided on

the predictors and conditions that motivate farmers' mitigation and adaptation intentions and actions. Haden et al. (2012) examined whether farmers' past experiences with climate change and their level of concern for climate change (focusing on local and global levels of concern). They surveyed farmers in California and found that adaptation was more likely for farmers who had personal experience with water shortages. Overall, the results suggest that farmers' mitigation is largely motivated by global concerns and beliefs about climate change, while adaptation is driven more strongly by local concerns for local impacts (Haden et al., 2012). In a sample with New Zealand farmers, Niles et al. (2016) found that the only variable that consistently predicted intentions and actual adoption of mitigation and adaptation practices on farms was farmers' perceived capacity to implement actions. In a Danish context, however, a survey assessing farmers' perceptions of climate change and related implementation of mitigation and adaptation farming practices found no relationship between perceptions of climate change (e.g. levels of concern and risk perceptions) and mitigation or adaptation actions (Jørgensen & Termansen, 2016). This is despite the finding that many farmers were already taking some action to prevent future losses. As such, in the context of agriculture farmers' considerations of the relationship between mitigation and adaptation and their subsequent decisions remain relatively underexplored.

2.3.1. Theoretical perspectives on mitigation and adaptation: risk salience and compensation

There are two separate and opposing views that have been put forward regarding how individuals respond to the need for climate mitigation and adaptation. From a theoretical perspective, the global and long-term scope of climate change means it can be hard to observe, easily perceived as a problem for the future, and difficult to identify effective remedies for, thereby leading to low risk salience and motivation for action (Gifford & Nilsson,

2014; Weber, 2006). One stream of research suggests that learning about adaptation could help individuals to consider and visualise possible impacts of climate change, which could increase the *risk salience* and in turn elicit a need to respond to the risk (Carrico et al., 2015; Urban et al., 2021). Given a risk salience effect, if people learned about climate change adaptation for example, one would therefore expect stronger subsequent support for mitigation efforts.

On the other hand, calls for adaptation could negatively affect mitigation actions and result in compensatory behaviour, formalised in the *risk compensation* conjecture. In the environmental context, experimental evidence examining perceptions around carbon dioxide removal (CDR) suggested that information about such technologies could have indirect and unintended effects in the sense of lowering people's support for climate mitigation policy via a reduction in their perceived threat of climate change (Campbell-Arvai et al., 2017; Hart et al., 2022; Hornsey & Fielding, 2016). In one study, participants who read different descriptions of CDR technologies reported feeling less concern about immediate threats of climate change and in turn voiced lower concern for mitigation efforts (Campbell-Arvai et al., 2017). The risk compensation conjecture further suggests that efforts to reduce risk such as precautionary resource use or insurance expenditures could lower motivations to physically manage risks or undertake cautionary behaviour (moral hazard), for example in the way purchasing agricultural insurance could result in planting of riskier crops (Cole et al., 2017). As such, according to this view, recent calls for adaptation could elicit views that adaptation itself would be a sufficient response and therefore dampen an already insufficient mitigation effort (Pielke et al., 2007).

Given the complexities involved in these conjectures, the following section further explores the range of predictors of behavioural responses towards mitigation and adaptation. It does not attempt to be exhaustive and focuses on key elements that are relevant for the purpose of this thesis, i.e. the behavioural underpinnings of climate change mitigation and adaptation in the agricultural context. The section does so by first reviewing literature primarily rooted in the psychological sciences that considers predictors of individual perceptions, beliefs, and behaviours. I first review general findings before considering methodological advancements to promote behavioural change, and then focus specifically on the agricultural context to define the research gap examined in the thesis.

2.3.2. Perceptions, beliefs, and behaviour

There are many possible pathways between individuals' attitudes (people's specific judgements toward an object or situation) and beliefs (assumptions of truthfulness based on facts and experiences) and their behaviours, that are relevant for environmental management and decision-making (Albarracin & Johnson, 2019; Bouman et al., 2021; Ives & Kendal, 2014; Stern et al., 1999; Wolske et al., 2017). As explicated above, attitudes are often conceptualized to build on values which are considered in the psychological sciences as more general, stable, and underlying guiding principles in life (Stern et al., 1995). Extensive evidence exists on individual-level predictors such as attitudes, beliefs, and preferences, and how they relate to pro-environmental behaviour (Clayton et al., 2015; Reichl et al., 2021). This body of literature has resulted in comprehensive models that capture a wide set of possible behavioural predictors (Klöckner, 2013; van der Linden, 2015) as well as other approaches that are based on more simplified theoretical frameworks, such as the Theory of Planned Behaviour (TPB), the Values-Belief-Norm model, or Protection Motivation Theory (Fishbein & Ajzen, 1975;

Rogers, 1975). The various models have in common the aim to shed light on individual-level predictors that promote or hinder action, and to inform which individuals are more or less likely to engage in certain pro-environmental behaviours (Fishbein & Ajzen, 2011; Michie et al., 2011; Nielsen, Clayton, et al., 2021; Stern et al., 1999). The literature that draws on these models demonstrates that certain individual-level beliefs and attitudes are conducive to pro-environmental intentions and behaviours, particularly in combination with contextual circumstances that enable particular behaviours or eliminate barriers for them (Bamberg & Möser, 2007; Klöckner, 2013; Naito et al., 2022). Attitudinal change is also important for shaping public opinions and support for environmental policies, which in turn can advance systemic change (Leiserowitz, 2019; Weber, 2020). For example, studies have demonstrated that people who believe that climate change is real, human-induced, and has negative consequences are more likely to support mitigation policy and intend to undertake mitigation actions (Heath & Gifford, 2006; Hornsey & Fielding, 2016; van Valkengoed et al., 2021) and support adaptation policy and actions (Brink & Wamsler, 2019; Mildemberger et al., 2019; van Valkengoed & Steg, 2019).

In general, the literature further indicates that belief in and concern for climate change is growing (Leiserowitz et al., 2020; Milfont et al., 2021), but there is still a proportion of the population that denies that it is human-caused or even happening (Krange et al., 2019). Perceptions and beliefs regarding climate change are fundamentally social, tied to not just how people experience climate change and related impacts but how and what they learn from others about the topic (Boyd et al., 2011; Guilbeault et al., 2018; Wolske et al., 2020). There are also large cultural differences between the cognitive and psychological variables that

underlie public opinions, and how they respond to different interventions (Wolf & Moser, 2011).

2.3.3. Interventions

Equipped with these theoretical approaches and empirical insights, researchers have designed and tested various tools and interventions to encourage action on climate change (i.e. pro-environmental behavioural change). A popular strategy has been the deployment of educational campaigns and information interventions that aim to influence individuals' intentions and ultimately their actions (van der Linden, 2014; Whitmarsh et al., 2013). While these approaches have helped shift people's attention to the issue, raised environmental concern, and boosted the political priority of sustainability issues across scales (European Commission, 2021; FAO et al., 2023; International Energy Agency, 2023), actual changes in consumption and lifestyles to the extent that is required for a sustainable transition, let alone at larger scales such as in markets and political systems, have failed to materialise.

In response researchers are to a growing extent endorsing a public engagement perspective, which emphasises that beyond increasing individuals' climate change awareness, understanding, and engagement, communication programs and interventions should also aim to make individuals an active part of learning and action on climate change (Wibeck, 2014). This perspective further suggests that interventions should both examine outcome measures related to increased public engagement as well as seek to understand the psychological mechanisms driving the effects of the intervention (Geiger et al., 2017; van Valkengoed et al., 2021). Not considering both these elements could lead to ineffective or even backfiring effects in the sense of undermining intrinsic motivations, provoking discouragement, and/or

producing other unintended consequences (Barreiro-Hurle et al., 2023; Bolderdijk et al., 2013; Geiger et al., 2017).

There is thus widespread agreement across academic and practitioner circles that information provision is often necessary but not in itself sufficient for instigating behavioural change (Moser & Dilling, 2011; Rose et al., 2018; Weber, 2020; Whitmarsh et al., 2013). It is likely a critical component to help promote change that can be complemented using various strategies (Haaland et al., 2020). Improving the efficacy of information provision is also of interest given it is of the cheapest, most accessible, and easily scalable forms of intervention. Several studies demonstrate that the way in which information is framed, i.e. offering different arguments about or conceptions of an issue, can influence individuals' support for environmental policy and their willingness to adopt pro-environmental behaviours (Berger et al., 2021; Bicchieri & Dimant, 2019; Haaland et al., 2023; Howe et al., 2021; Sparkman et al., 2021). These studies have identified a range of predictors that appear to increase the acceptability of climate change mitigation policies, where key predictors include social comparisons and financial incentives (Bergquist et al., 2023). Moreover, evidence from diverse disciplines demonstrates that information provision in various forms can be leveraged and applied to change attitudes and beliefs, including in health (Mantzari et al., 2022), dietary change (Ammann et al., 2023), and conservation (Balmford et al., 2021; Travers et al., 2021). Whereas the effects of information interventions depend on the domain and target behaviour (Bergquist et al., 2023), several studies suggest that information interventions can also produce pro-environmental behavioural change with possible lasting effects (Byerly et al., 2018; Jalil et al., 2023; Schulze et al., 2024). In the agricultural context, for example, framing effects can influence farmers' intentions to adopt sustainable farming practices including conservation tillage (Andrews et

al., 2013), adaptation measures such as flood protection (Ngo et al., 2022), and crop insurance uptake (Dalhaus et al., 2020). Given the availability of information provision as a tool and its potential to be scaled, from a cost-benefit perspective there is an opportunity to employ and improve information approaches.

2.3.4. Methodological considerations in framing interventions

Framing interventions thus hold demonstrated potential, and studies that use information provision have predominantly relied on text-based interventions. Recent advancements in the body of work that experimentally examines the effects of framing information include that of video-based interventions (Stantcheva, 2023). The basic idea is that, similarly to text-based information provision experiments, the content of the experimental intervention is framed in different ways relevant to the research question. However, instead of providing participants with pieces of text to read, the information and respective framings are captured in video-based interventions to provide additional visual and auditive information that could be more effective in conveying the message (Haaland et al., 2023). Video-based interventions have been found effective for increasing the public's efficacy beliefs about climate change, i.e. beliefs that they have the ability to handle and respond to the challenge—which is critical for action—that subsequently enhance their engagement in climate change discussions (Bostrom et al., 2019; Doherty & Webler, 2016; Geiger et al., 2017). In a recent experiment, Dechezleprêtre et al. (2022) provide video-based interventions to demonstrate that three key perceptions influence people's support for climate change policies, namely the effectiveness of the policy (effectiveness concerns), the distributional impacts of the policy (inequality concerns), and the impact on the individual (self-interested concerns). They find that video-based interventions explaining how climate policies work and impact different segments of

the population can be critical to foster policy support in the short term, and that simply informing people about climate change is instead ineffective (Dechezleprêtre et al., 2022). Moreover, in a video-based information provision experiment with a representative sample of the U.S. population, Fang and Innocenti (2023) show that either correcting misperceived norms about climate action (i.e. providing truthful information that the majority (69%) of the population in fact supports the country in taking steps to become carbon neutral by 2050) or explain the policy (i.e. in simple terms describing how carbon taxation could reduce greenhouse gas emissions and its distributional effects) led to an initial boost in support for climate mitigation policy. Whereas the effect faded away after several months and did not increase environmental donations, the combined intervention persistently reduced strong opposition by over 20%, demonstrating its potential role in fostering public acceptability for ambitious climate measures like carbon taxes (Fang & Innocenti, 2023). In short, video-based interventions offer a promising method for further understanding the relationship between preferences and behaviour and how it can be influenced.

2.3.5. Diverse influences on farmers' decision making

To meet the aims of the thesis, I consider how these methodological developments and advancements in knowledge about human decision-making could be leveraged in the context of agriculture and farmers' adoption of sustainable farming practices. As alluded to above, farmers can adopt a variety of sustainable farming practices to mitigate their environmental impact and adapt to climate change, thus enhancing the resilience of their farm and the overall agricultural system. Farmers can mitigate emissions by optimising fertiliser use, reduce crop tillage and machinery operations, and planting cover and bioenergy crops (IPCC, 2022; Skevas et al., 2022). To adapt farmers can for example employ crop rotations, diversify their

production systems, and purchase crop insurance (Gosnell et al., 2019; Mase et al., 2017; Skevas et al., 2022). These practices are often not mutually exclusive, and some offer both mitigation and adaptation benefits. For example, cover crops are grown next to or after the main cash crop, primarily to cover the soil rather than for harvest. They offer numerous benefits, including sequestering carbon, improving soil health, reducing erosion, enhancing water retention, and increasing biodiversity (Büchi et al., 2018; Kaye & Quemada, 2017). By incorporating practices like cover crops into their farming systems, farmers can thus improve soil structure, suppress weeds, and reduce the need for chemical inputs, thereby contributing to more sustainable and resilient agricultural practices. In this thesis I focus on cover crops as a specific practice that framers can adopt.

To understand these adoption decisions, a growing body of literature points to a range of behavioural predictors and particularities pertaining to the agricultural context that must be considered. In a recent review of predictors, or behavioural factors using their language, that influence farmers' adoption of sustainable farming practices, Dessart et al. (2019) categorise the main factors into three groups depending on their proximity to the adoption decision: dispositional, social, and cognitive factors (Figure 2.2). The cognitive factors are the closest (most proximal) to actual decisions, including for example level of knowledge (Barnes et al., 2020; Feola et al., 2015) and perceived risks (Arbuckle et al., 2015; Findlater, Satterfield, et al., 2019). Moreover, the perceived costs and benefits of an action are also important. Several studies underline that economic incentives and the ways in which they are designed can influence behaviours (Barreiro-Hurle et al., 2023; Brown et al., 2021). In particular, a recent scoping review of incentives that encourage adoption of sustainable farming practices demonstrates that farmers have a higher adoption rate of interventions linked to short-term

economic benefits than those that aim solely to provide environmental benefits (Piñeiro et al., 2020).

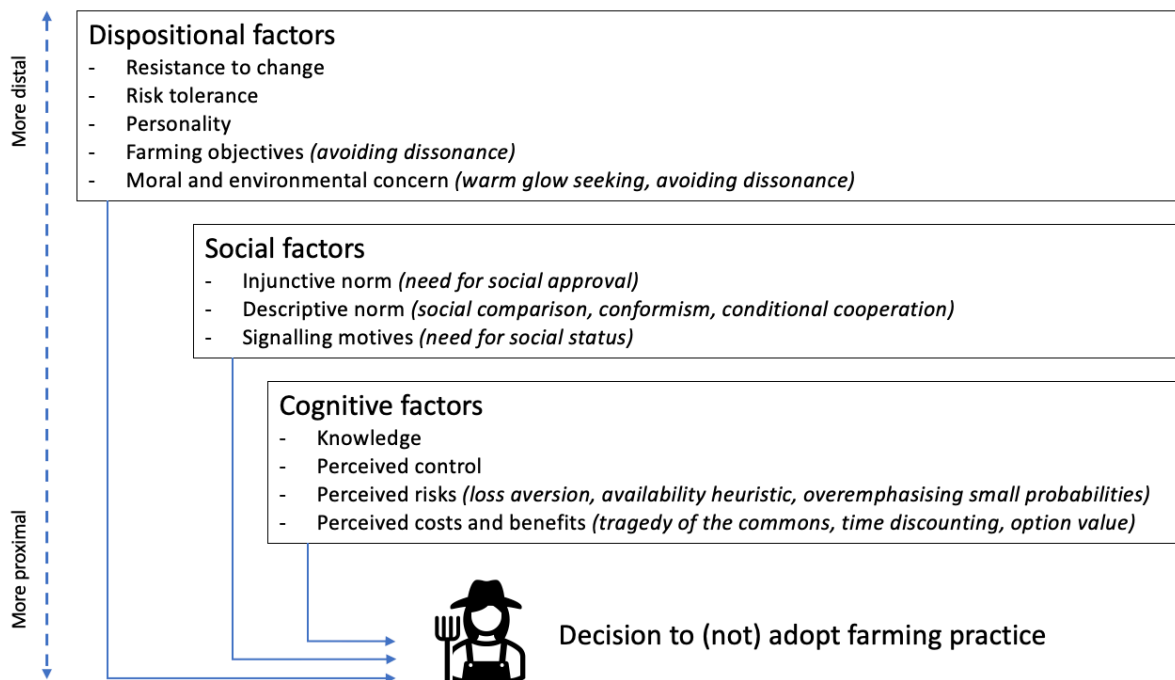


Figure 2.2. A framework of factors that influence farmers' adoption of sustainable farming practices. Mechanisms and biases are represented in italics. The behavioural factors in each group are not necessarily situated at the same place along the proximal-distal axis. Adapted from Dessart et al. (2019).

The second group emphasised by Dessart et al. (2019) refers to social factors. These include for example social norms and signalling motives. There is growing empirical evidence demonstrating how farmers often engage in social comparison, initiatives such as peer learning and knowledge exchange, and that they consider successful peers as reliable sources of information (BenYishay & Mobarak, 2019; Bijman et al., 2014; Skaalsveen et al., 2020; Wynne-Jones, 2017). Moreover, agricultural advisory services are frequently used and can influence intentions and behaviours at individual and community levels (Ingram et al., 2022). To complement these findings, research also focused on agri-food value chains that include farming communities, regulations and subsidies, and market contexts, that interact with and

restrict or enable farmers' opportunities for action (Milford, Trandem, et al., 2021; Richards et al., 2013; Soubry et al., 2020).

Finally, Dessart et al. (2019) highlight dispositional factors as the most distal group of factors that influence farmers' decisions. These relate to an individual's tendency to act in a certain way and are understood as relatively stable factors that do not relate exclusively to specific decisions. Dispositional factors that have been found to be important include e.g. an individual's personality (Sok et al., 2021), tolerance of risk (Mzoughi, 2011), attitudes and goals (Greiner, 2015), and environmental concerns and preferences (Arbuckle et al., 2013; Prokopy et al., 2019; Raymond et al., 2011). A meta-concept that seeks to link these factors include that of farmers' self-identity (Burton & Wilson, 2006), where several studies demonstrate that farmers' consideration of their occupation and identity influence their farm management (Cullen et al., 2020; McGuire et al., 2013; Sulemana & James, 2014).

The framework introduced above is useful for several reasons. First, it is based on a large body of work and corroborates evidence on the need to move beyond perspectives rooted in economic rationality to understand farmers' decisions and propensity to adopt sustainable farming practices. Cover crops, for example, can mitigate emissions, enhance soil structure and, and make it more resilient to e.g. rain fall and erosion, but implementing the practice also requires time and monetary investments. Second, the framework underlines the nuanced interplay of diverse predictors for farmers' decision-making. Thus, since it moves towards an integration of both internal and external sources of influence, it is useful to consider alongside other literature that calls for change to regulatory environments or economic incentives to encourage behavioural change at the farm level (Barreiro-Hurle et al., 2023; Gosnell, 2021).

For example, it offers a separate but complementary perspective to that of the relational values approach introduced earlier in the chapter. Such integrated approaches are necessary in order to develop more targeted interventions that address the specific barriers and motivators farmers face.

Taken together, the literature reviewed above demonstrates that farmers' behavioural changes and farm management decisions have important societal implications. In aggregate they can mitigate climate change, adapt to the consequences of it, and potentially effectuate large-scale change via supporting policy and promoting institutional change. The risk salience-risk compensation conjectures have sparked a debate on whether the focus on adaptation affects public perceptions of mitigation in a way that holds policy implications (Carrico et al., 2015; Urban et al., 2021). At the same time there is a need to better understand how climate risks are perceived and addressed at the farm level (Wheeler & Lobley, 2021). It is of urgent interest to further explicate how farmers respond to such communication, and the potential outcomes for their decisions and actions. Recent methodological advancements related to the design of experimental surveys and information provision coupled with the urgency of implementing both mitigation and adaptation in agricultural systems motivates the research in Chapter 5 (Paper 2). It tackles the following research question:

Research question 2: How does learning about cover crops as a strategy for climate change adaptation and mitigation influence farmers' support for large-scale mitigation policy and adoption of cover crops?



Clearly, the relationship between professed values, preferences, and intentions on the one side and behaviour change on the other is an issue of long-standing interest and importance in the social sciences. Yet for practicality, economic, and time commitment reasons, studies often rely on cross-sectional approaches and measure people's willingness and intentions to act instead of utilising objective measures of behaviour. For example, rather than measuring farmers' actual reduction of e.g. chemical fertilisers or pesticide use, which would be quite demanding both technically and practically, surveys would be issued to measure their stated intentions and willingness to reduce usage. Critically, findings from such approaches can only give a partial picture of human psychology and decision-making processes, and they may not offer insights that are representative for explicating actual behavioural change. I now turn to examine this issue in more detail.

2.4. What people say versus what they do

Accurate representations of pro-environmental behaviour and the conditions that facilitate or hinder it can inform policy and support sustainable transitions. An enigma across the literature addressing pro-environmental behaviour is that people often express values and intentions to mitigate emissions and conserve nature yet act in ways that harm it. The question of when and how assumed predictors of behaviours, such as values, attitudes, and intentions, do in fact predict actual behaviour has attracted attention from across the social sciences. These assumed behavioural predictors have received a central place in many theoretical approaches to understand behavioural change. Indeed, behavioural intention is the most important predictor of behaviour in the TPB (Theory of Planned Behaviour) (Fishbein & Ajzen, 1975) and Protection Motivation Theory (Rogers, 1975), both of which are widely used in the context of environmental decision-making. For example, the TPB links individuals' intentions and

behaviours closely by conceptualising subjective norms, attitudes, and perceived behavioural control to together predict behaviour (Ajzen & Fishbein, 1980). The TPB is in fact one of the most commonly used approaches to explain and predict the behaviour of farmers (Rose et al., 2018, 2019). Studies employing this or other such frameworks (e.g. Protection Motivation Theory) often conclude that intentions, in combination with other behavioural antecedents such as values, attitudes, and beliefs, influence people's behaviour, and derive policy recommendations accordingly (see for example Kothe et al., 2019; Mitter et al., 2019; Sok et al., 2021; Wensing et al., 2019; Werner et al., 2017; Zhou et al., 2023). Yet these theories are unable to account for how various other factors influence the relationship between e.g. values and intentions on the one side and behaviours on the other.

In fact, meta-analyses of this body of experiments suggest that medium to large effect sizes on intention correspond with small to medium effect sizes for behaviour (Rhodes & Dickau, 2012; Webb & Sheeran, 2006). This is noteworthy because a common finding is that underlying values and intentions do not automatically translate into behaviour: while people often express intentions to engage in pro-environmental behaviours, these intentions are often not reflected in their actual behaviours (Kollmuss & Agyeman, 2002; Sheeran & Webb, 2016). The limited influence of values and intentions on behaviour, a phenomenon known as the value-action gap, attitude-behaviour discrepancy, or intention-action gap (in this thesis I will use the term intention-action gap), is observed across domains, including organ donation, workplace safety, consumption, and pro-social behaviour (Conner & Norman, 2022). Reviews suggest its size to be significant, e.g. between 18% to 23% in health behaviours (Conner et al., 2016; Hagger & Chatzisarantis, 2009; McEachan et al., 2011) and 30% in climate change adaptation behaviour (van Valkengoed & Steg, 2019).

For example, in a recent study focusing on intentions related to and actual consumption of clothing, Nielsen et al. (2022) evaluated factors including cognitive, affective, and social predictors drawn from commonly-used theories such as the TPB. Examining the predictiveness of psychological factors for clothing-related consumption and the associated environmental impacts, they found that the psychological factors strongly predicted self-reported clothing purchasing but only weakly predicted clothing-related greenhouse gas emissions (Nielsen et al., 2022). In the energy domain, Klöckner et al. (2024) conducted a large-scale field experiment across six European countries assessing the effectiveness of a public-facing campaign to reduce electricity consumption. While they found no differences in the effectiveness of interventions tested, including competitions, information provision, and social norm interventions, they found that psychological factors predicted self-reported energy saving behaviour, but did not correlate with actual consumption data (Klöckner et al., 2024). In the food domain, a study examining the situational predictors of people's failure to follow up on their intentions to reduce meat consumption, Laffan et al. (2023) found that situations appealing to hedonic rather than instrumental consumption (e.g. social settings, non-habitual meals, eating out) were particularly predictive of failure.

Further demonstrations of the caveats of relying on self-reported pro-environmental behaviour and cross-sectional approaches come from empirical evidence on the significant gap between self-reported intentions and behaviour and objective pro-environmental actions (Kormos & Gifford, 2014), and studies showing that individuals' self-reported pro-environmental intentions are weakly correlated, if at all, to their actual environmental impact (Bleys et al., 2018; Kennedy et al., 2015). Taken together, if stated intentions are weakly related

or not at all related to actions, studies that are based on measures of willingness or intentions cannot accurately inform predictors of actual behaviour. They could also result in ineffective or potentially maladaptive policies that aim to influence behaviour.

The intention-action gap is documented and highly relevant in the agricultural context. A recent meta-analysis on the importance of socio-psychological predictors of farmers' adoption of sustainable agricultural practices identified intentions as the most important predictor (Swart et al., 2023). However, the authors cautioned that the effects of motivational factors on the actual adoption of sustainable agricultural practices might be overestimated as they found a lower effect size when the outcome was actual behaviour as compared to intentions (Swart et al., 2023). Indeed, while many farmers report intentions to adopt environmental practices, the actual adoption rates remain low (Hasler et al., 2022; Mills et al., 2020). There are widespread observations of an incongruity of farmers' attitudes and their adoption of sustainable practices, for example pertaining to decisions to adopt organic farming (Luh et al., 2023), no-till and cover crops (Jin et al., 2022), and to reduce pesticide use (Bakker et al., 2021).

This evidence holds methodological, practical, and policy significance. When the goal is to use empirical insights to advance sustainability transitions in general and that of agriculture in particular it is highly problematic that most studies have been based on intentions and self-reported actions—the predictors of which may not necessarily accurately represent predictors of actual behaviours (Brügger et al., 2015; Niles et al., 2016). An overreliance on such data risks limiting generalisability, practical impact, and the potential for producing insights to help overcome the intention-action gap. Moreover, using behavioural data (as opposed to intentions) at the same time point still does not solve the problem, as such cross-sectional

approaches will only capture snapshots in time. Research using longitudinal studies that measure actual behaviour at a later time point are rare (Swart et al., 2023), yet critical to examine the predictors of not just intentions but behavioural change, in the short term as well as long term. In turn, this would offer a stronger fundament upon which to base policy and programming to support farmers in adopting sustainable practices.

As such, attention to differences between self-reported and objectively measured behaviours and their respective predictors is important for advancing research on pro-environmental behaviour change (Howe et al., 2019). There is an urgent need to move beyond relying on measures of intentions and willingness and to adopt longitudinal approaches. Doing so can help further advance understandings of sustainable change with theoretical and practical relevance and produce more targeted and effective interventions. As a start, it is thus of urgent scientific and policy interest to explicate the intention-action gap and how it can be addressed. To contribute to this gap the following ensemble of research questions is addressed in Chapter 6 (Paper 3):

Research question 3: 1) Of what magnitude is the intention-behaviour gap? 2) Are the predictors of intentions also predictors of behaviour? 3) Which predictors explain whether intentions turn into behaviour?



2.5. Summary of thesis structure and chapters

Drawing on insights from various disciplines and methodological approaches as reviewed above, the following empirical chapters thus seek to advance a more nuanced understanding of decision-making processes and behavioural change at the individual farmer level, and to

contribute to an interdisciplinary body of work focusing on human-nature relationships, farmer decision-making, and sustainability transitions (e.g. Braito et al., 2020; Chan et al., 2018; Gosnell et al., 2019; Kenter et al., 2019). To address this aim in a manner compatible with the scope of the thesis I formulated three research questions (summarised in Figure 2.3). The chapters place those at the front lines of climate change—farmers—at the centre of the work, and posit that their values, knowledge, preferences, and lived experiences must be central to effective interventions that pertain to sustainable agri-environmental change.

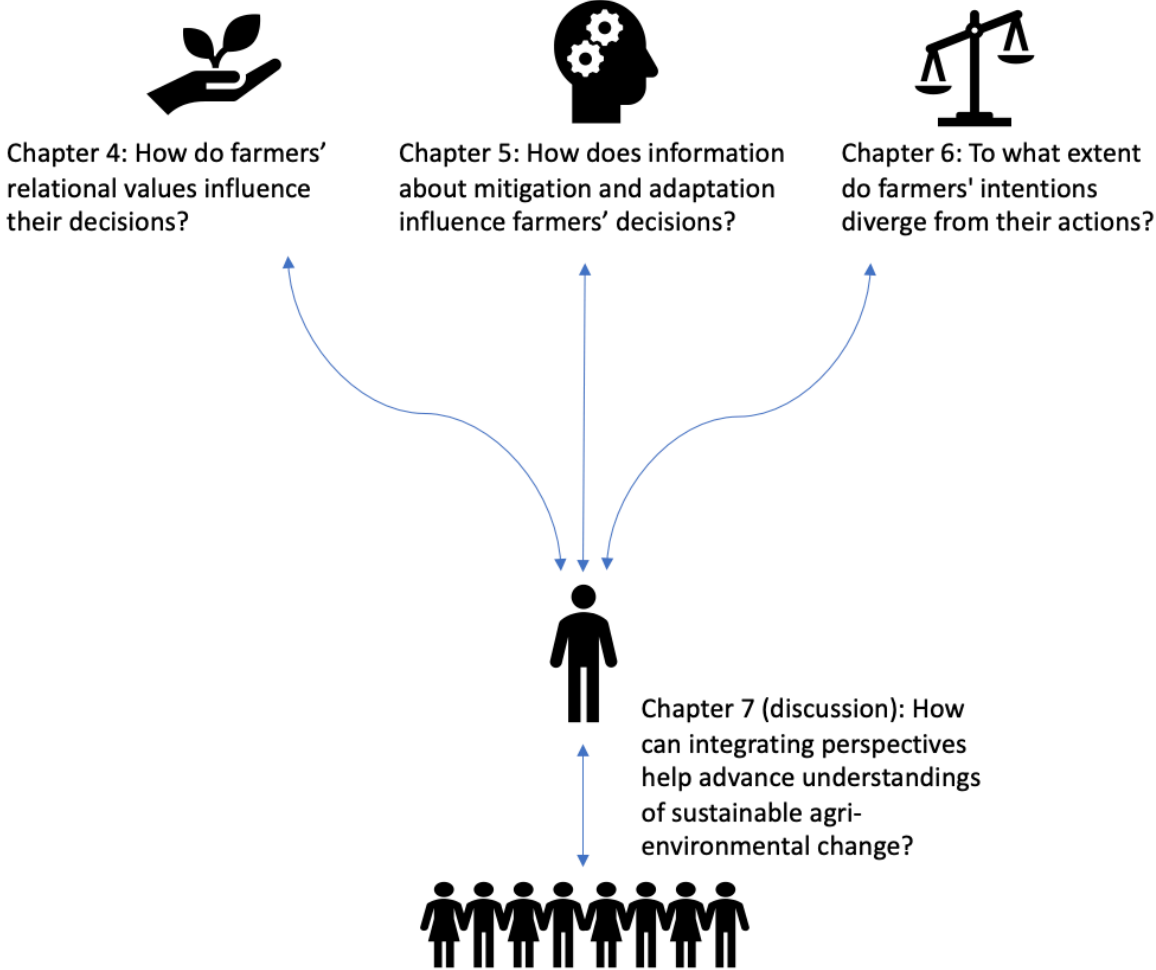


Figure 2.3. Summary of thesis approach. The thesis posits that the farmer is an important decision-maker to influence large-scale change. Values, beliefs and information processing, and determinants of the gap between values and actions influence (non-exhaustively) individual behaviours, which influence and are influenced by collectives. These are dynamic and bidirectional relationships as indicated by the arrows.

I address the research questions in respective chapters, as follows. In Chapter 4 I consider relational values, a concept which is inherently interdisciplinary and which emerged to offer more nuanced understandings of human-nature relationships, and how they interact with various actors in the agri-food value chain to offer novel insights on farmers' decision-making. Then, in Chapter 5 I seek to explicate how farmers respond to calls for climate mitigation and adaptation, focusing on the predictors of their responses and the respective outcomes for their support for climate change mitigation policy and behaviour change. In Chapter 6, I consider the fact that much of the literature relies on self-reported measures of values, intentions, and willingness to infer decisions and behaviour. I examine the predictors of farmers' intentions and their actions, the conditions under which intentions translate into actions, and further characterise the intention-action gap in the context of agriculture. Finally, I conclude the thesis in Chapter 7 by highlighting the main findings and their implications. I connect the elements from the preceding chapters and discuss their limitations to illuminate possible pathways forward for sustainable agri-environmental change.

3. Chapter 3: Methodology

This chapter presents the methodological approach of the thesis. The specific methodological details for each project is contained to the respective chapter, and the following serves to provide an overview of the research context and approach.

3.1. Study context

To make the project feasible I restrict the thesis to consider Norway as the focal geographic area and horticultural farmers—those farming fruit, vegetable and/or ornamental plants—as the population of interest. This thesis focuses on vegetable farming. There are several practical and policy-relevant reasons for doing so, including recently introduced climate policy for the agricultural sector and the need for specific insights for particular types of farmers. In Norway, 3.5% of land area is farmed land (Statistics Norway, 2024). Of this percentage, a smaller part is located in areas with climatic and agronomic conditions that are suitable for food crops (Knutsen, 2020). Central guiding points in Norwegian agricultural policy include ensuring national food security, promoting agricultural activity throughout the country, increased value creation, and sustainable agriculture with low greenhouse gas emissions (Regjeringen, 2019). In 2019 the Norwegian government approved with the farmer unions to introduce and specify a climate agreement for agriculture that sets targets to reduce emissions from agriculture and increase carbon sequestration in soils by 5 million tonnes CO₂-equivalents by 2030 (Bondelaget, 2020). Recent years have also seen multiple shocks including a pandemic, energy crises, and extreme weather events that have further raised sustainable domestic food production on the political agenda. Norwegian horticultural farmers thus operate within a sector going through comprehensive scrutiny and change. This offers an enticing context in

which to consider the nuanced interplay between farmers' socio-psychological factors and their context.

The Norwegian horticultural value chain comprises several intermediaries, where most horticultural producers are members of one of two producer cooperatives (Gartnerhallen and Nordgrønt). The cooperatives each sell exclusively to two grocers (BAMA and Coop), that in turn sell to three large supermarket chains, which dominate the retail market. The sector is uniquely exempt from national competition law in the agricultural sector, allowing producers to collaborate in planning their production and determining the price of their products. This unique collaborative approach by the producers is coordinated by The Green Growers' Cooperative Council (GPS) that aims to maximize market share of Norwegian produce, ensure market balance, and recommend retail price (OECD, 2021a). Most producers in Norwegian horticulture are conventional producers that are part of the cooperative approach and delivery system. Only 4.2% of the agricultural area was under organic production in 2021 (Milford, Lien, et al., 2021; SSB, 2021).

In the Norwegian context there are productivity challenges due to prolonged periods of cold weather and short seasons. Combined with high costs of labour and agricultural inputs it makes for high production costs and restricts the possible types of crops (Beitnes et al., 2022). The extent of farming varies throughout the country, and from an international perspective most farming occurs on a small scale (OECD, 2021a). Still, food self-sufficiency is highly valued by Norwegians (Mittenzwei et al., 2016). The agricultural sector is also a policy priority for ensuring value creation and maintaining rural communities which are both long-standing national policy goals (Landbruksdirektoratet, 2020; Regjeringen, 2019). The sector benefits

from subsidies and import tariff protection, which are some of the highest in Europe (OECD, 2021a). Given that Norway is not a member of the European Union (EU), its agricultural sector is outside the Common Agricultural Policy of the EU and uses import tariffs to compete with the European market. Still, retailers are free to import and sell foreign produce. Estimates suggest that Norway's self-sufficiency rate is approximately 42%, which is one of the lowest in the world (Milford, Lien, et al., 2021; OECD, 2021a). Norwegian consumers generally have high trust in Norwegian producers, however they are also price conscious and many regularly travel across the border to Sweden to buy cheaper groceries. Norwegians also consume less vegetables than the European average, and below what the health authorities recommend (Norwegian Directorate of Health, 2022). This suggests a large growth potential for Norwegian produce, in line with the strategy suggested by a public-private partnership representing the sector in *The Horticultural Sector Towards 2035* to increase the production volume, demand, and market shares of Norwegian horticultural produce by 50% by 2035 (Landbruksdirektoratet, 2020).

At the same time, similarly to other regions across the world, Norwegian agriculture is and increasingly will be influenced by climate change. Uncertainties in climate scenarios make it difficult to predict the exact impacts on future agricultural productivity. In general, coastal regions will likely face increases in heavy precipitation events and increased risk of flooding, whereas inland and boreal regions (e.g. areas surrounding Oslo) can also expect an extended growing season and increased crop yields (McEldowney, 2020; Rosenzweig et al., 2014). However, the onset of e.g. soil diseases and pests add further uncertainties to yield estimates (Wiebe et al., 2019). Thus far, policies and initiatives (e.g. by agricultural and environmental authorities) have largely focused on supporting behavioural changes to mitigate and adapt by

providing relevant information and enabling access to agricultural advisory services, as well as introducing subsidy schemes to encourage uptake of certain environmental practices (Farstad et al., 2022).

Another particularity of the Norwegian agricultural system concerns the legal framework of Odelsrett, which is central to farming culture in general and to agricultural land ownership in particular. The Odelsrett is a familial right of redemption regarding landed, agricultural property, that dates back more than a millennium (Fuglestad & Palmer, 2019). Traditionally the oldest son would have priority to inherit the farm, however the Odelsrett now applies to any firstborn (Regjeringen, 2024). This has prevented agricultural properties from being bought out, repurposed, or split up, e.g. by developers. It has also reinforced a strong sense of familial continuation and generational transfer tied to agriculture, and many farms have been in the same families for generations.

3.2. Collaboration

To increase the success and the feasibility of the thesis I collaborated with the Norwegian Institute for Bioeconomy (NIBIO), one of Norway's largest research institutes which specialises in food safety and security, sustainable resource management, and innovation through knowledge production. The main collaborators from NIBIO include Dr Anna Birgitte Milford and Dr Valborg Kvakkestad. They provided expert advice on the conceptualisation and the implementation of the studies, as well as expertise on the configuration of the horticultural value chain in Norway. The thesis also feeds into the NIBIO project GreenRoad (funded by the Norwegian Research Council), which aims to develop "knowledge and solutions for increased value creation and sustainability in the horticultural food system in Norway" (NIBIO, 2020).

NIBIO offered to fund my research including field work in Norway, thereby also gaining a broader social science perspective of relevance to their project.

For Chapter 6 I collaborated with Dr Anne van Valkengoed, a postdoctoral researcher at the Environmental Psychology Group based at the University of Groningen, the Netherlands. She is an expert on determinants of human behaviour, has worked specifically on pro-environmental behaviour change and the context of climate change adaptation, and published in top journals in the field. She advised on the methodological and analytical approach used in Chapter 6 and contributed to the writing and editing process by providing feedback on drafts of the paper.

3.3. Qualitative data collection and analysis

To answer the first research question I conducted semi-structured interviews with horticultural farmers producing vegetables (and possibly other crops such as potatoes or cereals) and stakeholders in the agri-food value chain in Norway. The data were collected in August-October 2022 and focused on three key geographic areas for horticultural production: Jæren, Trøndelag, and Viken (Figure 3.1). The locations and content of the interviews were determined in collaboration with NIBIO and conversations with farmers and farm advisors. The interviews took place on farms, in which a farm tour was sometimes offered, or over the phone if the participant preferred (primarily due to time constraints). In all instances the interviews were semi-structured and compiled information around the type of farm, farmers' management practices, their motivations, perceived barriers and opportunities in farming, beliefs about social norms and engagement in knowledge exchange with other farmers, and concerns around climate, soil quality, various risks, and links to their management. However,

they were highly dynamic and guided by what each participant shared (for sample questions, see Table 3.1). Due to this format the interviews naturally changed over the course of the interview process, and I reflexively adapted the questions depending on the answers of the participants (Punch, 2014). All participants were informed of the purpose of the study and the nature of the interviews in advance, and of the opportunity to withdraw at any point during or after the interview, in which case their data would be deleted. All participants gave oral informed consent to participate. We opted for oral consent given that some of the interviews were conducted by phone. I received ethics approval from the Central University Research Ethics Committee (CUREC), certificate number SOGE1A2021-029.



Figure 3.1. Main geographic areas for interviews.

Table 3.1. Sample questions from interviews.

Question topic	Sample question
Farming background	Can you explain the current operation, what you grow, scale of production, and number of employees?
Farming priorities	What priorities inform decisions you make when operating your farm?
Use of information sources	When you make decisions about what to do on your farm, what sources of information do you use?
Environmental change	Have you recently changed any farming practices due to environmental impacts of your farming?

The interviews were analysed following a thematic analysis approach (Punch, 2014). The analysis focused on relational values and the outcomes on farm management decisions, drawing on previous work including Chapman et al. (2019), Knippenberg et al. (2018), and Kreitzman et al. (2022) in developing and interpreting the analysis. The relational values lens served to better understand how different stakeholders in the agri-food value chain, such as grocers, retailers, and farm advisors, influenced farmers' relationship with the environment and the opportunities they have in their farm management.

3.4. Quantitative data collection and analysis

To address the second and third research questions of the thesis I use a quantitative approach and survey methodology as separate, but complementary to the qualitative approach in Chapter 4. First, in Chapter 5 I examine the risk compensation and risk salience conjectures (Carrico et al., 2015; Urban et al., 2021) and the mitigation-adaptation relationship in the context of farmer behaviour. To do so I use a survey to elicit individual preferences and beliefs and introduce two separate information framings focused on mitigation or adaptation (see Figure 3.2). In doing so I also help to better understand how farmers react to a mitigation or

an adaptation frame and the impacts on farmers' support for large-scale mitigation policy and actual behaviour. Specifically, I design an experimental survey incorporating video interventions using the online survey platform Qualtrics. Video-based information interventions are a promising method for influencing attitudes and behaviours (Fang & Innocenti, 2023; Goldberg et al., 2019; Stantcheva, 2021). The videos were developed specifically for this study, in collaboration with the larger research team, a professional illustrator, and communication experts. This was to ensure that the content and information in the videos were accurate, easy to understand, and that the visuals were well developed. The survey items were further based on discussions with the Agricultural Agency and farm advisors, and primarily adopted from previous studies conducted by NIBIO to ensure that the items had been previously tested with the population of interest. This also gave the option to compare across studies if relevant. The survey was piloted with farmers in January 2023. Based on the piloting I refined the survey items and opted not to make answering every item compulsory as this was found to possibly deter responses. I then administered the survey in February-April 2023 by sending an initial email inviting all farmers that met the criteria for the study, i.e. above 18 years old, horticultural farmers in Norway, with a farm area above 5 hectares. I sent two subsequent reminder emails ten days apart to those who had yet to respond to the survey invitation, as well as a final SMS-based invitation to those who had not responded to the emails. I received a response rate of 24%, which is considered good based on past NIBIO surveys. In addition, I circulated the invitation to participate to farm advisors who included it in their newsletter sent out to farmers. Thanks to these efforts, in total I was able to sample 513 farmers, approximately 20% of the target population.

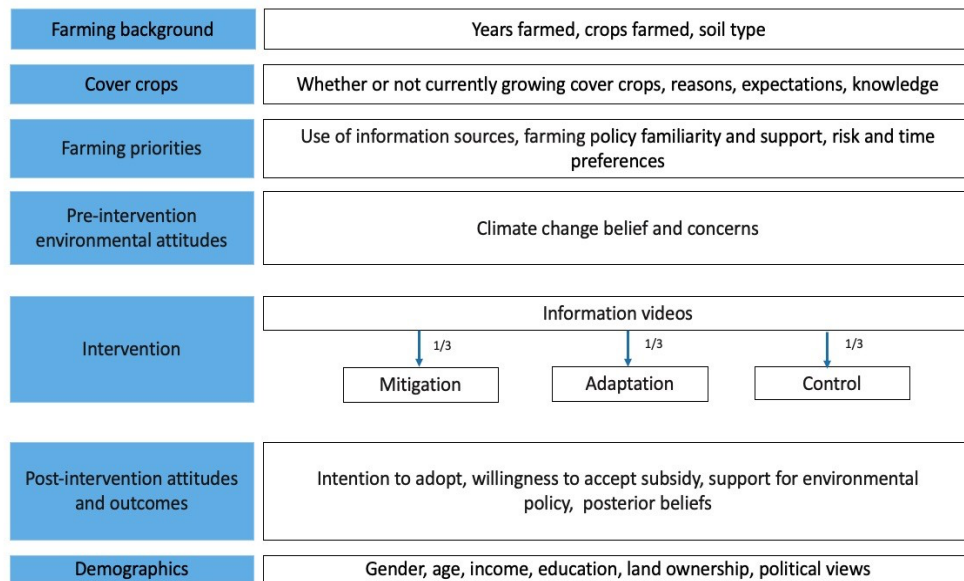


Figure 3.2. Structure of the survey.

In the survey I used cover crops as the focal agricultural practice. There are several reasons for this. Cover crops, sometimes also called catch crops, provide many potential benefits to an agricultural production system. Typically, cover crops are planted alongside or after the main (cash) crop to cover bare soil and stubble. There are many types of cover crops that have different properties, so to maximise benefits farmers should choose an option that is compatible with soil and rotation types as well as the equipment and expertise of farmers. In general, cover crops can offer multiple functions that contribute to mitigation and adaptation benefits, such as binding soil nutrients, alleviating weed infestation, improving yields, reducing soil erosion, and carbon sequestration (Büchi et al., 2018; Kaye & Quemada, 2017; Lugato et al., 2020). In Norway there is a subsidy offered through Regional Environmental Programs (“Regionale miljøprogram” which are managed via the Agricultural Agency) that aims to stimulate uptake of cover crops. Studies in Norway indicate that cover crops can be beneficial for e.g. binding carbon, reducing soil erosion and compaction, and reducing prevalence of weeds, but that the uptake remains low (Bøe et al., 2019).

Independent of the survey I also collected data on farmers' actual adoption of cover crops from the Production Subsidy Registry. I was able to access a complete dataset of farmers' adoption through the collaboration efforts described above. I strived to obtain such a behavioural measure to address a main limitation of much of the current work relying on survey data only, namely the gap between stated intentions and actual behaviour. The dataset thus provided important objective behavioural measures used for addressing research questions 2 and 3 of the thesis (in Chapters 5 and 6, respectively). The behavioural data was coupled with the survey data by creating de-identified keys for each survey respondent and each subsidy application using a numbering system for farms and municipalities. Each survey would have two columns with a farm number and municipality number, as would the subsidy applications. By combining these numbers into a unique key each survey and subsidy application could thus be matched via the de-identified key.

I used the survey data and the adoption data to address research question 3. I also considered a second, follow-up survey to gather additional data to inform this research question, however given the monetary constraints, time constraints, and participant requirements, I opted to continue investigating the topic using the existing data already collected without further participant burden. Combined with specific variables from the survey dataset that have also been identified as important predictors for farmers' adoption of sustainable farming practices in the literature, the behavioural data thus allowed me to answer the third research question from a different angle (i.e. the nature and characteristics of the gap between intentions and actions, as well as relevant predictors). Other contributing factors that discouraged me from

conducting a second survey include the limited sample pool, the likelihood of attrition, and self-selection into the follow-up survey.

Taken together, the survey and adoption data from the Production Subsidy Registry form the foundation for Chapters 5 and 6 in the thesis. I pre-registered the quantitative data collection including the survey experiment in the Open Science Framework website (link to pre-registration here: osf.io/5tnc4) and received CUREC ethics approval, certificate number SOGE C1A-23-2.

3.5. Positionality

I endeavoured to conduct rigorous academic research throughout this thesis. Yet I acknowledge that it is impossible to approach its topics completely objectively. For one, this bias is reflected in the regional focus, namely Norway. It is one of my homes, and I have a vested interest in a successful sustainable (agricultural) transition. Moreover, my upbringing and experiences have surely influenced my understanding of human-nature relationships, the interactions between individuals and their communities, and more specifically predictors of farmers' decisions and agri-environmental change. In turn, this has inevitably shaped my research approach and design.

My extended family consists predominantly of farmers and I personally grew up on a farm. In addition to my lived experience with farming I have lived, studied, and worked on four continents and in major cities in public and practitioner settings to complement my rural upbringing. As an educated, Nordic female researcher, my approach to studying behaviour change in general and farmers in particular is grounded in Western worldviews and the

psychological sciences. I recognise that my approach and interpretation of the analysis and data cannot account for all possible explanations.

I also note that in my approach to research and science I emphasise collaboration and transparency. I formulated the research questions through conversations with my supervisors as well as with collaborators and community members in the country where the research is conducted. I pre-registered the experimental study for transparency, reproducibility, and repulsion of p-hacking, and recompensated my participants to recognise their time and efforts.

4. Chapter 4

Chapter 4 (paper 1) addresses research question 1: How do farmers' relational values inform their experiences, priorities, and farm management decisions? How do other actors in the agri-food value chain interact with the relational values?

It uses qualitative data to examine farmers' relational values, their interactions with other actors in the agri-food system, and how these actors create barriers and opportunities for farmers in enacting their relational values. The paper is written for a broad scientific audience interested in the role of (relational) values on behaviour in general and that of farmers in particular. It specifically addresses empirical gaps that would benefit from further research.

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<https://doi.org/10.1002/pan3.10640>

Abstract

1. A sustainable transition in the agri-food system holds society-wide implications. Farmers play central roles in responding to climate change, environmental degradation, and sustainable food production. Still, factors underlying how farmers make decisions and manage their farms are often marginalised in efforts to develop policies to tackle these issues.
2. The concept of relational values, defined as preferences, principles, and virtues based on human-nature relationships, recently emerged to expand understandings of environmental decision-making in general and that of farmers specifically. As agricultural landscapes are dynamic and characterised by the interaction of various actors with diverse values and interests, how these interactions influence farmers' decisions remains underexplored.
3. This paper engages with these issues by using qualitative data on Norwegian horticultural farmers' motivations, opportunities, and challenges in farming. We find that their relational values a) are influential in shaping farmers' decisions about farm management, and b) are continually unfolding and embedded within a web of other actors, including grocers, retailers, consumers, farm advisors, and policymakers, that shapes farmers' enactment of their relational values.
4. In the context of agriculture, this research underlines the utility of an in-depth understanding of relational values as embedded in wider social systems to enrich analyses of farmer decision-making. How farmers' relational values are shaped and realised through interactions with other actors holds important implications for policy and programming to navigate tensions between different interests and actors for sustainable and long-term change.

4.1. Introduction

The sustainable transition of agriculture is climbing political agendas worldwide, with targets to cut greenhouse gas emissions, increase production and consumption of fruit and vegetables, and improve soil health (European Commission, 2020a, 2021; Masson-Delmotte et al., 2019; Pörtner et al., 2021). To this end, farmers and their communities are key stakeholders as they manage large areas of land and carry out necessary change at the local level (Allen et al., 2018; Blackstock et al., 2010; Dang et al., 2019; Woods et al., 2017). Scholars and policymakers alike increasingly recognise that equitable and effective policy must support farmers in sustainable agricultural change and account for the various factors that influence farm management (Dessart et al., 2021; Feola et al., 2015; Ingram et al., 2016; Mills et al., 2017). This paper examines this issue through the lens of relational values. Relational values have recently gained traction in efforts to further understand the nuanced interplay between human-nature relationships, resource management, and environmental policy. We aim to expand knowledge on farmers' relational values and decision-making, and their role in the agri-food value chain more broadly, by illuminating how these values are shaped by and enacted as a function of a complex system of actors.

Despite potential long-term benefits, many farmers have not adopted sustainable farming practices (Braitto et al., 2020; Byerly et al., 2021; Mase et al., 2017; Niles et al., 2016; Prokopy et al., 2015). Adoption decisions often have an opportunity cost for farmers: instead of farming land intensely for profits it may involve new tillage practices, reduced application of fertilisers or pesticides, or establishment of buffer zones for water ways. A growing body of research on processes underlying these decisions has identified relevant individual (internal) drivers and socioeconomic and market (external) drivers, and both dimensions are now recognised as

important for farmers' decisions. Factors pertaining to the individual include farmers' personal attitudes, values, and beliefs, whereas external drivers include farmer networks, advisors, and governance structures (Dessart et al., 2019; Ingram et al., 2022; Mills et al., 2017). Moreover, farmers' behaviours are influenced by concern and experience with climate change (Arbuckle et al., 2013; Findlater, Kandlikar, et al., 2019) and the ways policy interventions are designed to support behaviour change (Barreiro-Hurle et al., 2023). Notably, the literature increasingly highlights farmers' social networks and perceptions of their social referents as important for decisions, to establish a sense of social norm, and sustain behaviour change (BenYishay & Mobarak, 2019; Bijman et al., 2014; Rust et al., 2020; Wynne-Jones, 2017). Farmers consider successful peers as reliable experts, and participation in social networks can facilitate the uptake of new practices (Skaalsveen et al., 2020). Recent research often situates farmers in their wider socio-political context and networks, underlining a non-linear dynamic of people and their interactions with local communities, landscapes, and policy environments (Brown et al., 2021). Considering the agri-food system as comprised of farming communities, policy, and market contexts, and the way in which these interact is important for understanding barriers or enablers of farmers' opportunities for action (Milford et al., 2022; Richards et al., 2013; Soubry et al., 2020).

4.1.1. A relational values approach to understand farmers' decision-making

Recognising that farmers' decisions and actions are of society-wide importance, scholarly and policy interest in further understanding the conditions that influence their decisions and actions has risen markedly in recent years. Such efforts often focus on the values associated with human-nature relationships and their role in the management of natural landscapes and ecosystems (Chapman et al., 2019; IPBES, 2022; Ives & Kendal, 2014; Jones et al., 2016;

Wensing et al., 2019). The concept of relational values emerged as a “third kind” of values that expands on the dichotomy previously dominating the discourse: instrumental (valuing nature for people’s sake) or intrinsic (valuing nature for its own sake) values (Chan et al., 2016; Deplazes-Zemp, 2023; Himes & Muraca, 2018). Relational values refer to values linked to human-nature relationships and can be defined as “preferences, principles, and virtues associated with relationships, both interpersonal and as articulated by policies and social norms” (Chan et al., 2016, p. 1462). Rather than centring on the value of things or outcomes, relational values are based on the recognition that relationships are fundamental to people’s sense of well-being and identity. They are embedded within culture and (re)produced through behaviours (Allen et al., 2018), and thus more context-specific (in the sense that the entity of value cannot be substituted by another entity) than other types of values (Himes & Muraca, 2018). For example, a farmer can assign relational values of pride and respect to a specific plot of land that delivers rich yields and to which they tend carefully, or joy to a bird species that returns to their area at a given time each year that signals the arrival of spring and motivates their farming.

Empirical efforts to expand knowledge on relational values suggested close links with other concepts such as human-nature connectedness (Riechers, Balázs, García-Llorente, et al., 2021) and sense of place (Allen et al., 2018; Chan et al., 2016), and that they underlie motivations for environmental stewardship (West et al., 2018). In this sense, the concept of relational values offers an approach to examine diverse environmental values. Researchers and practitioners increasingly use the concept to communicate the importance of multiple—plural—values and human-nature relationships for land management (S. Díaz et al., 2015; Pascual et al., 2017). The concept is thus particularly enticing for agriculture, an activity

situated at the human-nature interface that produces society-wide economic and social prosperity as well as individual and local-level livelihoods and wellbeing.

4.1.2. Expanding on relational values in farming landscapes

Recent empirical studies illustrate the relevance of relational values in the agricultural context by identifying their content and relationship to other types of values (Allen et al., 2018; Chapman et al., 2019; Kreitzman et al., 2022; Tobin, 2022). Findings also specified features of relational values and how entities are valued in the relational sense, describing them as bidirectional and expressed by sentiments including care and respect on the one hand, and contributing to wellbeing on the other (Chapman & Deplazes-Zemp, 2022). While working with the land and producing food are costly activities in terms of time, effort, and money, the way in which they allow experiential and experimental interactions with nature can stimulate the formation of relational values to influence priorities and decisions, as well as sustaining such work (Geissberger & Chapman, 2023; Jones & Tobin, 2018). These findings help illuminate how relational values develop in a context like agriculture, what they are, and their role in driving decisions.

With the growing understanding of farmers as embedded in complex systems consisting of various stakeholders, however, much is yet to be known regarding farmers' relational values as they pertain to decisions and the influence of other actors (Githinji et al., 2023). This is particularly so considering the multifaceted relationship between values and behaviour (Fish et al., 2016; Vatn, 2009). It is increasingly recognised that various actors and contexts can facilitate the expression of some values while restricting others (Bataille et al., 2021; Gould et al., 2023; Hoelle et al., 2022). As such, the utility of the concept in policy and practice could be

furthered by elaborating on how different actors, policies, and economic drivers influence the structures that constrain the relationships that people develop with nature in different contexts. Here, we expand and deliver on the idea that farm management could be better understood by accounting for farmers' relational values and the interactions with other actors by asking how farmers' relational values inform their experiences, priorities, and farm management decisions, and how other actors influence this dynamic. We analyse the narrative accounts of Norwegian farmers and other stakeholders in the agri-food value chain focusing on relational values and farm management decisions. By doing so we also shed light on interactions with system actors to inform enablers and barriers of farmers' enactment of relational values and how resulting narratives and tensions are navigated. Our results expand on relational values as a useful lens for understanding how farmers hold a web of relational values that interacts with a web of actors to help identify opportunities for change. Given the necessity to transform the agri-food system, this insight will be useful for decision-making at local as well as national levels.

4.2. Methods

4.2.1. Context

The Norwegian horticulture sector is valued at around 19 billion NOK, corresponding to 17% of the total primary production value in Norwegian agriculture (Statistics Norway, 2024). Most horticultural producers are members of one of two producer cooperatives (Gartnerhallen and Nordgrønt) that each sell exclusively to two grocers (BAMA and COOP), that in turn sell to three large supermarket chains (for an in-depth description of the fruit and vegetable market value chain in Norway, see Milford et al. (2021)). The sector is uniquely exempt from national competition law, allowing producers to collaborate in planning production and determining

price. This is coordinated by The Green Growers' Cooperative Council (GPS) that aims to maximize market share of Norwegian produce, ensure market balance, and recommend retail price (OECD, 2021a). This offers producers some predictability for production plans and deliveries and is considered important for producers' growing decisions. Due to high production costs including for agricultural inputs and workforce, Norway has implemented import tariffs for most vegetables that could be produced domestically during the main season for Norwegian produce, which increases consumer demand for domestic products. Yet, retailers can still import vegetables at lower prices and Norwegian producers continue to face significant competition from imports: currently, around 50% of vegetables consumed are imported (Norwegian Directorate of Health, 2022). The average Norwegian consumes 51,6 kg of vegetables per year which is lower than the European average and 60% of what is recommended by the health authorities (Mittenzwei et al., 2020; OFG, 2022). This suggests a large growth potential for Norwegian produce, in line with the strategy suggested by a public-private partnership representing the sector in "Grøntsektoren mot 2035" (*The Horticultural Sector Towards 2035*) to increase the production volume, demand, and market shares of Norwegian horticultural produce by 50% by 2035.

4.2.2. Study areas

We conducted semi-structured interviews with horticultural farmers in three main and geographically distinct horticultural regions in Norway: Viken county, Rogaland county, and Trøndelag county (Figure 4.1). Growing vegetables in Norway is demanding due to a cold climate, short growing season, mountainous topography, and lack of optimal soil quality. These agricultural areas were chosen as they represent most of Norwegian horticultural production and hold both small- and larger scale farm operations. The areas are coastal with relatively flat

terrain and mild temperatures, offering soils relatively well suited for vegetable production. The agricultural composition otherwise is mixed with animal husbandry and crop farming, and the areas are in proximity to three major cities in Norway: Oslo in Viken, Stavanger in Rogaland, and Trondheim in Trøndelag. The three areas are hubs for vegetable production and offer similar opportunities for farmers to connect formally and informally via e.g. delivery points and social gatherings. The areas are part of the same value chain and market, and have changed over the last few decades due to agricultural intensification and face continued pressure from urban expansion and population growth. We did not find significant differences between participants that could be attributed to the geographic regions, likely due to their embeddedness in the same value chain and policy frameworks.



Figure 4.1. Farms in three areas that are hotspots for horticultural production in Norway participated in the study. Map source: N5000, Norwegian Mapping Authority.

4.2.3. Data and analysis

The data were collected between August-October 2022 via semi-structured interviews consisting of open-ended questions that covered participants' motivations and priorities in their farming business, perceived challenges, risks and opportunities, use of and trust in different information sources, significant social relationships, and attitudes toward climate change and environmental issues. Access to participants was facilitated through a listing of all farmers who were registered to receive horticultural farming subsidies from the government. From this we drew a purposive sample to ensure horticultural farms (producing vegetables in outdoor fields) of various sizes and regions were represented. Potential participants in the selected areas were phoned and invited to participate. The acceptance rate was high: only four out of the 29 farmers that were contacted declined (primarily due to time constraints). All interviews were conducted in Norwegian by the first author and recorded with the interviewees' consent. Interviews were conducted on farms where possible, in farmers' homes or offices, otherwise in cafes or over the phone. The interviewer would also do a farm tour if invited. To get different perspectives on the agri-food value chain we also interviewed farm advisors and other industry actors. The total sample consisted of 34 participants: 25 farmers, three farm advisors, and six industry actors from the GPS (four individuals) and one retail chain (two individuals). We stopped interviews at this point due to theoretical saturation. Two of the interviews were conducted with a father and son who were currently both involved in the farm operations, where in both cases the father was close to retirement age and the son had recently stepped in to inherit the farm business. One interview was conducted with a couple who managed their farm as a team. All participants were asked for oral consent in the study, as some participated via phone interviews. The research was approved by the University of

Oxford's Central Research Ethics Committee and the Norwegian Centre for Research Ethics (Sikt).

The interviews were transcribed and coded by the first author using thematic analysis. A relational values framework was adopted for data collection and interpretation, a choice which was validated in the early stages of piloting and analysis. The coding followed a hybrid inductive-deductive approach aligned with the principles of qualitative data analysis (Punch, 2014). From an initial literature review we identified possible relational values and codes to reflect motivations around management practices, priorities, and common challenges and opportunities that farmers face. These included care, joy and pride, respect, and relationships with time (Chapman et al., 2019; Chapman & Deplazes-Zemp, 2022; Kreitzman et al., 2022). The interview-based codes, chosen for their empirical salience, allowed for more nuanced topics to also be included. These included different values and priorities, such as intergenerational thinking, various risk perceptions, and concerns around the dynamics and structure of the agri-food value chain. We further drew on the work of Chapman et al. (2019), Knippenberg et al. (2018), and Kreitzman et al. (2022) in developing and interpreting our analysis. Using a relational approach means acknowledging that knowledge is context-dependent and situated within relationships between different entities. This helped bring forward farmers' perspectives and decision-making processes and their examination in terms of relationships to various entities in the farmers' environment, including on-farm and societal elements and actors.

4.3. Results

Our analysis revealed two interrelated main findings which together demonstrate how farmers' values and decisions are shaped by a complex system of actors. First, all participants expressed relational values predominantly rooted in three relationships: to farmland, to nature more broadly, and a connection to past, present, and future farming communities. Farming communities at the local scale are diverse and consist of both farmers and non-farmers that can provide a stable backbone for farmers to facilitate cooperation and learning (Schreiber et al., 2023; Skaalsveen et al., 2020). The relational values could be grouped into five categories: *care*, *respect*, *joy and pride*, *cooperation*, and *intergenerational thinking*. Second, the relational values were entwined with a web of other actors that significantly influenced participants' capacity to enact their relational values (Figure 4.2). As such, farmers' values and decisions should be considered not just from an individual perspective but as embedded in a complex system of actors, the relationship with which brings to life certain values. While the profession of farming is defined by uncertainties (e.g., due to seasonal weather and market fluctuations), the behaviours of these actors, combined with political shifts and economic turbulences, resulted in a suite of barriers and enablers for participants' enactment of values. We also observed that the relational values were closely interwoven and often mutually reinforcing one another. We structure the remainder of our results and discussion as follows: we first unpack the relational values (summarised in Table 4.1) in their respective sections to illustrate how they shape decisions and interact with the web of actors by highlighting the most salient connections. Figure 4.2 provides a visual summary. Finally, we discuss our findings' contributions and implications, and summarise enablers and barriers to farmers' relational values in Table 4.2.

Table 4.1. A definition and description of the five key relational values associated with the three relationships in this study. Example quotes are provided in the text, and further data can be found in the Supplementary Information (Table A1).

	Farmed land	Nature	Community
Care – An attitude of concern and principle of active care, seeking to tend for the needs of other human and non-human entities (Jax et al., 2018)	Close attention to farmland, crop conditions, e.g., assure crops are provided with nutrients	Take steps to nurture nature, protect waterways, assist pollination, avoid unnecessary use of e.g., pesticides	Profound attention to other members of farming community, nurturing relationships, and sharing experiences with other farmers
Respect – A sense of admiration and consideration of natural conditions on the farm and beyond, and toward other farmers; seeking sufficiency rather than exploitation	Acceptance of (limitations to) capacities, needs, and requirements of farmland, e.g. irrigation measures	Acceptance and reverence of nature as it is, balance farming and nature stewardship	Consideration of other farmers' needs and production, treat other farmers as collaborators rather than competitors, sharing knowledge and experiences
Joy, pride – Sentiments of joy and pride tied to farming and farmland, to nature more broadly, and to relationships with other farmers	Experience and emotions of land management, sentiments tied to their farm and plots of land, feels good to 'create'	Experiential and emotional bonds with nature more broadly, motivations to act accordingly in farming decisions	Sentiments from being part of a wider farming community; gives further purpose in farm operations; encouragement and motivation
Cooperation – Farming as an act of working together with soils and nature, embracing learning, and a sense of close connection with other farmers	Attitude of cooperation and co-creation with crops and farmland	Expressions of partnership with nature, consciousness of being one of many actors that manage and depend on nature	Working with other farmers and building each other stronger as an integral part of farming; balance own production with that of other farmers
Intergenerational thinking – A value-laden relationship with past, present, and future farming generations and time	Ensure soils are managed with a long-term perspective, actively considering past and coming generations in farm management	Nature should last forever; considering long-term impacts of activities on nature	Active connection to past and future farming generations through farming practice, the next generation as an integral part of the farming community

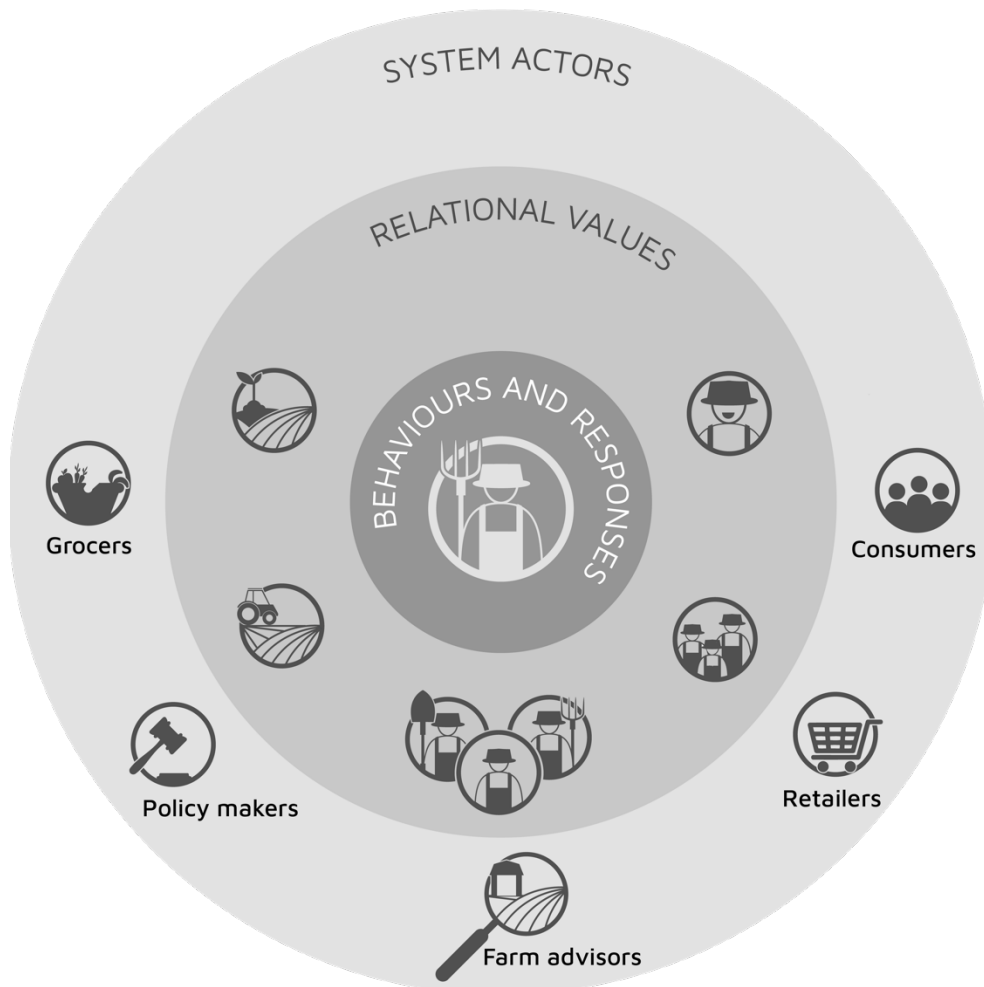


Figure 4.2. Farmers' relational values are entwined with a web of actors. The inner circle represents farmers' behaviours and responses, including farming-related behaviours as well as social and psychological responses. The middle circle captures the relational values held by farmers, namely care, respect, cooperation, joy and pride, and intergenerational thinking. The outer circle represents the web of actors that shapes farmers' opportunities for enacting their relational values. The circles are thus all connected and interact so that changes in one can influence changes in another.

4.3.1. Care

The relational value of *care* was clearly anchored in all relationships, and participants expressed care both as affective concern and practical action (Jax et al., 2018). Moreover, these expressions intersected with the various other actors that farmers interact with, most notably grocers and policymakers. When speaking of their farming, participants often described practices of care as embedded in their farm operations, such as soil management and crop

care, and in connection to the wider farming community. These were important for their own identity, place attachment, and often for a sense of tradition. One farmer explained,

“I learned from my father. He was one of the ones who was out in the field all the time, on his knees, studying the plants, to check how they were doing. Now I am like that too, kneeling, head down in the field to see how they really are doing. Because understanding that, and employing the right tools at the right time, is critical for the crop, the soil, and for the environment.” A3A

The farmer elaborated that following his father, and being known for it in the community, gave him a stronger sense of purpose. Along these lines, many farmers described their contributions to various community projects of waterway rehabilitation, forest management, and habitat establishment for pollinators, expressing a sense of duty of care. Thus, they connected the importance of farm-specific practices with healthy crops and biodiversity more generally, blurring the line between their commitment to land stewardship and connection to nature.

These sentiments notably intersected with grocers and policymakers, which were consequential for participants' care. All participants stressed how influential grocers were for their farm management, including for production plans, future farming considerations, and personal levels of stress and well-being. Many voiced concerns over grocers' growing power and wealth in recent years which caused increased uncertainty for producers and often depreciated their practices. For example, two advisors underlined that farmers often had to limit their crop rotations and harvest times to respond to grocers. This relationship and increased uncertainty further interacted with policy. Participants expressed that policymakers did not understand the economic, climatic, and social demands they faced. For example:

“One of the strongest risks in Norwegian agriculture is the way it is politicised. We experience major differences between the blue government from last electoral cycle and the red-green government we have now. This creates significant uncertainty for someone who is trying to make a living of it.” C2

The short-termism of policy programming as it fluctuated with four-year electoral cycles provided additional uncertainty. At the same time pressures from grocers, costs for farming equipment and inputs (e.g., fertiliser, seeds), and salary expenses increased, so that many farmers experienced additional significant economic uncertainty. Taken together, this could erode their care as exemplified by their limited opportunities for crop rotations, increased tension in the farming community, and cutting expenses such as for advisory services.

Some participants underlined the opportunities that could come from more integration and strengthened relations with grocers and policymakers. In collaboration with a grocer one participant had significantly reduced the amount of imperfect produce going to waste by delivering to an industrial-sized kitchen. The strict aesthetic demands that grocers and retailers maintain for the produce (e.g. to reject produce that is too large, too small, too wonky) was a barrier for many participants. Instead, this farmer found a collaborative solution which in turn had a profound effect on their motivation and relational values, notably care and respect. Many shared the view that policies could be co-created and better tailored to their needs to facilitate such solutions at a larger scale.

4.3.2. Respect

Like care, sentiments and acts of *respect* permeated all three relationships and were linked to farmers’ experiences with other actors, most notably grocers and farm advisors. Respect was

a main feature in how interviewees enacted their role as land stewards and food producers, and in descriptions of their influence on the environment.

Many participants expressed sentiments and acts of respect towards other human and non-human entities that were tied to their self-respect. These were often bound by the requirements set by actors such as grocers and consumers which ultimately determined what and how much to produce, surplus produce, and use of agricultural inputs, with important implications for farmers' sentiments and enactment of respect. This was exemplified in a range of participants' reflections, decisions, and activities, including measures taken on the farm and beyond. Participants expressed the importance of contributing to pollinator habitats and healthy waterways, respecting and carefully considering weather and climatic influences, and respecting their communities and the needs and wants of other farmers. Interviewees' realities and struggles of production were brought to the forefront in cases where grocers would not accept produce e.g., due to aesthetic reasons, or consumers' complaints over quality or price. For many these held profound consequences such as diminished sense of purpose and self-respect that they otherwise derived from their farming.

For many of the farmers in our study, the sentiment of respect was thus a driving force that encouraged farming for sufficiency and to balance their production with nature stewardship and soil care. These sentiments were also reflected in how participants spoke about other farmers, closely linked to the notion of cooperation further described below. One farmer stated:

“To work together and build each other stronger is essential for a good production here. [...] There are guidelines for production plans, the distribution of quotas and so on, and you have to respect these and cannot for example take the quotas from one producer [in one part of the country] and move it [to this part], there should be predictability for everyone.” C5

However, there were also farmers who were more “productivist” (A. P. Barnes et al., 2011) or business oriented. When prompted to talk about challenges, one such farmer noted:

“The main ambition is to make money to make the factory go around. [...] for our main concerns, it is definitely the economic aspect – we have to make a living. In our sector, even though costs are going up for everyone, we can’t just increase the prices of what we produce. When you open the newspaper and read about increasing food prices, that is not going to us.” A1

These farmers often expressed frustration over lack of profitability and emphasised the economic aspect of developing their farm business. Still, they were often forward-leaning and innovation-oriented, focusing on developing their knowledge and win-wins between economic and environmental aspects. Here, influences from farm advisors were noteworthy in reinforcing participants’ relational values in general and that of respect in particular. Many described regular meetings, often weekly, with advisors as helping them deliver on tangible goals of food production and environmental outcomes (e.g., fertiliser, pesticide use) as well as intangible values of community and wellbeing. For our participants, these articulations were grounded in sentiments of respect for their own production as well as for nature and the broader farming community.

4.3.3. Cooperation

Expressions demonstrating relational values around *cooperation* were particularly evident in the farmer-farmland and farmer-community relationships. These were also evident

throughout interactions with other system actors, most notably with grocers, advisors, and policymakers. Interviewees described parameters for their production by e.g. grocers and policy regulations and subsidies, and that cooperation-laden relationships with their farmland and peers helped drive and connect the practices, meanings, and production outputs of individual farmers to the wider society. One farmer explained,

“Community in agriculture is more important than many are aware of, that we can discuss challenges with other farmers is extremely important. [...] Everything we work with is alive. The experiences of one farmer are different from the experiences of another, and all [our experiences] can be discussed and shared between colleagues.” C2

Interviewees often voiced the importance of “getting to know” and “working with” their crops and soil for producing food. This value-laden cooperativeness with their crops and land as well as nature more generally permeated many of the motivations, skills, and concerns that farmers expressed. For example,

“To succeed in your production you have to understand the plant, and what it needs. [...] It is almost strange to say out loud but to place yourself in the position of the plant, to understand what it needs, to work together, I think is very exciting.” C4

Participants further described a profound sense of collectiveness with others in the farming community and often found cooperative ways of addressing challenges in their farm management via social ties and cooperation (Bijman et al., 2014; Wynne-Jones, 2017). While recognising that they were to varying extents competing with other farmers, often these reciprocal relationships represented a source of motivation and comfort for the farmers in our study. Such relationships were particularly prevalent for farmers associated with the same delivery point, facilitating both professional and social bonds. Some of these relationships

were also facilitated by farm advisors, which helped organise formal and informal gatherings. Advisors' efforts could thus strengthen farmers' relational connection to both farmland and to the farming community.

Participants often stated that their abilities to cope with challenges including weather, climatic impacts, and securing a skilled workforce on their farm were strengthened by being part of social farming environments. Some would also emphasise how sharing equipment with neighbours allow for less expenses and more efficient investments and resource use in their own farming, and the importance of farming communities for their resilience. Others would express negatively laden relationships within their communities, often in the context of competition and experienced stress linked to grocers and policymakers (similar to the dynamics of care). For example, due to low profit margins and the amount of work necessary to secure income, farmers would strive for larger land areas to increase profits.

"[In this area] there is a lot of competition to access land [...], I feel that is one of the largest challenges for us. It has gotten to the extent where people are not afraid to go out of their way to obtain something at the expense of others." B4

Several participants shared the perception that farmers would increasingly negotiate privately and behind the backs of other farmers to secure larger land areas instead of cooperating openly as before. Some also strongly emphasised the increasing competitiveness as an element of stress, underlining the complex dynamic between their relational values, interactions with various actors, and farming activities.

It should also be noted that three farmers underlined productive, direct, and cooperation-loaded relationships with grocers and consumers, and some farmers did not express cooperation as important in their farm management. These farmers were often more isolated, in the sense that they did not have many farmers with comparable production nearby. They also often held a strong economic orientation and relied more on personal experiences and agricultural education.

4.3.4. Joy and pride

A profound sense of *joy and pride* characterized most participants' articulations around farming and descriptions of their motivations and priorities. These sentiments often overlapped with other relational values, in particular care and intergenerational thinking, and permeated the links with the other actors. For example, doing what felt good, excitement, and a sense of pride often coincided with measures to care for crops and promote soil health, contributions to ecosystem services and maintaining biodiversity, and a connection with other farmers and generations. One farmer noted,

"I calculated the amount we produce here, and there is of course something to it, pride in what we produce, it equals what [municipality] eats in a year—we supply our community with what we produce. And we are the only ones around here doing this [...]. There is nothing like walking in a [crop] field in spring, and watch [crop] mature once you remove the covering, it is beautiful, that is actually what is behind everything we do, you feel like you are doing an important job and that the landscape looks nice, that you are doing a good job." C6

These sentiments of pride in the ability and act of living off the land and producing vital goods for the local community and beyond, in a way that participants felt is also good for the environment, were echoed by many participants. In this regard the influence of retailers and consumers was particularly salient. Most participants noted that the utility of farming

vegetables and any potential increase in production depended on consumer demand. Participants often suggested that consumers were distant to food production and ignored how work and resource intensive it is, which reinforced farmers' low status in society and undermined their joy. In this context many pointed to a key role for retailers in both boosting farmers' status and in stimulating market growth. Whereas some participants expressed that they had made efforts to connect with consumers, for example via farmer markets, direct sales, or hosting school classes on their farms, given the limited scale they doubted any influence beyond their local communities. Instead, they considered retailers' market knowledge, store environments, promotions, and policy as key for increased demand for Norwegian produce. Additionally, for many interviewees, the relationship with the wider farming community and feedback from consumers helped counteract these negative attitudes to strengthen sentiments of joy and pride in their farming. One farmer stated:

"It is fun to watch [crops] grow, getting response on what you are doing, caring for the plants, that is fun. It is also fun to try out new crops, to learn something new, and maybe that will also bring economic benefits, to develop in that sense." B5B

4.3.5. Intergenerational thinking

The relational value of *farming with an intergenerational perspective* encompassed diverse sentiments and emerged as a defining feature for many of the participants' decisions and interactions with other actors. Participants often felt limited and uncertain due to short-term grocer and policy programs, and emphasised opportunities for co-creating longer-term production planning and supporting policy.

When considering motivational and driving forces behind their farming, participants often mentioned the principle of leaving the farm and land in a better state than they got it, closely linked with the values of care, respect, and pride described above. In turn, this was influenced by interactions with other actors and shaped their decisions on the farm. Most farmers in our study articulated an intergenerational perspective where farms, equipment, local knowledge, and even production contracts with grocers were passed down among family. For example:

“To produce something, knowing that all your efforts result in produce that you can sell, and knowing that in this area people eat what you managed to cultivate yourself, that is valuable. We also have two small children, and it is very nice to have them stumbling around our feet and to offer them that upbringing and perspective on life, that is a key part of my motivation.” C3.

These statements exemplified that for many, while the act of farming is in itself worthwhile, the notion of passing the associated set of skills, values, lifestyle, and traditions on to the next generation added a value-laden dimension to their farming and often motivated sustainable and innovative farming approaches. These findings indicated that participants held purposeful and value-laden perspectives on time, in line with previous research (Kreitzman et al., 2022; Mikołajczak et al., 2022).

These sentiments were critical for their interactions with other actors. Many farmers underlined how this perspective would influence most if not all their decisions, whether it was navigating demands from grocers, presenting their food at local markets to connect directly with consumers, or contributing to active farming communities. For example:

“We work all the time to improve what we are doing, to maintain the resources we have, and the land. This is about short-term goals of a plentiful yield this year, but also for ensuring that will be possible in five years and in ten, and for the next generation.” A7

In this regard, several participants noted the opportunities they saw for co-creating more long-term policy and programming. The one-year production plans from grocers and policy that fluctuated in line with the four-year electoral cycles could be starting points for more meaningful engagement between different actors in the value chain to further develop initiatives that would offer more predictability for farmers.

Finally, it is worth noting that two farmers did not have explicit reflections around the traditions and lifestyle of farming in relation to past and future generations. Both had inherited the farm from family, but the future of the farm and plans for passing it on did not considerably influence present decisions. There are many possible reasons for this, where economic concerns, competition, and increasing uncertainty in their farm management were mentioned by both.

4.4. Discussion

Understanding how and why farmers make decisions lies at the core of sustainable agricultural change. We draw on the concept of relational values to show that while participants held diverse preferences and beliefs and operated in a range of different contexts, a common set of values predominantly relational in nature were widely shared, continually unfolding, and important for farm management. Moreover, these values were entwined in a complex web of other actors that acted as barriers and enablers for farmers’ enactment of their relational values. As such, our findings underline that considering relational values in this wider context

can help deepen our understanding on how various actors and economic and socio-political forces influence and are influenced by farmers, with important implications for sustainable livelihoods and environments.

4.4.1. Relational values as guiding farm management

The farms in our study differed in their geographic regions, size, and crop output. Still, how participants managed their farms, including the use of (chemical) crop protection measures, seeking advice from and socialising with other farmers, and contributing to thriving pollinator habitats and waterway management on and beyond the farm, could be broadly understood as expressions of relational values and, critically, how they interacted with other actors. This could be seen e.g. by the experience of farmers' joy and pride in tending to their farmland and producing crops, which could be strengthened by the positive feedback they got from supplying fresh produce to their community, or diminished if their produce was rejected due to aesthetic demands by grocers or consumers. In line with previous findings, these relational dimensions existed in addition to the instrumental values that participants held linked to crop production, economic profits, and food security (Hoelle et al., 2022; Tobin, 2022) and intrinsic values of biodiversity and nature (Braitto et al., 2020; Geissberger & Chapman, 2023; Mills et al., 2017; Moroder & Kernecker, 2022). Our observation of the relational values as rooted in relationships with farmland, nature, and community also aligned with previous research from other contexts, for example in Europe (Chapman & Deplazes-Zemp, 2022; Mikołajczak et al., 2022) and North America (Chapman et al., 2019; Kreitzman et al., 2022). Taken together, the relational values and sentiments of their farming to be meaningful, deriving a sense of pride, achievement, and community, outweighed the labour-intensive and long days that farming entails.

Thus, the relational values identified in this paper exemplified some of the diverse values of farmers that either directly or indirectly influenced their farm management practices, such as responsibility and commitment to soil health, nature, admiration, and place attachment (Chapman & Deplazes-Zemp, 2022; Mikołajczak et al., 2022). For example, care is central in human-nature relationships as well as for human well-beings, and fosters trust, responsibility, and social connectedness (Jax et al., 2018). Here, one participant's collaboration with other farmers to manage a water stream not adjacent to or directly relevant for their farms was an intriguing example of an initiative that did not enhance on-farm productivity, soil properties, or economic benefits. Indeed, it took up energy, time, and economic costs that could have been spent otherwise. Instead, it served to strengthen feelings of care, community, and place attachment, and worked indirectly to encourage other environmental actions, thus reflecting relational values and a commitment to personal and social welfare as well as ecological wellbeing (Jones & Tobin, 2018).

As such, our findings highlight that most horticultural farmers have close relationships with their farmland, with nature, and with the farming community—the nature and quality of which constituted “the good life” (Jax et al., 2018). The embodied notion of relational values like care and respect apparent in participants' decisions further align with findings from Kreitzman et al. (2022) and the conceptual framework of Chan et al. (2016) of relational values as both individual in nature (stemming from farmer-farmland and farmer-nature relationships) and involving human collectives (farmer-farming community relationship). Moreover, the findings underlined the utility of considering relational values as they pertain to a diverse set of actors to understand the driving and restricting forces. Taken together, our results thus augment

recent arguments to move beyond understanding agricultural decision-making as predominantly individual and economically oriented, by demonstrating the roles that a web of relational values and actors, and their interactions, play in farm management.

4.4.2. Navigating multiple values and interests: how do other food system actors influence farmers' relational values?

Expanding on findings focusing on individuals' relational values in the context of agricultural landscapes, our results demonstrate the utility of considering these values as embedded in a dynamic system of actors that enable or restrain farmers' enactment of them. This helps to show the different contexts that work as enablers and barriers for farmers (Fischer et al., 2021; Fish et al., 2016), and possible solutions (West et al., 2020).

There were both enabling and restricting forces associated with the identified actors. Notably, most participants expressed that grocers' accumulation of power, unpredictable decision by both grocers and policymakers, and low political prioritisation of horticulture threatened their agency and sense of purpose in farming. Many also expressed consumer preferences as a key influence driving retail, grocer, and in turn farming constraints and priorities. These dynamics in turn defined the opportunity space for enacting relational values (Baker et al., 2021; Bataille et al., 2021; Chapman & Deplazes-Zemp, 2022). This is not to say that in their absence farmers would refrain from unsustainable farming practices such as overfertilizing or using pesticides (enacting only "desirable" relational values; Hoelle et al., 2022). For example, while farmers considered themselves responsible for avoiding harmful pesticide use (Milford et al., 2022), many considered spraying to be safe and necessary, and that they lacked support from policy and programming to further reduce their usage and mitigate the risks of doing so. This reveals

a gap between farmers' various values and motivations, the conditions needed to enact their relational values in a way that enables sustainable consumption and production, and the current reality of the nuanced interlinkages with multiple actors in the agri-food value chain.

This broadened consideration of relational values can be particularly useful for a sector like agriculture that must respond to challenges like climate change, environmental degradation, and population growth (Riechers, Balázsi, Engler, et al., 2021). Values can be vulnerable to such turbulences which can provoke conflicts and unrest between different groups of people living within a landscape (Chapman et al., 2019). For our participants, interactions with e.g. grocers and policymakers have over time eroded their relational values and resulted in an accumulation of stress and strong sense of uncertainty, to the point where several considered exiting farming. Critically, other types of support including formal and informal support from peers, farm advisors, and consumers helped to reduce such effects. This demonstrates the clear relevance of considering these multiple actors and their interactions in efforts to support farmers' enactment of relational values.

Moreover, this perspective helps to demonstrate that "individual" decisions rarely are so. Instead, they are subject to contextual influences. While reductionist approaches could be useful as a temporary way for understanding decision-making (Eyster et al., 2022), it is crucial to recognize the broader context in which choices are made. Our participants, situated within a complex value chain, navigated interacting biophysical, social, and political processes that heavily influenced their farm management and any potential to change. As such, adopting a relational values lens that explicitly considers interlinkages with valued entities and other actors helps illuminate dynamic decision environments and change rather than static features

and states. This is useful for shifting focus to the relations that can enable transformational change (Gould et al., 2023; West et al., 2020). Just as individuals do not operate in isolation, relationships or valued entities do not exist in a vacuum. The barriers and enablers associated with value-chain actors that shape farmers’ enactment of their relational values are summarised in Table 4.2, and we consider this an important area for further research. Future work could also consider the interactions between the relational values themselves, and how they develop over time.

Table 4.2. Summary of enablers and barriers for enacting relational values associated with the different value-chain actors.

	Grocers	Retailers & consumers	Farm advisors	Policymakers
Barriers	Production plans favor myopic decisions over long-term planning	Aesthetic demands on produce	Farmers’ time/economic constraints can hinder engagement	Farmers not included in decisions
	Infringing individual identities	Disconnect between producers and consumers		Regulations not responding to farmers’ needs
	Fractured community cohesion through fostering competition	Upholding and sustaining farmers’ low status (e.g., by choosing foreign produce)		Agricultural policy too short-term (tied with electoral cycle)
Enablers	Stimulating innovation through partnerships	Meaning in work by providing fresh and healthy produce	Formal and informal collaboration for peer support and knowledge exchange	Opportunity to co-create policy
	Supporting a stewardship ethic	Community contribution: economic, health, and environmental	Foster resilient farming communities	Meaningful engagement between policymakers and farmers
	Predictable planning processes and horizons	Educational opportunities	Individual capacity building	Predictable planning processes and horizons

4.5. Concluding remarks: Implications for decision-making

This paper integrates views on elements underlying farm management, and sheds light on how different value chain actors influence farmers’ enactment of a wider suite of relational values.

Considering the importance of these values in farm management, and the increasing demands, regulations, and uncertainty imposed on farmers' enactment of them, how can these insights be leveraged for understanding farmers' decisions and a prosperous horticultural sector moving forward?

Several findings in this paper relate to policy-relevant topics for supporting farmers. Value-laden social relationships—the significance of farmers' communities and social networks—represents one such topic which merits further attention (Castillo et al., 2021; Rust et al., 2021; Skaalsveen et al., 2020). Notably, given farmers' diverse needs and wants the social support networks do not have a one-size-fits-all configuration (Cofré-Bravo et al., 2019; Schreiber et al., 2023). A critical consideration of the role of social interactions and processes between actors in a network, including how collaboration and conflict can occur in tandem, can help understand underlying processes of social influence and their outcomes (Bodin et al., 2020; Reed et al., 2010). Although our participants were individual decision-makers who generated their livelihoods from farming, their social relationships to other farmers often enabled access to more and better information, offered a channel through which to cope with and find solutions to challenges, and functioned as a source of motivation and comfort. There were also examples of strong competition and negative community relations, often linked to value chain pressures (Chapman et al., 2019). Supporting and strengthening farmers' social networks according to their needs is therefore important.

Another topic includes the restructuring of subsidies and regulations related to horticulture and agricultural imports. Participants frequently mentioned that the status quo economic and policy environment promoted practices that compromised their ability to manage their farm

in line with agronomic and environmental ideals. A relational values approach as demonstrated in this paper, could help expand insights beyond individuals' motivations, preferences, barriers, and opportunities in farm management, to provide novel perspectives on system dynamics and the priorities and values of other actors in the agri-food value chain. It may be that it is the current (mis)alignment of these values, and not the organising principles of the system, that determines the opportunity for systemic sustainability (Jones & Tobin, 2018). Understanding diverse values held by actors and relevant barriers and enablers for enactment could lead to better design of these programs.

Indeed, nascent literature suggests that relational value framings can affect stakeholders' perceptions of policy instruments (Allen et al., 2018; Chan et al., 2018; Chapman et al., 2019, 2020; S. Díaz et al., 2015). Converting policy tools from instrumental to a relational logic, emphasizing relationships with people and nature, rather than market exchange, could significantly increase policy support from farmers (Gallemore et al., 2022). From a policy perspective, understanding if and how different actors' values harmonise, or whether they are incompatible, can help to identify areas of conflict in ecosystem management, facilitate joint goal setting, and encourage open dialogue about prioritisations in land use (Bataille et al., 2021; Ives & Kendal, 2014). Constraints to relational values, such as power differences between value chain actors, societal norms that do not value farming, and policy that frequently fluctuates with electoral cycles, must be addressed at multiple levels of the agri-food value chain to deepen our understanding of farmers, the agricultural context, and opportunities for change.

4.6. Author contributions

Andrea Byfuglien, Mark Hirons, and Anna Birgitte Milford conceived the ideas and designed the methodology; Andrea Byfuglien collected and analysed the data; Andrea Byfuglien wrote the first draft of the manuscript including the development of the table and figure contents, and led the revisions. All authors contributed critically to the drafts and gave final approval for publication.

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4.8. Conflicts of interest

The authors declare that the research was conducted with no commercial or financial relationships that could be construed as a potential conflict of interest.

4.9. Data availability statement

Full transcripts of the interviews cannot be made available to avoid compromising respondents' anonymity.

5. Chapter 5

Chapter 4 collected qualitative data from Norwegian farmers to underline how an in-depth understanding of relational values as embedded in wider social systems can enrich analyses of farmers' decision-making. It pointed to the ways in which farmers' relational values are shaped and realised through interactions not just with the land and their peers, but also with other actors in the agri-food system. Actors such as grocers and policy makers significantly influence their farm management.

These interactions can offer synergies and enable farmers to practice in line with their relational values, however they could also restrict farmers' opportunities and erode relational values. Some participants voiced concerns related to the social and environmental sustainability of farming, for example due to the strong influence exerted by grocers or consumer demands. The findings offer new insights on how a web of actors influences a web of relational values in the context of agricultural change.

Clearly, individual farmers can play important roles since they must think and act on the information that is available to them at any given time. In this chapter I therefore shift focus from relational values and qualitative methods to draw on psychology and behavioural science, using experimental methodology to address a complementary but distinct research question. Specifically, I focus on how information framing can influence farmers' preferences and support for climate policy and encourage broader behavioural change. In the context of sustainable agri-environmental change, there has recently been a notable shift in the discourse from a prominent focus on mitigation, i.e. reducing greenhouse gas emissions, towards also underlining the importance of adapting to climate change, i.e. responding and adjusting to its

expected and ongoing consequences. Both responses are urgently needed, particularly in a sector like agriculture that both contributes to climate change and is critically impacted by it. I now turn to examine this issue in more detail, using an experimental survey approach.

In particular, Chapter 5 of this thesis (Paper 2) addresses research question 2: How does learning about cover crops as a strategy for climate change adaptation and mitigation influence farmers' support for large-scale mitigation policy and adoption of cover crops?

It does so by using an experimental survey to examine how farmers respond to mitigation and adaptation framings, specifically addressing the risk compensation and risk salience hypotheses. The paper is targeted at a wide readership interested in the relationship between mitigation and adaptation and individual preferences and responses (e.g. policy support and adoption of sustainable farming practices).

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Status: Completed and under revised review in Climatic Change.
Authors: Byfuglien, A., Kvakkestad, V., & Innocenti, S.

Abstract

Mitigation and adaptation are both urgently needed to effectively address climate change and reduce its effects. This is particularly pertinent in the agricultural sector, a major contributor to emissions and highly vulnerable to climate impacts. Our study investigates how farmers perceive and respond to mitigation and adaptation information. We develop and test animated video interventions in an incentivised survey experiment with Norwegian horticultural farmers (N = 513). We examine how an intervention framed in terms of mitigation (Mitigation treatment) or adaptation (Adaptation treatment) influenced support for sector-wide mitigation policy and actual adoption of a sustainable farming practice (cover crops). The results show that the Adaptation treatment significantly increased support for national agricultural mitigation policies compared to the Control, while the Mitigation treatment had no significant effect, suggesting that adaptation is not seen as a substitute for mitigation. However, neither treatment impacted the adoption of cover crops. These findings highlight the need for careful climate messaging in agriculture.

5.1. Introduction

Productive agricultural systems are necessary to feed a growing global population, however they are threatened by climate change and environmental degradation. At the same time the agricultural sector is a key contributor to these crises, being responsible for a significant proportion of global greenhouse gas emissions and biodiversity decline (Lynch et al., 2021; Masson-Delmotte et al., 2019; Newbold et al., 2016). Addressing this unsustainable trend requires large-scale shifts along the agricultural value chain (McGreevy et al., 2022; Poore & Nemecek, 2018). Recognising the urgent need for a sustainable agricultural transition, the agriculture-climate-biodiversity nexus has climbed political agendas worldwide (European Commission, 2020b; FAO et al., 2023; IPBES, 2019; Masson-Delmotte et al., 2019). Many countries have launched programs to encourage the uptake of sustainable farming practices, including information campaigns, economic incentives and subsidies, and long-term innovation projects.

It is urgent that more farmers adopt such sustainable farming practices as they can contribute to emissions reductions at the aggregate level as well as provide critical benefits at the farm level (Clark et al., 2020; Jones & Kammen, 2011). For one, farmers can implement mitigation strategies and thereby contribute to addressing the root cause of climate change. Examples of such mitigation strategies include optimising fertiliser applications, reducing tillage and machinery operations, and using diverse crop rotations (Camargo et al., 2013; Wollenberg et al., 2016). Farmers can also take adaptation actions which offer more private benefits to protect themselves from damages caused by climate change. Examples of farm-level adaptation actions include ensuring a flexible farm organisation, diversifying production

systems to spread risks and create buffers, and optimising soil and crop management to make their production more resilient (Anderson et al., 2020; Darnhofer et al., 2010).

While there is an established consensus that pursuing both mitigation and adaptation at individual and systemic levels is essential to effectively tackle climate change (Calvin et al., 2023; IPCC, 2022), early responses focused primarily on mitigation (Pielke et al., 2007). As adaptation has gained growing attention, concerns have been raised that these adaptation activities could influence risk perceptions and dampen already insufficient mitigation efforts (Tol, 2005; Weber, 2006). In fact, if people learn about adaptation options, they may view it as a viable alternative to mitigation. However, some evidence suggests that emphasizing adaptation may actually enhance engagement in mitigation by highlighting the risks of climate change (Brügger et al., 2015; Carrico et al., 2015; Greenhill et al., 2018).

Although risk perceptions play a central role in farmers' decision-making (Mase et al., 2017; Rodríguez-Barillas et al., 2024), limited knowledge exists regarding the extent to which farmers think about adaptation and mitigation as complements or substitutes, and how this shapes support for large-scale policies and decisions to adopt sustainable farming practices (Arbuckle et al., 2013; Haden et al., 2012; Moerkerken et al., 2020; Zhang et al., 2020). Large-scale policy efforts provide additional incentives and infrastructure to facilitate individual actions. In turn such policies can enable more wide-spread opportunities to act sustainably (Chater & Loewenstein, 2023). Given that farmers are the ones upon whom the tasks of agricultural mitigation and adaptation will largely fall, and both are urgently needed, it is critical to improve our understanding of how farmers perceive and respond to mitigation and adaptation information.

To address this gap we conduct an information provision experiment with Norwegian farmers and evaluate how farmers respond to information about cover crops, a sustainable farming practice, framed either in terms of mitigation or adaptation. We focus on information not because we believe it by itself can create the large-scale change necessary for a sustainable transition—instead, it is likely a necessary factor for any intervention aiming to promote change, including regulations, incentives, and campaigns. Indeed, information plays an important role to raise awareness about mitigation and adaptation and creating support for systemic action (Fang & Innocenti, 2023; Jalil et al., 2023; Moser & Dilling, 2011). Since information approaches remain some of the most readily available to policy makers and practitioners there is a cost-benefit argument to enhance their efficacy. Our results demonstrate that farmers who are exposed to the adaptation frame show stronger support for mitigation policy than those exposed to the control condition.

5.1.1. Related literature and gap

Climate change can be addressed either through prevention (i.e. by implementing mitigation strategies) or by managing its effects (i.e. taking steps to adapt to it). Previous studies on the relationship between mitigation and adaptation have focused on responses to risk at the individual level of decision-making. Several studies suggest that emphasizing the salience of one risk can amplify concerns about related risks and potentially lead to stronger support for preventive actions (Carrico et al., 2015; Evans et al., 2014; Greenhill et al., 2018). This is known as the risk salience effect.

For instance, prompting participants to answer survey questions about sea level rise and local adaptation measures for their community increased their willingness to engage in mitigation actions, more so than for participants who did not answer adaptation-related questions (Evans et al., 2014). Similarly, Carrico et al. (2015) found that presenting the public with mock newspaper articles that framed a policy as helping farmers adapt to climate change increased support for both agricultural mitigation and adaptation policies compared to a focus on mitigation or energy efficiency (control). It also increased climate risk perceptions (Carrico et al., 2015). Urban et al. (2021) surveyed residents in four countries across five experiments to find partial evidence (in two of five studies) that a prior focus on adaptation increased participants' attitudes toward mitigation. A prior focus on mitigation did not influence subsequent adaptation attitudes (Urban et al., 2021).

Some studies suggest that increasing the risk salience could stimulate such effects also in agricultural decision-making. In particular, farmers who are more concerned about climate change impacts on agriculture have been found to support both mitigation and adaptation (Arbuckle et al., 2015; Mase et al., 2017; Prokopy et al., 2015). Studies focusing specifically on adaptation further suggest that farmers who are more concerned about climate change, perceive higher risks, and have stronger capacity for action are more likely to undertake further climate adaptation measures (Azadi et al., 2019; Kreft et al., 2021; Nainggolan et al., 2023; Skevas et al., 2022; Woods et al., 2017). Moreover, a scoping review of nearly 18 000 papers finds that the strongest motivations for farmers to adopt sustainable practices is perceived benefits for either their farms, the environment, or both (Piñeiro et al., 2020). How such practices are communicated, framed, and made salient, for example by the media, can also alter their perceived relevance and influence uptake (Piñeiro et al., 2020; Rust et al., 2021).

Overall, salience effects could thus enhance farmers' responses to protect against threats from climate change.

However, there are also indications that focusing on adaptation might crowd out mitigation efforts. This is known as the risk compensation effect. Previous studies have demonstrated the occurrence of this effect when measures that provide partial protection against risks lead to increased risky behaviour, such as when information about possible risk adaptation steps reduce perceived risks and increase intentions to engage in the risky behaviour (Bolton et al., 2006; Hasanzadeh et al., 2020). This effect is evident in various fields, such as energy conservation, where increased efficiency, despite reducing energy costs, has been shown to also drive up overall energy consumption (see for example Gillingham et al., 2013).

In the agricultural sector, farmers who believe in technological solutions to climate change may be less willing to adopt additional measures by perceiving these solutions as sufficient (Gardezi & Arbuckle, 2020). Some studies also suggest that farmers pursue mitigations strategies due to economic benefits rather than wanting to reduce greenhouse gas emissions (Davidson et al., 2019; Rochecouste et al., 2015). Moreover, if farmers perceive climate change as highly uncertain and too far in the future, they may not believe that extensive short-term investments or changed farming practices are warranted (Mortreux & Barnett, 2017; Wheeler & Lobley, 2021). The single-action bias may partially explain this dynamic, where individuals focus on a single response and neglect additional actions, even if the chosen response only offers incremental risk reduction or is not the most effective solution (Weber, 2020).

Taken together the literature does not offer conclusive evidence on how farmers respond to calls for agricultural mitigation and adaptation. The fact that few studies have actively used an intervention and monitored its behavioural impact adds additional uncertainty. A recent review of farm-related behavioural change found that only 15 did, across which education interventions were the most common (Rose et al., 2018). For example, information provision and educational interventions have been shown to improve farmers' soil nutrient management (Genskow, 2012), pest control (Helitzer et al., 2014), and increased uptake of precision agriculture technologies (Barnes et al., 2019). However, evidence of how such interventions impact actual behaviour has been scarce and sometimes mixed. A study with Ugandan farmers found that providing rice farmers with information about agronomic practices via videos increased their knowledge, but there was no evidence that it affected their actual use of the practices (Campenhout, 2021). Thus, while the way information is presented can significantly affect how farmers respond to it, it remains unclear whether the information received translates into support for environmental policies aiming to reduce emissions (Andrews et al., 2013; Doran et al., 2020; Ngo et al., 2022; Rust et al., 2021).

Given this context, our main objective is to study how farmers react to a mitigation or an adaptation frame and how such information alters farmers' self-reported mitigation policy support using experimental methodology. Specifically, we investigate how Norwegian farmers respond to information interventions that emphasise the benefits of cover crops as either a climate adaptation or mitigation strategy.

In particular we ask: how does information about cover crops framed in terms of mitigation or adaptation influence farmers' support for mitigation policy? Is the effect aligned with the risk

saliency or risk compensation effect? We specifically evaluate support for the Agricultural Climate Mitigation Agreement, a large policy initiative between the Norwegian government and farmer unions. It forms the foundation for agricultural climate policy and sets targets to reduce emissions from agriculture and increase carbon sequestration in soils by 5 million tonnes CO₂-equivalents by 2030 (Bondelaget, 2020).

Based on the reviewed literature we expected the two frames to have the following effects. Given a risk saliency effect, we anticipated that participants exposed to either the Adaptation or the Mitigation framing would show stronger support for the national mitigation policy than their counterparts in the control condition. This is because learning about adaptation strategies may increase climate concerns and therefore heighten the perceived need for mitigation. Equally, informing people about the importance of collective measures to counteract climate change might increase risk perceptions and the need for adopting large-scale mitigation policies (Carrico et al., 2015; Greenhill et al., 2018).

In the case of a risk compensation effect, however, we would expect participants in either the Adaptation or Mitigation condition to demonstrate lower levels of policy support. This is because emphasising adaptation might trigger people to view adaptation as a remedy to a problem that can be dealt with in the future and does not require costly preventative measures such as the implementation of large mitigation policies (Carrico et al., 2015). Equally, learning about the possibility to collectively mitigate climate risks in the future might make immediate mitigation efforts less attractive due to their high upfront financial and coordination costs, thereby lowering support for national mitigation policies.

We also evaluate the influence of our intervention on farmers' actual behaviour by retrieving participants' applications for a cover crops subsidy in the 2023 growing season to indicate their adoption of cover crops.¹ Since the literature predominantly relies on self-reported measures of adoption intentions despite the well-known gap between intentions and actions in general (Kollmuss & Agyeman, 2002) as well as in the agricultural context (Luh et al., 2023), this offers a novel contribution to understand how calls for mitigation and adaptation influence farmers' preferences and, ultimately, actions. Our approach thus helps inform whether video information interventions could influence support for large-scale mitigation policy, including an objective measure of behaviour to further inform whether farmers are influenced by these interventions.

5.2. Methods

5.2.1. Study context and participant recruitment

We conducted a pre-registered survey experiment incorporating animated video interventions with a sample of 513 Norwegian farmers in February-April 2023. Farmers were recruited from the horticultural farmer population in the country.²

The agricultural sector in Norway is under pressure to reduce emissions in line with national and international commitments. It remains outside the Common Agricultural Policy of the European Union and is a high-latitude country where farmers face both potential benefits and

¹ In Norway, farmers can apply for a subsidy in October (i.e. to receive a refund) through the Agricultural Agency if they planted cover crops in that year. The size of the subsidy is determined by the size of the land area on which the cover crops are planted, measured in hectares. The cover crops subsidy application period is from end of September to the end of October every year.

² A statistical power analysis conducted a priori using G x Power revealed that a planned sample size of $n = 400$ complete responses would give the study sufficient statistical power, $1 - \beta = .95$, to detect a small effect size, $w < 0.2$ (95% Confidence Interval). To account for possible missing data we decided to sample approximately 500 participants.

challenges due to climate change. Coastal regions are expected to experience increased heavy precipitation and flooding, while inland and boreal areas, such as those around Oslo, may benefit from an extended growing season and higher crop yields (McEldowney, 2020; Rosenzweig et al., 2014). There are however considerable uncertainties due to the potential rise in soil diseases and pests which could significantly impact yields (Wiebe et al., 2019).

We focus our interventions on cover crops for several reasons. They represent a sustainable farming practice involving crops that are planted alongside or after the main crop. Planting cover crops is widely available to farmers, however it emerged relatively recently in Norway and requires additional economic and time investments (Bergtold et al., 2019). The relevance of information interventions is therefore plausible even for experienced farmers. Moreover, cover crops offer both mitigation and adaptation benefits, such as binding soil nutrients, alleviating weed infestation, improving yields, reducing soil erosion, and enhancing carbon sequestration (Büchi et al., 2018; Kaye & Quemada, 2017; Lugato et al., 2020).

Three reasons motivate our focus on horticultural farmers. First, horticultural fields are to a larger extent exposed to soil erosion and runoff than other productions since larger areas are not covered by crops. Measures such as cover crops could thus be beneficial, however uptake remains low (Bøe et al., 2019). Second, the economic value of horticultural crops is larger per hectare of land than for other types (e.g. cereals). Due to the high quality requirements and shorter growing seasons, horticultural farmers are more vulnerable to climate change and associated impacts (OECD, 2021b; Statistics Norway, 2024). Third, horticultural farmers have received considerably less empirical attention than other types, such as animal husbandry and cereal production.

The recruitment process entailed multiple steps. First, we accessed the national Production Subsidy Registry from the Norwegian Agricultural Authority. The Registry includes data on farmland used for the cultivation of various crops on all Norwegian farms entitled to governmental payments. It lists all farm holdings that receive any kind of government subsidies, capturing virtually all farms in Norway. Based on the Registry we sent email invitations to all vegetable and/or potato farmers in line with preregistered criteria (a total of 2076 invitations). We sent out three rounds of email reminders and one round of SMS-based reminders over a period of six weeks. This yielded 460 responses from interested farmers. Second, we collaborated with the Farm Advisory Service (Norsk Landbruksrådgivning, NLR) to post a link to the survey in their newsletter sent to farmers as well as on relevant online forums. Fifty-three responses were collected thanks to this effort.³ As such, we were able to survey approximately 20% of our target population. Given the particularity of our sample (i.e. horticultural farmers) and findings from a small pilot, it was evident that forcing respondents to answer all questions could deter participation. We therefore opted to not enforce survey responses. This resulted in some missing values throughout the data set, leaving 369 complete responses out of the 513 for the analysis of our main outcome variable, i.e. Policy Support.

The sample was 82.4 percent male and had a mean age of 53.18 ($SD = 10.97$). The median education was "Professional certificate" (completed high school with further professional education) and the median income level was NOK 400-499k (approx. EUR 34-43k). Geographically most of the sample was located in central and southern parts of Norway (further south than Nordland county) which corresponds to the distribution of the farmer

³ The survey was posted on online forums with an unknown number of views so the exact response rate cannot be determined. Of the email recipients the response rate was 24 percent.

population. Comparing with statistics of the national farmer population we consider these sample characteristics to be approximately representative (for details see Appendix B Table B.2) (Statistics Norway, 2024).

5.2.2. Design and procedures

The study was introduced to participants as a survey of horticultural farmers' experience with and use of cover crops in their farming system, without explicit reference to mitigation policies, adaptation, or information videos in the recruitment ad. Because of this it is possible that farmers with prior knowledge or interest in cover crops selected into participating in our study. However, the study followed a complete random assignment procedure and a between-subjects design to tame self-selection bias.⁴ Respondents assigned to treatment saw one of two video variants, depending on which experimental condition, while those assigned to the control condition saw no video. We focused on framed video interventions for several reasons. From a cost-benefit perspective, they can help improve communication approaches which are shown to influence attitudes and beliefs (Fang & Innocenti, 2023; Jalil et al., 2023; Moser & Dilling, 2011). Videos capture attention more effectively than text or static images and can present complex information in a more engaging and accessible manner. Along with the growth of digital platforms, videos that leverage framing thus represent a promising tool for policy makers and practitioners to effectively disseminate targeted information to many people. The content of the survey and video scripts were discussed with regional experts, farm advisors, and farmers to verify that the content was accurate and easy to understand. The

⁴ As noted in randomized controlled trials literature (see for example Belot & James, 2014; Duflo & Kremer, 2003), randomization within a self-selected sample helps mitigate self-selection bias to yield valid and robust treatment effect estimates. Furthermore, even if participants self-selected into the study, the random assignment procedure was implemented after people joined the study. By being randomly allocated to either the treatment groups or the control, participants reactions can be attributed to the interventions themselves rather than pre-existing differences between participants.

survey was coded in Qualtrics and the median time for completion was 15.5 minutes. At the end of the survey participants could opt in for a lottery to win one of five prizes of NOK 1,000 (EUR 90) as compensation for their time.⁵ The links to the videos and their transcripts are provided in Appendix B.

The survey instrument consisted of three main blocks.

Pre-intervention block. The first block collected information on respondents' personal characteristics. All participants, after accessing the study, provided their informed consent and answered questions about their farming practices, their knowledge about cover crops, and their previous experience using cover crops. They then answered further questions related to their farming including their use of various information sources. They also answered questions about their risk preferences (such as "In general, to what extent are you willing to take risks?" and "To what extent are you willing to try something new in the operation of the farm, without knowing what the outcome is for other farmers who have tried it?" on a 7-point Likert scale), and belief in and concern for climate change (e.g. "To what extent do you agree that climate change is happening?" and "I am concerned about global climate change"). We also assessed participants' pre-intervention support for the Agricultural Intention Agreement to reduce greenhouse gas emissions (signed by the Norwegian Government and farmer interest organisations in 2019) on a 7-point Likert scale as a baseline measure of mitigation policy support.

Intervention block. The second block of the survey contained the video-based information

⁵ The use of a lottery incentive is common practice to stimulate responses in Norwegian farmer surveys. Five participants were randomly selected for the lottery prize, which was a gift card to a well-known farming shop.

treatments. The videos were animated by a professional graphic designer and narrated by a professional reporter. The Mitigation condition narrated in simple terms the contribution of agriculture to climate change and the beneficial mitigation effects that widespread adoption of cover crops could offer. The Adaptation condition focused on the vulnerability of agriculture to climate change and that individuals' action of adopting cover crops could offer private benefits and help make their own farming system more resilient (for a visual summary see Figure 5.1, and for full scripts see Appendix B). Each video lasted approximately 1.5 minutes. Participants in the Control condition did not watch any video and proceeded directly to the next survey item.

Post-intervention block. The third block elicited participants' post-intervention level of support for the Agricultural Climate Agreement between the Norwegian farmer organisations and Government on a 7-point Likert scale (Policy Support). This constitutes our main outcome variable. We also asked their level of intention to adopt cover crops in the 2023 season. To understand how and why farmers may have changed their views on mitigation strategies in response to the treatments we further collected a rich set of post-treatment beliefs. Specifically, we measured respondents' level of concern about global climate change post-treatment, perceived need for climate adaptation, their priorities of adopting new technology, taking care of soils, biodiversity, and farming with future generations in mind on a 7-point Likert scale (e.g., "To what extent do you agree with the following statement: 'It is important to improve the farm for the next generation'"). The survey concluded with socio-demographic questions, which is normally the case with agricultural surveys. Participants were then thanked for their participation and had the option of providing any comments and to enter the lottery.

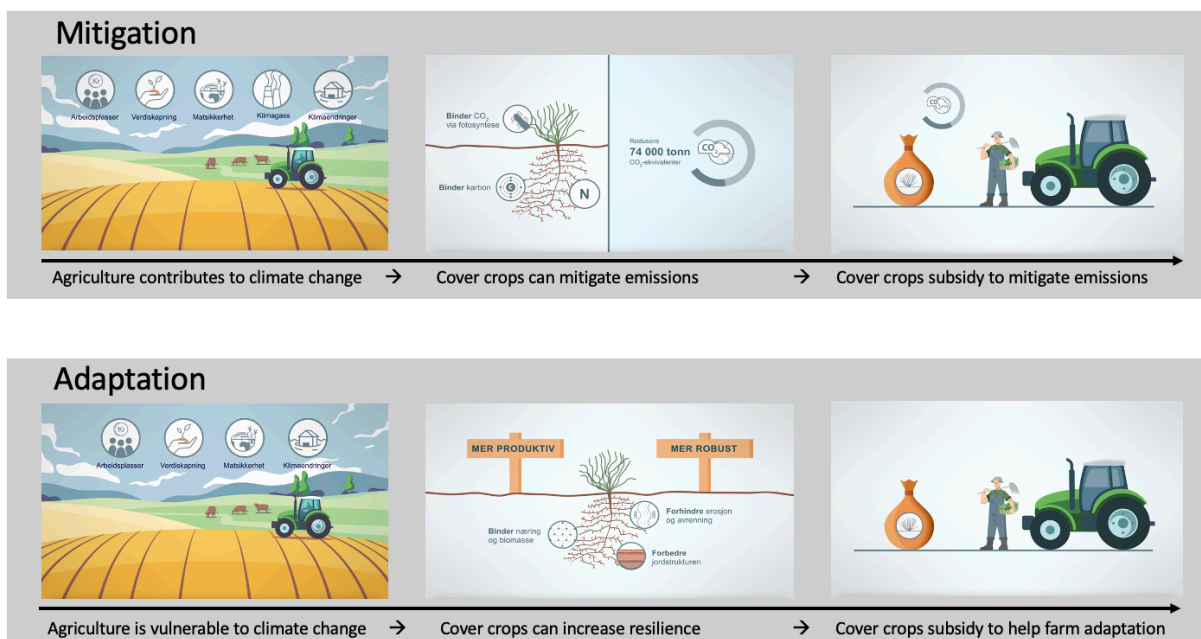


Figure 5.1. The content of the video information interventions visually presented with example screenshots and brief explanations. The upper panel illustrates the Mitigation intervention and the lower panel illustrates the Adaptation intervention.

Finally, alongside the survey yet independently from it, we obtained participants' post-intervention decision to apply for a cover crops subsidy in the 2023 growing season as a proxy for their adoption of cover crops (variable termed "Adoption"). This constituted our secondary outcome variable (see Appendix B Table B.1 for an overview of the dependent measures).

In terms of the cover crops subsidy, farmers can apply for it via an online form during a set application window in September-October every year. It is thus a retroactive process granting farmers a subsidy which refunds a significant amount of the expenses incurred if they implemented cover crops in that season. To be eligible for a subsidy in 2023, farmers could decide to adopt cover crops shortly after being exposed to our interventions in the spring. Farmers can adopt various cover crop options depending on their agronomic conditions and main crop, such as grasses, legumes, and other species. They must also meet certain requirements for being eligible for the cover crops subsidy such as refraining from using

pesticides on the covered area and to avoid tillage by March 1st the following year. We extracted the record of submitted cover crops subsidy applications in November 2023 from the Norwegian Agricultural Agency. We then paired the record with respondents' survey responses to determine if a participant had applied for the subsidy (coded as a dummy variable with 1 indicating that an application was made) before performing statistical tests.

5.3. Results

Our experimental conditions were balanced in terms of observable characteristics. We observed no significant differences between conditions on participants' baseline support for the Agricultural Intention Agreement to reduce greenhouse gas emissions ($F(2, 355) = 1.97, p = .14$), and that most participants declared at least some level of knowledge of cover crops (70%) and considered their soils to be suitable (94%) (for details see Table 5.1 and Appendix B section B.3).

Table 5.1. Descriptive statistics and balance check, including sample sizes and statistical tests. There was no significant difference between any of the study conditions on any of the variables, suggesting a balanced design.

Variable	Mitigation		Adaptation		Control		Test
	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	
Age	54 (SD=11)	134	54 (SD=12)	132	52 (SD=10)	131	F=2.14
Gender		134		131		134	X2=0.61
... Male	87 %	117	84 %	110	86 %	115	
... Female	13 %	17	16 %	21	14 %	19	
Education		135		132		135	X2=1.10
... No university degree	58 %	78	52 %	68	54 %	73	
... University degree	42 %	57	48 %	64	46 %	62	
Land ownership		135		133		134	X2=2.28
... Own 100%	38 %	51	31 %	41	30 %	40	
... Renter	62 %	84	69 %	92	70 %	94	
Pre-intervention support	4.6 (SD=1.4)	118	4.8 (SD=1.5)	120	4.5 (SD=1.2)	120	F=1.97
Concern for climate change	3.5 (SD=1.1)	137	3.5 (SD=1)	135	3.4 (SD=1)	143	F=1.16

5.3.1. Post-intervention support for sector-wide mitigation policy

As per our preregistration, we report the effects of our interventions on participants' post-intervention Policy Support (support for nation-wide agricultural mitigation policy) and Application for the cover crops subsidy. All analyses were performed in R version 4.2.3.

We found that 54% of respondents in the Control condition were in favour of mitigation Policy Support (i.e. a score of 5 or higher on the 7-point Likert scale), 66% in Mitigation, and 75% in Adaptation (Figure 5.2). A Chi-square test of independence revealed a significant difference between conditions ($\chi^2 = 11.36, p = .003$). Pairwise comparisons indicated that participants in Adaptation ($M = 4.92, SD = 1.51$) showed significantly higher Policy Support than Control ($M = 4.47, SD = 1.35$). No significant difference was observed between the Mitigation ($M = 4.80, SD = 1.40$) and Adaptation treatments, nor between Mitigation and Control.

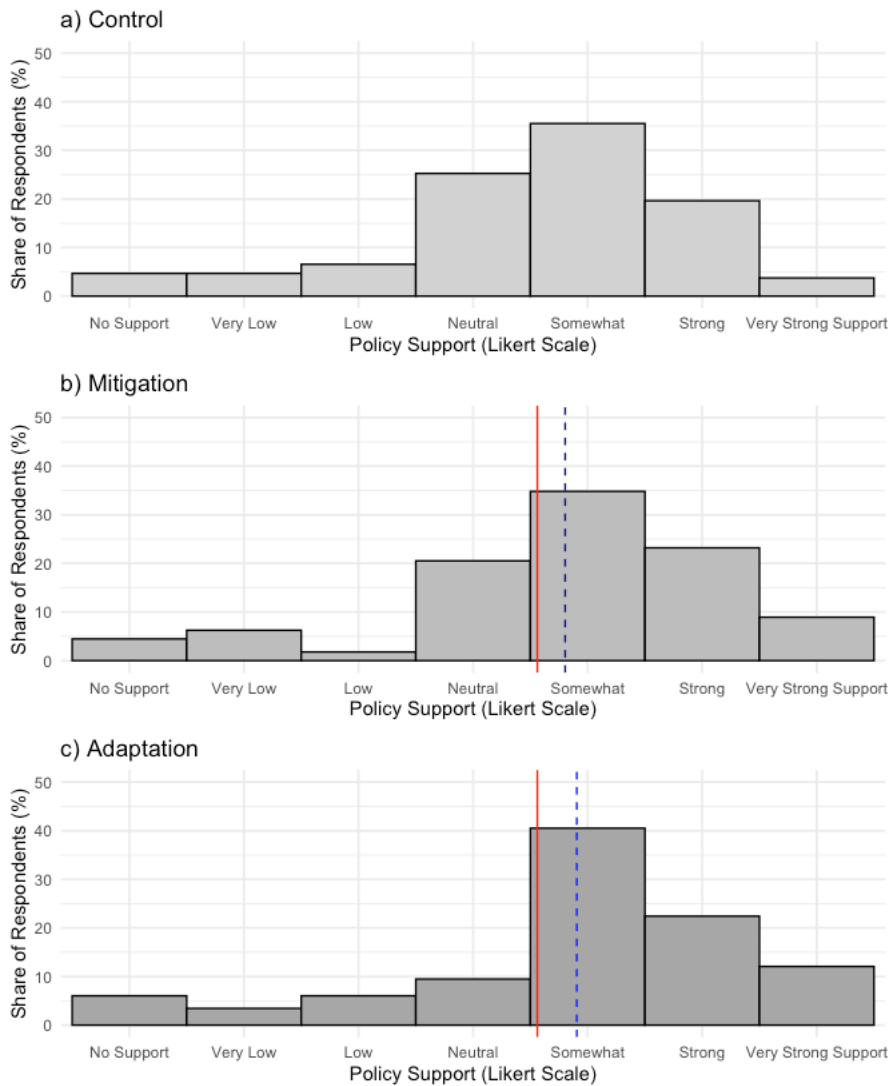


Figure 5.2. Share of respondents indicating level of post-intervention Policy support (i.e. support on a 7-point Likert scale for the Agricultural Climate Mitigation Plan) by condition. Panel a) shows the control condition. Panel b) shows the Mitigation condition with the red solid line indicating the control mean and the blue dashed line indicating the group mean. Panel c) shows the Adaptation condition, with the red solid line showing indicating the control mean and the blue dashed line indicating the group mean.

Following our pre-registration we estimated linear regression models (LMs) with robust standard errors (Table 5.2, columns 1-3).⁶ Column 1 shows that in the full sample, the level of mitigation Policy Support was significantly higher for participants in the Adaptation condition relative to those in Control ($p < .05$). We note the low explanatory power of the model ($R^2 = .02$).

⁶ To retain as many observations as possible we handle the missing values in each regression model, hence the reduced n in certain models. We performed several checks of our regression models to ascertain that the missing values did not bias our results or interpretation thereof (for statistical details see Appendix B.4).

Moreover, to better understand the effects of the interventions based on participants' prior attitudes to the policy we considered different segments of the population accordingly. We observed a positive effect of both the Mitigation and Adaptation conditions (albeit stronger for the Adaptation condition) when excluding participants who reported strong opposition to the policy in baseline (i.e. those who expressed 1 or 2 on the 7-point Likert scale in baseline). However, when excluding those strongly supportive in baseline (reporting 6 or 7 on the 7-point Likert scale), we observed no significant differences in effects.

Table 5.2. Support for agricultural mitigation policy after the intervention.

	Linear regression			Ordered logistic regression		
	(1)	(2)	(3)	(4)	(5)	(6)
Mitigation	0.33 (0.18)	0.33* (0.16)	0.26 (0.19)	0.49* (0.23)	0.47 (0.26)	0.26 (0.28)
Adaptation	0.44* (0.18)	0.51** (0.15)	0.10 (0.21)	0.73*** (0.23)	0.67*** (0.25)	0.14 (0.29)
Observations	369	272	342	369	238	308
Excl. strong prior opposers		Yes			Yes	
Excl. strong prior supporters			Yes			Yes
R ²	0.02	0.01	0.03			
Adjusted R ²	0.01	-0.001	0.03			
AIC				1227.67	774.34	953.21

Note: * $p < .05$; ** $p < .01$; *** $p < .001$. Dependent variable: Policy support as measured on a 7-point Likert scale. Columns 1-3 report results from linear regression with robust standard errors in parentheses. Columns 4-6 report ordered logistic regression results with standard errors in parentheses. Variables Mitigation and Adaptation are treatment variables and Control is the reference variable.

To more accurately account for the ordinal nature of the post-treatment Policy Support measure and to address the slight deviation from normality in the distribution of residuals we also employed an ordered logistic regression (OLR) to consider the robustness of the effects. Taken together these complimentary findings help ensure that our conclusions do not depend on the specific model chosen. The results (Table 5.2, columns 4-6) are consistent with those

from the linear models while also showing a marginally significant effect of the Mitigation condition in the full sample (column 4).

These findings partially support a risk salience effect and offer no evidence for a risk compensation effect. Furthermore, the results show that the increase in Policy Support achieved through the exposure to the Adaptation condition is primarily driven by a shift in the views of those who were already favourable toward national mitigation policy. We did not observe any change for those who initially had strong opposition to it.

5.3.2. Heterogeneous effects and mechanisms

To understand how the effect of the interventions may vary depending on participants' prior characteristics we performed pre-registered moderation analyses also using LMs. Specifically, we assess the effects of the treatment conditions on Policy Support based on participants' baseline beliefs, sociodemographic factors, and farm-related characteristics.

The results (reported in Appendix B.5) showed a significant effect of the Mitigation (Table B.4 column 2: coef. = 0.48, $p = .02$) and Adaptation (coef. = 0.50, $p = .02$) conditions among participants with high climate concern at baseline. We observed no such effect for those with low levels of climate concern (column 3). This suggests that the effect of the Mitigation condition captured in the OLR presented in Table 5.2 could be driven by individuals with high levels of climate concern.

Analyses of participants' baseline risk preferences showed that the Adaptation treatment significantly increased Policy Support among risk seeking individuals (Appendix B Table B.4

column 4: coef. = 0.54, $p = .02$). We found no significant differences in treatment effects for risk averse individuals (Appendix B Table B.4 column 5). However, we observed significantly higher levels of policy support in both conditions compared to control for farmers with larger farm areas, those holding a university degree, and those renting land, and stronger levels of support in the Adaptation condition for those who were older and had higher income (for statistical details see Appendix B Table B.5).

We also investigated the mechanism underpinning the effects of the interventions. Based on our hypotheses, we would expect both interventions to heighten concerns about the possible climate change impacts given a risk salience effect. Conversely, if risk compensation took hold, we would expect profit-making to overshadow environmental concerns, as the farmer might feel either absolved of responsibility or confident that environmental issues can be managed in other ways. The results of this exploration (Appendix B Table B.6) showed that the Adaptation condition increased participants' concern for local impacts of climate change (column 3, coef. = 0.41, $p = .03$). We observed no effects of either intervention on participants' perceived importance of making profits of the farm. We thus consider these results to align with the risk salience effect in that our interventions, particularly the Adaptation intervention, appear to work by heightening concerns about climate change risks in the region.

5.3.3. Application for cover crops subsidy in the aftermath of the interventions

To investigate the effect of our treatments on farmers' behaviour we examined whether they applied for a cover crops subsidy in the 2023 growing season.

Overall, we observed a low rate of subsidy applications: 15.8% of our sample applied for the cover crops subsidy in 2023 (Figure 5.3). A Chi-square test of independence revealed no difference between the share of participants that applied in the Mitigation ($M = 16.8$, $SD = 37.5$), Adaptation ($M = 15.6$, $SD = 36.4$), or Control ($M = 15.4$, $SD = 36.1$) conditions ($\chi^2 = 0.14$, $p = .93$).

The low rate of applications contrasted with the significantly higher share of individuals who expressed an intention to apply (49%)⁷ when completing the survey. We found a weak relationship between Intention to apply and Actual application for cover crops subsidy (Pearson's $r(397) = .22$, $p < .001$). As per our pre-analysis plan, we examined further predictors for Actual application using logistic regressions, reported in Appendix B Table B.7. Treatment exposure does not predict the subsidy applications. Having previously used cover crops significantly predicts the likelihood of applying for the subsidy, and concern for climate change is a negative predictor of applying (see Appendix B Table B.7 for statistical details).

⁷ A Chi-square test of independence revealed no difference between the share of participants that intended to apply in the Mitigation ($M = .5$), Adaptation ($M = .5$), or Control ($M = .47$) conditions ($\chi^2 = 0.36$, $p = .83$).

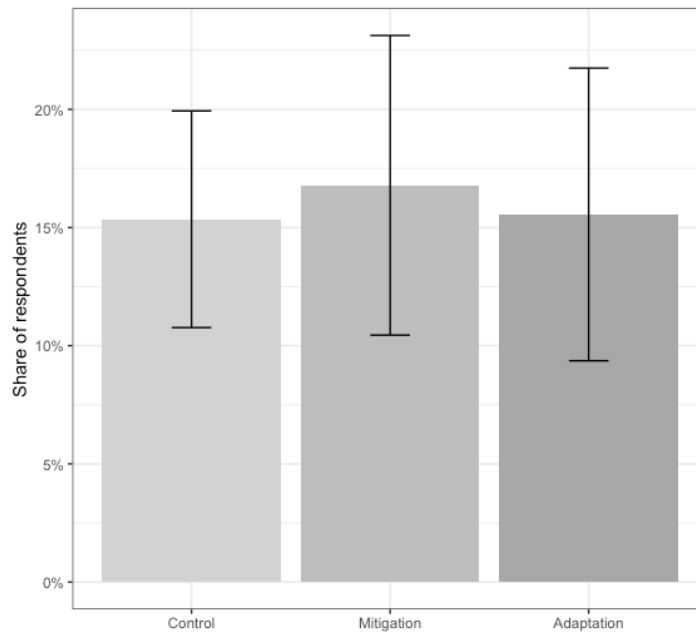


Figure 5.3. Share of respondents applying for the subsidy to adopt cover crops in 2023 by treatment condition ($n = 513$).

5.4. Discussion

Mitigating emissions and adapting to the consequences of climate change are both urgent aspects of addressing climate change, particularly in a context like agriculture. These tasks will largely fall on farmers. We show in an experimental setting that an adaptation information intervention is most effective for increasing farmers' support for national agricultural mitigation policy. We also find a discrepancy between intentions to adopt and actual adoption of cover crops as a sustainable farming practice. Our findings thus corroborate evidence that information interventions can influence support for agricultural mitigation policy, yet they do not close the gap between farmers' intentions to adopt and their actual adoption.

We find that farmers' support for sector-wide mitigation policy increased when exposing participants to a short video intervention focusing on agricultural adaptation featuring cover crops as a farming practice. This suggests that risk compensation effects may be less prevalent than previously suggested (Bolton et al., 2006), at least in the agricultural sector. The risk

salience effect appears to be more pronounced in this context. While the effect sizes reported in our paper are small, they are consistent with and build on previous studies addressing the mitigation-adaptation relationship in the general population (Carrico et al., 2015; Evans et al., 2014; Urban et al., 2021) and results which indicate that climate-related concern, perceived risks and need for adaptation are linked to farmers' efforts to address climate change (e.g., Haden et al., 2012; Mase et al., 2017; Roesch-McNally et al., 2017).

Our results further suggest that the interventions primarily influenced farmers who are already in favour of implementing agricultural mitigation policies. Conversely, the interventions were not effective in swaying those who were initially opposed to the policy. Indeed, we find evidence to suggest that the Adaptation condition worked in part through heightened concerns for local impacts of climate change. This aligns with previous findings that link belief in and concern for climate change with the perceived psychological distance to climate change, both in the general population (Maiella et al., 2020; Vlasceanu et al., 2024) and in farmers (Azadi et al., 2019; Haden et al., 2012). Moreover, the heterogeneity analysis showed that the Mitigation condition increased policy support for individuals who held a university degree, rented land, and farmed on larger areas. More educated farmers may be more familiar with and receptive to the abstract nature of mitigation efforts, and farmland tenure status and size could influence farmers' perceived ability to carry out and deliver successful outcomes.

Theoretically, these findings contribute to the framing literature by demonstrating that farmers respond differently to the mitigation and adaptation frames and that targeted adaptation narratives can influence farmers' support for mitigation policy. The results are in line with the wider policy support literature showing that attitudes and perceived personal benefits predict

support and that such narratives can help bridge farmers' immediate priorities and concerns with long-term policy goals (Bergquist et al., 2022; Dechezleprêtre et al., 2022; Drews & Van Den Bergh, 2016; Klenert et al., 2018). Practically, they underscore the need for equitable and tailored communication strategies that meet individual needs over a "one-size-fits-all" approach to agricultural policy, since a certain level of leniency is needed to for interventions to be effective.

We complemented the analysis of Policy Support with an objective behavioural measure to allay concerns of experimenter demand effects (Haaland et al., 2023). Our findings revealed no effect of our interventions on farmers' actual behaviour, as measured by their applications for a subsidy to adopt cover crops in 2023. The adoption rate was notably low, with only 16% of farmers taking advantage of the opportunity to receive a refund for cover crop expenses. This observed gap contributes to further demonstrate how attitudinal change is decoupled from behaviour change in agriculture (Luh et al., 2023; Swart et al., 2023), which is also widely discussed in various pro-environmental contexts (see for example ElHaffar et al., 2020; Kollmuss & Agyeman, 2002; Laffan et al., 2023). It is thus important to differentiate between stated intentions and actual behaviours. Our intervention could have influenced farmers at an early stage of behaviour change such as the contemplation stage (Hanna et al., 2014), but it was not sufficient to ultimately alter their behaviour (Campenhout, 2021; Sutherland et al., 2012). It is beyond the scope of this paper to elaborate on the potential mechanisms behind this intention-action gap and possible ways to close it, which we consider a fruitful avenue for future research.

Taken together, this study holds important implications for a context like agriculture by drawing a link between an adaptation framing and farmers' support for mitigation policy as well as a detachment between intentions to adopt and actual adoption. It corroborates evidence that specific population segments are more supportive of government action and that policy effectiveness may improve by considering the characteristics of the target population (Arbuckle et al., 2013; Brown et al., 2021; Piñeiro et al., 2020; Sutherland et al., 2012; Woods et al., 2017). Combined with the finding of a significant intention-action gap, our findings further underline the importance of measuring actual behaviours as opposed to stated intentions for policy-relevant insights.

5.4.1. Limitations and further directions

We acknowledge several limitations to this work and opportunities for future studies. First, while the use of video information interventions is novel and possibly more effective than text-based interventions, they were short and not repeated, thus their effects were likely limited. Our findings add to previous studies showing that video information interventions that are pedagogical and/or story-based could be more effective and they warrant further study (Fang & Innocenti, 2023; Morris et al., 2019; Stantcheva, 2021) as they can facilitate mental simulations of possible future events rendering risks more salient. There are also certain limitations to information provision as an intervention (Bergquist et al., 2023), as it does not remove e.g. cost barriers and may thus exacerbate inequalities. It is thus a tool to consider alongside others such as financial interventions.

Second, related to our design, while our sample was representative of the horticultural farmers population based on demographics, we acknowledge that the survey was administered online

and primarily distributed via email. There may thus be a selection bias, where predominantly technologically literate farmers or those with a particular interest could have self-selected to participate. Although we used a diverse recruitment strategy tailored to reach a wide range of the population (i.e. not only inviting via emails but also leveraging the Advisory Service and sending SMS-reminders), it is possible that many did not see, or purposely ignored, the email or the other advertisements. Yet, because the randomization occurred after participants self-selected into the study, and participating farmers had a chance of not receiving the treatment by being assigned to the control condition, differences between treatment groups and control can be attributed to the interventions rather than pre-existing differences between participants. The responses to the survey also included cases of missing data, plausibly biasing downward our effects so the results and interpretations could be strengthened with improved power.

Third, we cannot exclude the possibility that farmers could have adopted cover crops without applying for subsidy. This is however unlikely: the costs and time commitment associated with cover crops are considerable and given the economic incentive covering a significant amount of the expenses it is thus highly likely that those who did adopt cover crops applied for the subsidy to obtain a refund.

We conducted our randomised study in a real-world setting with farmers, using an objective (though possibly imperfect) measure of behaviour—specifically, the adoption of cover crops. This approach allowed us to move beyond the limitations of standard laboratory settings. However, we acknowledge that the study was tailored for the Norwegian context and policies. Therefore, also in view of the small effect size, we recommend further research to determine

whether these results are generalisable beyond the Nordic context, and if similar information interventions produce comparable outcomes (see List, 2020).

We already noted the fruitful research area of the intention-action gap. Another important question concerns the fact that we focused on cover crops. Future work is needed to examine whether the interventions produced spillover-effects in the sense that participants were influenced to adopt other sustainable farming practices.

5.5. Conclusion

This paper shows that a short video information intervention highlighting the adaptation benefits of cover crops significantly increased farmers' support for mitigation policy, suggesting that adaptation can be a unifying argument for attracting farmers' support, especially among those who are already in favour of mitigation efforts. Considering the urgent need for adaptation and mitigation, this survey experiment is a timely contribution to augment our scientific knowledge of adaptation-mitigation dynamics and specifically how farmers think and act on them. We find our results to be better explained by a risk salience effect and no reason to suspect a risk compensation effect. The adaptation narrative does not crowd out support for sector-wide mitigation policies in the Norwegian agricultural context. We did not observe an effect of our treatment on farmers' adoption of cover crops, underlining the importance of dissociating stated intentions and support from actual behaviour. Ultimately, these findings move us one step closer to understanding the adaptation-mitigation relationship as well as how climate change communication can be framed in the agricultural context.

5.6. Statements and Declarations

We pre-registered the study in the Open Science Framework website (link to pre-registration here: osf.io/5tnc4). Ethical approval was received from the Central University Research Ethics Committee ([SOG E C1A-23-2](#)). The authors have no relevant financial or non-financial interests to disclose. This research was conducted in partnership with and supported financially (grant no. 320810) by the Norwegian Institute for Bioeconomy (NIBIO) that has a long-standing experience with conducting agricultural research in Norway.

All authors contributed to the study conception, design, and material preparation. Data collection and analysis were performed by A.B. The first draft of the manuscript was written by A.B. and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability Statement: the datasets generated during and/or analysed during the current study are not publicly available due to risk of compromising respondents' anonymity but are available from the corresponding author on reasonable request.

6. Chapter 6

Chapters 4 and 5 demonstrated important implications of considering farmers' relational values and their individual responses to targeted messages. They also uncovered important gaps between farmers' professed values and intentions on the one hand and their actual behaviour on the other. This demonstrates a phenomenon known as the value-action gap or the intention-action gap. Better understanding the intention-action gap, and how it could be bridged, can help develop policies and design interventions to support change at the individual level as well as realising sustainable transitions at collective levels.

Chapter 6 (Paper 3) therefore examines the third research question ensemble: 1) Of what magnitude is the intention-behaviour gap? 2) Are the predictors of intentions also predictors of behaviour? 3) Which predictors explain whether intentions turn into behaviour?

Paper 3 draws on the same dataset and participants as Chapter 5 and predictors identified in the literature to further understand the drivers of intentions and actions. It is targeted to environmental psychologists to contribute to methodological discussions pertaining to the reliance on measures of intentions and willingness for predicting behaviour that are prevalent in the literature, as well as to social scientists and practitioners more widely that are interested in policy-relevant insights and the relationship between intentions and actions in general and farmers in particular.

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Abstract

A vast body of literature has developed to predict farmers' pro-environmental attitudes, intentions, and behaviour to develop effective policy for supporting farmers' adoption of sustainable practices. This literature relies heavily on measures of intentions, self-reported behaviours, and cross-sectional approaches. Yet evidence from across the social and psychological sciences demonstrate a prevalent gap between intentions and actions, which is also observed among farmers, and that intentions do not necessarily predict actions.

We examine the nature and prevalence of farmers' intention-action gap, whether predictors of intentions also predict actions, and which predictors can explain whether intentions turn into behaviour. To do so we use survey and objective behavioural data from Norwegian horticultural farmers to examine their intentions to adopt and actual adoption of cover crops, a sustainable farming practice that can offer both mitigation and adaptation benefits. We survey farmers before the 2023 growing season to measure their farming preferences, environmental attitudes and concerns, and their intentions to apply for a cover crops subsidy (i.e. their intention to adopt). We subsequently access records of farmers' application for the cover crops subsidy at the end of the farming season, six months later, to measure their actual adoption of cover crops.

In line with the intention-action gap we found that whereas 49% intended to apply for the cover crops subsidy, only 16% of our sample applied for the subsidy in 2023. Past use and knowledge of cover crops, perceived need for adaptation, being risk seeking in farming, and using advisory services predicted intentions, whereas only past use of cover crops predicted both intention and actual adoption. Moreover, only the strongest level of reported intentions

had some value in predicting actual behaviour. Our results offer timely evidence of the intention-action gap in agricultural decision-making, the urgent need to address a widespread reliance on intentions as predictors of behaviour, and the importance of behavioural measures and longitudinal approaches to understand the intention-action gap.

6.1. Introduction

Agriculture in the 21st century is faced with daunting and interlocking challenges. Growing populations require efficient food production, but agricultural productivity is hampered by the rapidly unfolding consequences of climate change and biodiversity loss. At the same time the global food system is identified as the primary driver of biodiversity loss and emits approximately 25% of global greenhouse gas emissions (Clark et al., 2020; IPCC, 2022; Masson-Delmotte et al., 2019). Agriculture is thus a key contributor to the very crises that threaten it.

To protect the environment, secure reliable and adequate food production, and safeguard the livelihoods of farmers, an urgent transformation of agricultural systems to stop deforestation, diversify crop systems, and sustainably use agricultural inputs is needed (Crippa et al., 2021; Hertel et al., 2021; Poore & Nemecek, 2018). While governments and industry are critical to realise this transformation, the role of individual farmers should not be underestimated. Individual farmers can for example shift towards sustainable farming practices to reduce greenhouse gas emissions and enhance carbon sequestration and the resilience of soils, that in aggregate significantly contribute to more sustainable agricultural systems (Clark et al., 2020; Poore & Nemecek, 2018).

Developing an effective institutional context to support farmers in adopting sustainable farming practices requires an accurate understanding of what motivates and hinders them in implementing such practices. Critically, farmers' decision-making processes and adoption behaviour are not driven solely by external factors such as policies, financial flows, and market constraints (Piñeiro et al., 2020). A growing literature demonstrates that psychological and behavioural factors also play a key role (Dessart et al., 2019; Feola et al., 2015; Mills et al.,

2017). For example, a recent meta-analysis demonstrates that farmers' attitudes towards sustainable farming practices, their perceived usefulness, and considerations of environmental problems play important roles in decisions to adopt them (Swart et al., 2023). Such findings have led to a new direction of policy recommendations for how policy makers can promote sustainable farming practices. Instead of focusing only on financial stimuli, policy makers should also consider interventions that target the psychological predictors of behaviour, for example interventions that address possible barriers to increase farmers' capacity to act (see for example Rose et al., 2018; Rust et al., 2020; Swart et al., 2023).

Many studies that examine these psychological predictors of sustainable farming behaviours are cross-sectional in nature and predominantly assess farmers' intentions to adopt. Studies using longitudinal designs that measure actual behaviour at a later time point are rare (Milliet et al., 2024; Swart et al., 2023). Yet, there are two critical pitfalls associated with only studying farmers' intentions. First, intentions do not always translate into behaviour, i.e. there is an observable intention-action gap (Kollmuss & Agyeman, 2002). Recent studies show that while many farmers report intentions to adopt environmental practices the actual adoption rates remain low (Hasler et al., 2022; Mills et al., 2020). For example, a study considering Dutch farmers' level of awareness and adoption of mitigation measures including greenhouse gas emissions reduction, energy saving, and renewable energy use found that reported intentions predicted emissions reduction measures but were not predictive of energy saving measures (Moerkerken et al., 2020). Within the literature on sustainable agricultural farming, it is currently not clear how big this gap is (or can get) or when and why intentions do (or do not) turn into actions.

Second, and even more critically, some studies suggest that psychological predictors of intentions are not necessarily also predictors of the actual behaviour. For example, Niles et al. (2016) surveyed farmers in New Zealand to examine the relationship between their intended and actual adoption of climate change mitigation and adaptation measures. They found that attitudes and beliefs were associated with intended, but not actual, adoption of mitigation practices, and only farmers' perceived capacity and self-efficacy were important predictors of both intention and action (Niles et al., 2016). Another cross-sectional survey considering the link between Danish farmers' perceptions of climate change risk and mitigation and adaptation actions found no correlation between perceptions of climate change and their self-reported on-farm mitigation action (Jørgensen & Termansen, 2016). In a similar vein, albeit with households, a study examining the drivers of household-level adaptation decisions found that perceptions of climate change and perceptions of local risks were associated with intentions to implement adaptation measures, but not actual behaviour, which was determined by self-efficacy and outcome efficacy (van Valkengoed et al., 2023).

These inconsistencies between what predicts intentions and what predicts actual behaviour have key implications for conclusions that are currently drawn in the literature. First, as intentions are often used as a proxy for actual behaviour in the agricultural context, psychological factors that have been found to predict intentions to implement pro-environmental practices are often interpreted as if they are also predictors of actual behaviour (see for example Mitter et al., 2019; Wensing et al., 2019; Werner et al., 2017). However, given that predictors of intentions are not necessarily also predictors of behaviour, it is currently unclear which psychological factors can actually predict behaviour change (or the lack thereof). Second, recommendations for the design of interventions to promote sustainable agricultural

practices are often based on the results of studies that have looked at intentions. Yet, if the predictors of intentions and actual behaviour differ, interventions that are developed based on studies that have looked at intentions are likely limited in their effectiveness to promote actual adoption of sustainable farming practices.

Moreover, shortcomings associated with asking for intentions cannot be resolved by simply asking farmers for behaviours they already implemented in the past, which is also commonly done (see Swart et al., 2023). As explained by Weinstein et al. (1998), the relationship between psychological factors and behaviour is often not one-directional, as engaging in behaviour can also alter psychological factors. For example, while we often assume that a positive attitude towards a behaviour motivates people to engage in this behaviour, it can also be the case that people's attitudes towards a behaviour may become more positive *after* they have implemented the behaviour and can experience its benefits (e.g. Fishbein & Ajzen, 2011). Studies that simply correlate people's current levels of psychological variables with past instances of behaviour, are unable to uncover the causal relationship linking these two sets of variables (Weinstein et al., 1998).

To effectively promote the uptake of sustainable agricultural practices among farmers, it is therefore necessary to measure predictors and occurrences of actual behaviour and to use longitudinal study designs to evaluate the effect of interventions. In this article, we contribute to the literature by studying farmers' intentions to adopt and their actual adoption of cover crops. Cover crops represent a sustainable farming practice consisting of crops that are planted alongside or after the main cash crop. In addition to covering fields between seasons they offer various benefits to agricultural systems and surrounding communities, including carbon

sequestration, yield increases, increasing soil organic matter, nutrient fixation, and preventing soil erosion and compaction (Büchi et al., 2018; Kaye & Quemada, 2017; Lugato et al., 2020). To realise these co-benefits many governments seek to stimulate farmers' uptake by introducing subsidies, as there are direct (monetary) and indirect (time and labour requirement) costs for adopting cover crops (Bøe et al., 2019; European Commission, Joint Research Centre, 2019; Kathage et al., 2022). However, responses to such policies have been varied and uptake remains low. Focusing on this context, we specifically address the following questions:

- 1) What is the magnitude of farmers' intention-behaviour gap?
- 2) Are the predictors of intentions also predictors of behaviour?
- 3) Which predictors explain whether intentions turn into behaviour?

Recent reviews and meta-analyses have identified various predictors that play a role in farmers' intentions to adopt sustainable farming practices (Bartkowski & Bartke, 2018; Brown et al., 2021; Dessart et al., 2019; Swart et al., 2023). In this article, we consider ten variables grouped into five categories that are consistently found to predict intentions to implement sustainable farming practices, and by extension are also often interpreted as drivers of actual adoption behaviour. These categories are knowledge, experience, environmental and farming attitudes, social influence, and the use of advisory services. Given their prevalence in efforts to understand agricultural decision-making, they represent a suitable set of variables to expand our understanding of the intention-action gap in this context. We discuss the theoretical relevance and empirical background for explaining the adoption of sustainable farming practices of each of them in more detail below, italicising their labels when introduced.

Importantly, we stress here that unless otherwise stated, the studies reviewed have looked at farmers' intentions to adopt sustainable farming methods, but not actual behaviour.

6.1.1. Knowledge

One of the first and most intuitive explanations for why farmers may not take up sustainable agricultural practices is a lack of knowledge of them. The literature points to distinct differences between *subjective knowledge* (i.e. self-reported level of knowledge about an issue) and objective knowledge (i.e. an assessed measure of specific knowledge of an issue), where subjective knowledge is particularly important for understanding people's reactions to an issue (Kellstedt et al., 2008; Stoutenborough & Vedlitz, 2014). Indeed, recent reviews and studies across contexts find that farmers' self-reported knowledge (i.e. subjective knowledge) of agricultural practices relate to their decisions to adopt (Barnes et al., 2022; Feola et al., 2015). Farmers seek out knowledge of practices and relevant information on climate conditions, soil conditions, and new technologies to inform their decisions (Soubry et al., 2020). A survey of Iowa farmers showed that whether an environmental practice is easy to use and perceived as useful was important for widespread (self-reported) uptake (Arbuckle & Roesch-McNally, 2015). Similarly, an interview-based study with Dutch farmers found that farmers' self-reported knowledge of their environmental impacts was positively related to their self-reported uptake of mitigation practices (Gomes & Reidsma, 2021). In a scoping review of nearly 18 000 papers, Piñeiro et al. (2020) found that one of the strongest positive predictors of farmers' adoption of sustainable practices was farmers' knowledge of the perceived benefits for either their farms, the environment, or both.

6.1.2. Experience

Experience with and past use of farming practices also relate to uptake (Foguesatto et al., 2020; Kuehne et al., 2017; Rizzo et al., 2024). Farmers who have previously employed particular measures are more likely to continue or take up the same measure again, and the number of years of experience in farming has been positively related to intended adoption of sustainable farming practices (Doran et al., 2020; Meijer et al., 2015). Similarly, farmers who already adopted an adaptation measure have been found to be more likely to adopt a mitigation measure, and vice versa (Niles et al., 2016). However, there are also conflicting findings. Some studies suggest that lower levels of experience, e.g. recently established farms, can be more open to innovation and novel practices since more established farms have routines that can be more difficult to change (Barnes et al., 2019; Gütschow et al., 2021; Rosenbusch et al., 2011). Experience is also related to the concept of self-efficacy, or the belief in one's own skills to perform an action. Theoretically, people judge their level of self-efficacy based on various sources including their actual experiences (successes and failures), vicarious experiences (through observation of similar peers), and persuasion (Bandura, 2006; Bandura et al., 1963; Sewell et al., 2017). Self-efficacy is widely recognised to be an important behavioural predictor, including in agriculture (Bandura, 2006; Brown et al., 2022; Perry & Davenport, 2020).

6.1.3. Environmental and farming attitudes

Farmers' environmental attitudes, i.e. their positive or negative evaluation about the environment and climate change, are frequently cited to positively influence farmers' decisions to adopt (Swart et al., 2023). In particular, perceptions of the risks of climate change including the *belief in* and *concern for climate change* are related to uptake, where farmers who more strongly believe in and worry about higher risks from climate change can be more

likely to express intentions to adopt (Arbuckle et al., 2013; Mitter et al., 2019; Nguyen & Drakou, 2021). This relationship is however not clear, as some farmers do not connect extreme weather events and climate change, and stronger beliefs in climate change do not always relate to their self-reported on-farm mitigation and adaptation efforts (Jørgensen & Termansen, 2016; Niles et al., 2016).

Moreover, perceived risks of climate change are related to the *perceived need to adapt to climate change*. This literature predominantly focused on farmers' intentions or self-reported adaptation behaviour, and suggests that farmers who are more concerned about climate change, perceive higher risks, and have stronger capacity for action intend to undertake further adaptive measures to protect against threats from climate change (Kreft et al., 2021; Nainggolan et al., 2023; Skevas et al., 2022; Woods et al., 2017).

Finally, literature focusing on farmers' *risk preferences in farming* (i.e. tolerance for making risky decisions about farming operations without knowing the outcomes) suggests that risks associated with the adoption can hinder uptake (Azadi et al., 2019; Eitzinger et al., 2018; Menapace et al., 2013; Meraner & Finger, 2019; Schaub et al., 2023). In the context of reducing pesticide use, survey-based studies with farmers show that while the perceived risk of large production losses is a main obstacle for willingness to lower usage (Chèze et al., 2020), environmental attitudes can offset risk perceptions associated with lower pesticide levels (Bakker et al., 2021). Farming-related risk preferences thus play an important role in farmers' decision to adopt a measure.

6.1.4. Social influence

Peer effects are also widely discussed in literature concerning farmers' pro-environmental behaviour (Batáry et al., 2015). Peer effects are powerful influences on behaviour that offer information on what to do in complex decision environments (*informational influence*) and opportunities to stimulate fundamental needs for social belonging (*social influence*). They can boost the production of new knowledge, connect different insights and experiences, and facilitate social learning (Kreft, Angst, et al., 2023; Milliet et al., 2024). For example, farmers' participation in agricultural conservation programs that help farmers share experiences and offer peer support have been found to increase uptake of biodiversity management practices (Byerly et al., 2021; Knook et al., 2020). Bakker et al. (2021) found that Dutch farmers' intentions to reduce pesticide use were strongly determined by the extent to which other farmers also act, and that knowledge exchange with peers could, through mimicry and imitation, foster intentions to reduce pesticide use. There is however some mixed evidence, with some reporting null effects of social interventions targeting farmers' uptake of environmental practices (Milliet et al., 2024). For example, Niles et al. (2016) found no evidence that social influence predicted farmers' intentions or actions in the context of climate change adaptation in New Zealand agriculture. Still, little research has been conducted on actual on-farm pro-environmental behaviour, with a prevalent focus on self-report measures.

6.1.5. Use of advisory services

Finally, the *use of agricultural advisory services*, by facilitating the diffusion of information, can facilitate farmers' adoption of sustainable agricultural practices (Piñeiro et al., 2020), such as soil management (Mills et al., 2017), participation in voluntary agri-environmental schemes (Schaub et al., 2023), and reducing pesticide use (Bakker et al., 2021; Chantre & Cardona,

2014). These advisory services can boost knowledge as previously discussed, and in addition encourage uptake by providing further information, delivering technical advice, and facilitation to support farmers in transitioning their farm operations and management (Ingram et al., 2022).

6.1.6. Current research

In summary, the aim of this study is to explore the intention-action gap in the context of farmers' adoption of sustainable agricultural practices. Specifically, we aim to 1) examine how big farmers' intention-action gap is, 2) test whether predictors of intentions also predict actions, and 3) investigate which predictors can explain whether intentions turn into behaviour (summarised in Figure 6.1). To do so, we use a dataset of Norwegian farmers' intentions to adopt as captured in a survey and their actual adoption of cover crops objectively measured six months later. In Norway, farmers can retroactively apply for a cover crops subsidy. That is, if adopting cover crops during the farming season, farmers pay for the related expenses up front and subsequently apply for the subsidy via an online form in October the same year. The level of subsidy varies somewhat between municipalities, however the application process is streamlined and for most farmers it covers the costs associated with adoption (Bøe et al., 2019). Due to the economic and time investments associated with the use of cover crops, it is therefore highly likely that those who adopt cover crops apply for the subsidy to obtain a refund, making the application for subsidies a reliable indicator of whether farmers engaged in the behaviour. In our study we use data from a survey with 513 Norwegian horticultural farmers conducted in spring 2023 and a record of the same farmers' application for the cover crops subsidy six months later. We thus collect data on both intentions to apply for and actual applications for the cover crops subsidy. The survey further measured psychological and farm-

specific variables, allowing us to examine a range of characteristics that influence farmers' intention-action gap.

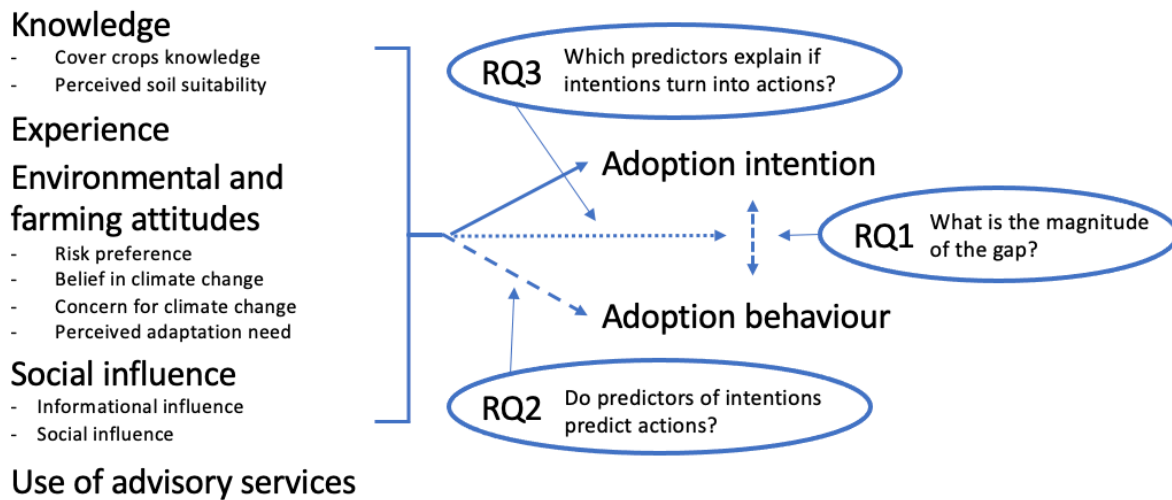


Figure 6.1. Summary of the main concepts and research questions of this paper.

6.2. Methods

6.2.1. Study context

The Norwegian agricultural sector contributes significantly to national food security, economy, and environmental goals. In 2019 the Norwegian government and farmer unions negotiated a climate agreement to reduce agricultural emissions and increase carbon sequestration in soils by 5 million tonnes CO₂-equivalents by 2030 (Bondelaget, 2020). Recent years have also seen multiple shocks including the Covid-19 pandemic, energy crises, and extreme weather events that have further raised sustainable domestic food production on the political agenda. Norwegian horticultural farmers thus operate within a sector going through comprehensive scrutiny and change. To support the implementation of sustainable farming practices the agricultural and environmental authorities focus on information provision and consultancy services, as well as subsidies which are available on a voluntary basis for various practices, such as cover crops (OECD, 2021b). Farmers can choose between different cover crop options depending on their agronomic conditions and main crop, including grasses, legumes, and

other species. These are implemented either parallel with the main crop or after harvest. To satisfy requirements for the cover crops subsidy farmers must submit an online application by October and meet certain conditions including that the cover crops have been sufficiently established, refrain from using pesticides on the covered area, and avoid tillage by March 1st the following year.

6.2.2. Participants and procedure

We use responses from an online survey conducted with 513 Norwegian horticultural farmers in February-April 2023. The survey was designed and administered in collaboration with the Norwegian Institute for Bioeconomy (NIBIO) and leveraged connections with the National Agricultural Agency and the Farmer Advisory Service (Norsk Landbruksrådgivning, NLR) for participant recruitment.

The study was coded in Qualtrics and emailed to 2076 potential participants. It was also included in online newsletters. The survey was introduced as examining horticultural farmers' experience with and use of cover crops in farming systems. The response rate of the emailed farmers was 24%. All participants provided their informed consent before responding. The sample was 82.4 percent male and had a mean age of 53.18 ($SD = 10.97$). The median education was "Professional certificate" (completed high school with further professional education) and the median income level from farming was NOK 300-399k (approximately EUR 25-34k). For further details see Appendix C Table C.1. Based on statistics of the farmer population we considered these sample characteristics to be well representative (SSB, 2021).

The survey measured farmers' practices and preferences in farming, environmental attitudes and concerns, their support for agricultural mitigation policy, and intentions to adopt cover crops. These items were drawn predominantly from previous surveys conducted with farmers by NIBIO and piloted with a small number of farmers prior to roll-out to ensure they were clearly understood. At the end of the survey respondents were thanked for their participation and could provide additional comments. As compensation for their time they could enter a lottery to win a voucher valued at NOK 1000 (EUR 90).

Independent of the survey, in November 2023, we obtained participants' decision to apply for the cover crops subsidy in the 2023 growing season as a proxy for their adoption. This was measured by extracting the records of submitted subsidy applications from the Norwegian Agricultural Agency which were then matched to participants' survey responses.

6.2.3. Measures

The dependent variables and their descriptive statistics are reported in Table 6.1. Participants' intention to apply was measured on a 7-point Likert scale. The independent variables (translated from Norwegian) and their descriptive statistics are reported in Table 6.2. They were decided based on discussions with agricultural advisors, researchers, and the Agricultural Agency. In terms of subjective knowledge, we include two items that are kept separate in analysis to measure participants' knowledge of cover crops and their knowledge of related soil conditions and suitability. For personal experience we include past use of cover crops. For environmental and farming attitudes we include four measures, namely belief in and concern for climate change, perceived need for adaptation, and risk preference in farming. To assess the role of social influence we include measures of the extent to which participants considered

other farmers in their farming decisions, and their use of information from peers. Lastly, we evaluate farmers' reliance on advisors as an information source for their farming decisions.

Table 6.1. Dependent variables and descriptive statistics.

Variable name	Definition	Description	Mean
Application	Binary = 1 if applied for subsidy	Post-intervention decision to adopt cover crops in 2023 as measured by applying for subsidy	0.16
Intention to apply	Ordinal, 7-point Likert scale	How likely are you to apply for a subsidy to establish cover crops in 2023?	4.19 (SD=1.95)

Table 6.2. Independent variables, their descriptive statistics, and where they were adopted from (we strived to use items that have been used and validated in the past. Most items were developed based on past surveys by NIBIO and NLR).

Variable category	Variable name	Definition	Description	Mean	SD	Adapted from
Knowledge	Cover crops knowledge	Measured on 7-point Likert scale	To what extent do you have sufficient knowledge of growing cover crops under your cultivation conditions?	3.6	1.7	NIBIO/NLR
Knowledge	Perceived soil suitability	Measured on 7-point Likert scale	How suitable do you consider your soil to be for establishing cover crops?	5.5	1.3	NIBIO/NLR
Experience	Past use of cover crops	Binary = 1 if "yes"	Are you currently using or have you previously used cover crops?	0.38		NIBIO/NLR
Environmental and farming attitudes	Climate belief	Measured on 5-point Likert scale	To what extent do you agree with the statement: climate change is happening	4.1	0.88	(Aasen et al., 2019)
Environmental and farming attitudes	Climate concern	Measured on 5-point Likert scale	To what extent do you agree with the statement: I am concerned about climate change	3.5	1.1	(Aasen et al., 2019)
Environmental and farming attitudes	Perceived need for climate adaptation	Measured on 7-point Likert scale	To what extent do you agree with the statement: there is increasing need for climate adaptation on the farm	4.9	1.5	NIBIO/NLR
Environmental and farming attitudes	Risk preference in farming	Measured on 7-point Likert scale	How willing are you to try out something new in farming, without knowing the	4.5	1.4	NIBIO/NLR

			outcomes for other farmers who have tried it?			
Social influence	Considering other farmers (social influence)	Measured on 7-point Likert scale	How important are relationships to other farmers for your farming?	5.1	1.2	NIBIO/NLR
Social influence	Information from other farmers (informational influence)	Measured on 7-point Likert scale	How important is information from other farmers for the decisions you make in your farming?	4.3	1.6	NIBIO/NLR
Use of advisory services	Use advisors in farming	Measured on 7-point Likert scale	How important is information from advisory services (NLR) for the decisions you make in your farming?	5.1	1.4	NIBIO/NLR

Note: All answer options for the Likert-scale items were labelled, e.g. 1 = "not at all," 2 = "very low," 3 = "low," 4 = "neutral," 5 = "somewhat," 6 = "high," and 7 = "very high." NIBIO: Norwegian Institute for Bioeconomy. NLR: National Agricultural Agency and the Farmer Advisory Service (Norsk Landbruksrådgivning).

6.2.4. Ethics

The Oxford University Central Ethics Review conducted an ethical review following local legislation and institutional requirements and provided a research permit for conducting the survey (certificate number SOGE C1A-23-2). The survey (but not the specific research questions addressed in this paper) was pre-registered in the Open Science Framework website (link to pre-registration here: osf.io/5tnc4).

6.2.5. Analytical strategy

To address our three research questions, we examine the relationship between farmers' intentions and actions in three parts. First, to evaluate the magnitude of the intention-action gap we calculate the correlation coefficient between farmers' intended and actual adoption. Thereafter, to evaluate predictors of farmers' intentions to apply and predictors of their actual applications we use regression models (linear for the Intention outcome variable and logistic for the Final application variable). We entered predictors into the model in blocks based on their expected effects as inferred from conversations with farming experts and the literature.

In the final step of the logistic regression estimation for actual behaviour we include the measure of Intention to adopt to examine if the strength of participants' reported intention is relevant for the predictive power of intentions on behaviour.

Finally, to examine the predictors of the intention-action gap we partition our sample to contain only those participants who stated their intention to apply in the survey. We then use logistic regressions to compare those who followed up on their intentions to those who did not (i.e. intention + no application vs intention + application).

In piloting the survey we received feedback that enforcing answers would deter respondents. There are therefore some missing values throughout the dataset, hence the reduced n in certain regression models. We performed several checks of our regression models to ascertain that the missing values did not bias our results or interpretation thereof (including regressions with additional control variables and regressions using only complete surveys, for statistical details see Appendix C Table C.2 and Table C.3). Furthermore, in exploratory analyses we tested for potential interaction effects (no important effects were found, reported in Appendix C Table C.4).

6.3. Results

6.3.1. Prevalence of the intention-action gap

We started by examining the extent to which intentions translated into actual behaviour. To do this we considered participants who reported an intention stronger than 4 ("neutral") on a 7-point Likert scale to have a high intention, and those with a score of 4 or below to have a low intention. As Table 6.3 shows, we found that 49% of participants reported having an intention

to adopt cover crops in 2023 (column 2). Yet, only 16% of farmers actually adopted cover crops as measured by the applications for the subsidy (row 2), meaning only one in three farmers that reported having intentions to adopt actually did so. This estimate is somewhat higher than the number for the overall farmer population (7%). This could be explained by the fact that the overall farmer population also includes farmers that cannot adopt cover crops in their production, for example because they farm animals only or cultivate grass. Additionally, it could be the case the current survey oversampled farmers who were already using cover crops, as the topic of the survey was explicit in the invitation (see Discussion). In assessing the strength of the association between reported intentions and actual behaviour we found a small to moderate correlation ($r(397) = .27, p < .001$), which corresponds to an R^2 of 0.07, explaining only about 7% of the variance of the actual adoption behaviour.

Interestingly, we further uncovered that only strong intentions to apply predicted actual application. That is, based on intentions the likelihood of adopting cover crops was similar across the scale up until an intention of 7 ("very high"), such that participants reporting an intention to adopt of 2 ("very low") had a similar likelihood to adopt as those reporting an intention of 5 ("somewhat"). The gap between participants' intention to apply and their application was significantly smaller only for participants who reported the strongest intention, i.e. 7 on the 7-point scale. Figure 6.2 demonstrates this pattern.

Table 6.3. Distribution of participants' intentions and applications: raw counts of observations and share of respondents in percent in parentheses. Percentages may not add to 100 due to rounding. Column 1, "Low intention" signifies 4 ("neutral") or lower on a 7-point Likert scale, whereas column 2, "High intention" indicates 5 ("somewhat") or above.

	Low intention	High intention
No application	187 (47%)	150 (38%)
Application	16 (4%)	46 (12%)

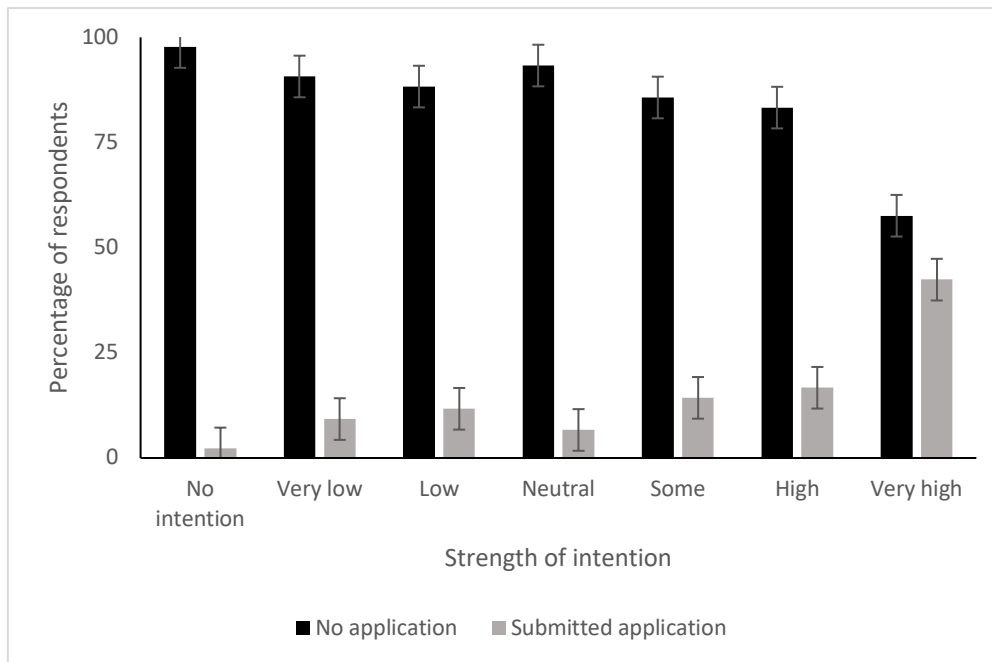


Figure 6.2. The relationship between strength of self-reported intentions to apply and final application. The x-axis represents participants' intention strength (measured on a 7-point Likert scale), and the y-axis represents the share of respondents. Error bars represent the standard error.

6.3.2. Predictors of intentions and actions

Next, using linear regression models, we examine whether knowledge, experience, environmental and farming attitudes, social influence, and reliance on advisors (see Table 6.2 for details on their measurement) are statistically significant predictors of both intentions to act as well as actual behaviour. When estimating the likelihood of actual behaviour we run a conditional model which in addition to all others also includes intention as a predictor. We observed that participants who reported past use of cover crops, higher levels of knowledge about cover crops, being more willing to take risks in the farming context, higher perceived need for climate adaptation, and more reliance on advisory services reported significantly higher levels of intentions to apply for the cover crops subsidy (Table 6.4). These findings align with previous literature and demonstrates the relevance of these variables for explaining intentions to adopt sustainable farming practices. However, variables we expected to be significant based on recent results and meta-analyses, including climate beliefs, climate

concern, and peer information, were not significant predictors of intentions to apply when accounting for all other factors.

With respect to actual applications (Table 6.5), using logistic regressions, we only found that past use of cover crops was a significant predictor, with cover crops knowledge as a marginally significant predictor. We also found that participants' intention to adopt was a significant predictor, driven by those reporting strong intentions (i.e. reporting a score of 7 ("very high")), as described above. We checked the robustness of these results by including additional control variables and found consistent results (for statistical details see Appendix C, Table C.2 and Table C.3).

In sum, our data show that predictors of intention do not necessarily predict actions and suggest that only strong intentions have predictive value for actions.

Table 6.4. Intention to adopt (Linear).

	(1)			(2)			(3)			(4)			(5)		
	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>
Cover crops knowledge	0.25***	0.07	[0.11, 0.40]	0.16*	0.07	[0.02, 0.30]	0.15*	0.07	[0.01, 0.29]	0.18*	0.07	[0.03, 0.32]	0.16*	0.07	[0.01, 0.30]
Perceived soil suitability	0.23**	0.09	[0.06, 0.40]	0.08	0.08	[-0.09, 0.25]	0.06	0.08	[-0.11, 0.22]	0.06	0.09	[-0.12, 0.23]	0.10	0.09	[-0.07, 0.28]
Past use				1.39***	0.22	[0.96, 1.83]	1.31***	0.22	[0.88, 1.74]	1.35***	0.23	[0.90, 1.80]	1.41***	0.23	[0.97, 1.85]
Climate belief							-0.26	0.15	[-0.56, 0.03]	-0.35*	0.16	[-0.67, -0.04]	-0.27	0.16	[-0.58, 0.04]
Climate concern							-0.01	0.13	[-0.26, 0.24]	0.06	0.14	[-0.22, 0.34]	-0.005	0.14	[-0.28, 0.27]
Perceived need for adaptation							0.32***	0.09	[0.14, 0.51]	0.27**	0.10	[0.07, 0.47]	0.24*	0.10	[0.04, 0.44]
Risk preference							0.17*	0.08	[0.02, 0.33]	0.17*	0.09	[0.005, 0.34]	0.20*	0.08	[0.04, 0.37]
Considering peers										0.12	0.10	[-0.07, 0.31]	0.13	0.09	[-0.05, 0.31]
Using information from peers										0.08	0.07	[-0.07, 0.22]	0.003	0.07	[-0.14, 0.15]
Using advisors													0.27***	0.08	[0.12, 0.42]
Constant	2.16***	0.49	[1.19, 3.13]	2.75***	0.47	[1.82, 3.68]	1.62*	0.70	[0.24, 3.00]	0.93	0.88	[-0.80, 2.66]	-0.43	0.93	[-2.25, 1.39]
Observations		304			294			286			260			252	
R ²		0.08			0.20			0.25			0.26			0.31	
Adjusted R ²		0.08			0.19			0.23			0.23			0.29	

Note: Results from the linear regression models on participants' intention to adopt cover crops. * $p < .05$; ** $p < .01$; *** $p < .001$. The outcome variable for columns 1-5 is "Intention to apply" (for the cover crops subsidy), measured on a 7-point Likert scale. "Past use" is the only binary predictor, for which 0 (no past use) is the reference category.

Table 6.5. Actual application (Logistic).

	(1)			(2)			(3)			(4)			(5)			(6)		
	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI
Cover crops knowledge	1.42 **	0.12	[1.13; 1.81]	1.36 *	0.13	[1.06; 1.77]	1.34 *	0.14	[1.03; 1.77]	1.43 *	0.14	[1.09; 1.92]	1.40 *	0.14	[1.07; 1.88]	1.32	0.15	[1.00; 1.78]
Perceived soil suitability	1.14	0.14	[0.88; 1.52]	0.98	0.15	[0.73; 1.34]	0.99	0.16	[0.73; 1.36]	1.04	0.17	[0.76; 1.47]	1.06	0.17	[0.76; 1.50]	1.03	0.18	[0.73; 1.47]
Past use				4.09 ***	0.39	[1.96; 9.10]	3.70 **	0.40	[1.74; 8.37]	3.93 **	0.41	[1.82; 9.04]	4.12 **	0.41	[1.89; 9.59]	2.57 *	0.45	[1.08; 6.36]
Climate belief							0.93	0.25	[0.57; 1.53]	0.85	0.26	[0.50; 1.42]	0.83	0.27	[0.49; 1.40]	0.92	0.28	[0.53; 1.59]
Climate concern							1.01	0.21	[0.68; 1.53]	0.97	0.23	[0.62; 1.54]	0.97	0.23	[0.61; 1.55]	0.95	0.24	[0.59; 1.54]
Perceived need for adaptation							1.04	0.15	[0.78; 1.42]	1.08	0.16	[0.79; 1.51]	1.09	0.17	[0.79; 1.53]	1.02	0.17	[0.73; 1.44]
Risk preference							0.98	0.14	[0.74; 1.30]	1.01	0.15	[0.75; 1.38]	0.99	0.15	[0.74; 1.36]	0.91	0.16	[0.66; 1.25]
Considering peers										0.99	0.16	[0.72; 1.35]	0.98	0.16	[0.72; 1.34]	0.93	0.16	[0.68; 1.29]
Using information from peers										1.20	0.12	[0.95; 1.54]	1.22	0.13	[0.95; 1.59]	1.23	0.13	[0.95; 1.62]
Using advisors													0.94	0.13	[0.72; 1.22]	0.86	0.14	[0.65; 1.14]
Intention to apply																1.45 *	0.14	[1.13; 1.92]
Constant	0.02 ***	0.83	[0.00; 0.09]	0.02 ***	0.88	[0.00; 0.12]	0.03 *	1.26	[0.00; 0.33]	0.01 **	1.60	[0.00; 0.22]	0.02 *	1.73	[0.00; 0.47]	0.02 *	1.81	[0.00; 0.50]
Observations		328			318			291			263			254			252	
AIC		278.42			249.89			246.82			232.54			228.23			220.79	

Note: Results from logistic regression models on Application for the cover crops subsidy. Effect sizes are reported as odds ratios (OR). * $p < .05$; ** $p < .01$; *** $p < .001$. The outcome variable for columns 1-6 is the Actual application for the subsidy, a binary measure (0 if did not apply). "Past use" is the only binary predictor, for which 0 (no past use) is the reference category.

6.3.3. When do intentions translate into action

We now turn to the predictors that explain when intentions lead to actions by considering adoption only for participants who held high intentions to apply (i.e. 5 (“somewhat”) or higher on a 7-point Likert scale) in the survey. The results of our logistic regressions show that the only significant predictor for application for the subsidy is past use of cover crops. Model statistics (Table 6.6) reveal that participants who self-report past use of cover crops have significantly higher odds of adopting cover crops, compared to their counterparts who have not used cover crops in the past. Overall, we thus find that participants’ intention to adopt cover crops is not a reliable predictor for their actual adoption, nor are other predictors that significantly predict intentions, such as use of advisory services, risk preference, and perceived need for climate adaptation. We caution that for these analyses our sample size is relatively low, and therefore we do not claim that our lack of evidence necessarily proves a lack of effect.

Table 6.6. Logistic regression results: predictors of Actual application (including only those who reported an intention to apply).

	(1)			(2)			(3)			(4)			(5)		
	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI
Cover crops knowledge	1.05	0.02	[1.00; 1.09]	1.04	0.02	[0.99; 1.09]	1.04	0.02	[0.99; 1.09]	1.04	0.03	[0.99; 1.10]	1.04	0.03	[0.99; 1.10]
Perceived soil suitability	1.05	0.03	[0.99; 1.11]	1.02	0.03	[0.97; 1.08]	1.03	0.03	[0.97; 1.09]	1.04	0.03	[0.98; 1.11]	1.04	0.03	[0.98; 1.11]
Past use				1.20*	0.07	[1.04; 1.38]	1.22*	0.08	[1.05; 1.41]	1.24**	0.08	[1.06; 1.46]	1.23*	0.08	[1.05; 1.45]
Climate belief							0.96	0.05	[0.87; 1.07]	0.97	0.06	[0.87; 1.08]	0.95	0.06	[0.85; 1.07]
Climate concern							1.00	0.04	[0.92; 1.10]	0.99	0.05	[0.90; 1.08]	0.99	0.05	[0.90; 1.10]
Perceived need for adapt.							1.01	0.03	[0.95; 1.07]	1.02	0.03	[0.95; 1.08]	1.02	0.03	[0.95; 1.08]
Risk preference							0.98	0.03	[0.93; 1.04]	0.98	0.03	[0.92; 1.04]	0.97	0.03	[0.91; 1.04]
Considering peers										1.00	0.03	[0.94; 1.07]	0.99	0.03	[0.93; 1.06]
Using info from peers										1.02	0.02	[0.97; 1.07]	1.03	0.03	[0.98; 1.08]
Using advisors													0.98	0.03	[0.92; 1.04]
Constant	0.81	0.17	[0.58; 1.13]	0.85	0.17	[0.61; 1.17]	1.02	0.27	[0.60; 1.74]	0.86	0.35	[0.43; 1.71]	1.03	0.39	[0.48; 2.24]
Observations	170			166			162			148			144		
AIC	195.72			182.36			184.38			178.47			175.89		

Note: Results from logistic regression models including only participants who held an intention to apply for the cover crops subsidy. * $p < .05$; ** $p < .01$; *** $p < .001$. Dependent variable: Actual application of subsidy for cover crops, a binary variable measured by whether or not an application for the cover crops subsidy was submitted (0 is reference category). "Past use" is the only binary predictor, for which 0 (no past use) is the reference category.

6.4. Discussion

An established literature underlines the importance of variables beyond economic motives for farmers' decisions: psychological variables also influence decisions to adopt sustainable farming practices. Yet this work has predominantly relied on intentions as proxies for behaviour, which is noteworthy as some studies warn that predictors of intentions are not necessarily predictors of actual behaviour. Because policy recommendations to change behaviour are formulated based on studies looking at intentions, it is urgent to quantify the intention-action gap and examine whether predictors of intentions also predict actual behaviour. Our paper is in direct relevance to a recent meta-analysis that highlighted intentions as one of the most important predictors of farmers' adoption of sustainable farming practices (Swart et al., 2023). We present further evidence that there are important differences in the predictors associated with farmers' stated intentions and their actual behaviours, specifically in the context of adopting cover crops as a sustainable farming practice. We examined the size of the intention-action gap, whether predictors of intentions also predict actions, and finally, which predictors could explain whether intentions turn into behaviour. Taken together our approach offers a novel contribution to help overcome limitations to the existing literature which focused primarily on intentions, self-report behaviours, and cross-sectional research designs.

Our results demonstrate a significant prevalence of the intention-action gap and further quantify it in the agricultural context. Whereas 49% of farmers reported intentions to adopt cover crops, only 16% followed through. Predictors of intentions included knowledge and past use of cover crops, perceived need for climate adaptation, being more willing to take risks in

agricultural decisions, and use of advisory services, all of which had a positive relationship with intentions. However, except for past use of cover crops, these predictors of intentions did not predict actual behaviour.

These results offer a critical perspective on which policy recommendations can be derived from studies that only examine farmers intentions, but not actual behaviour. For example, we replicated previous findings demonstrating that predictors including experience, knowledge, stronger perceived need for climate adaptation, and use of advisory services are positively associated with intentions to adopt sustainable agricultural practices (Bakker et al., 2021; Kuehne et al., 2017; Mills et al., 2020; Niles et al., 2016). Policy recommendations to promote the adoption of sustainable practices derived from such findings would recommend for example interventions for capacity building, agricultural advisory services, and peer learning aimed to enhance farmers' knowledge.

However, while such interventions may increase farmers' *intentions*, we have shown in this article that this does not necessarily lead to the actual adoption of sustainable farming practices. This is in line with previous studies that also suggest an intention-action gap among farmers (Floress et al., 2018; Niles et al., 2016; Zhou et al., 2023). In our study only around 1/3 of farmers that reported intentions did in fact adopt the sustainable practice. Moreover, we found that only participants who reported the strongest intentions were more likely to act on them.

Focusing on our findings pertaining to the role of experience, our study offers further indications of how to promote farmers' uptake of sustainable farming practices. We specifically found that more experienced farmers were most likely to translate intentions into behaviours. Interestingly, considering and using information from peers (our measures of social influence) did not significantly predict farmers' intentions to adopt or actual adoption, in line with e.g. Niles et al. (2016) but contrasting with other evidence (Kreft, Angst, et al., 2023; Milliet et al., 2024). It may be that social influence as a driver of agricultural change is limited in this context, that there is a particular structure or configuration of farmer networks that could be more effective, or that the study did not capture the channels through which peer influence operates (Floress et al., 2018; Prokopy et al., 2015). In designing interventions to promote the uptake of sustainable farming practices, policy makers should not only try to increase intentions, but also consider what happens between intentions and behaviours, and how this step can be facilitated (Conner & Norman, 2022; Laffan et al., 2023). Our study shows that stronger intentions to adopt are more likely to translate into behaviour, and that experience with a practice such as cover crops predicts uptake.

These findings would suggest that interventions such as workshops and demonstrations to build farmers' experience could be useful. Experience positively relates to their confidence that they can successfully perform an action and follow up on their intentions, i.e. self-efficacy (Brown et al., 2022; Perry & Davenport, 2020). In fact, several studies suggest that self-efficacy is a key factor in explaining the intention-action gap (e.g., Sniehotta et al., 2005; van Valkengoed et al., 2023) and that self-efficacy is needed to transform intentions into action (Bandura, 2006; Feola et al., 2015; Kreft, Angst, et al., 2023). Interventions to increase farmers'

sense of self-efficacy in implementing the sustainable practice can be promising for reducing the intention-action gap (Gebrehiwot & Van Der Veen, 2015; Niles et al., 2016).

The findings that the strength of intention is important for the relationship between intentions and actions and that experience is associated with a stronger positive relationship between intentions and actions are noteworthy. Whereas few participants overall followed up on their intentions, those with the strongest intentions to apply for the subsidy were significantly more likely to actually apply for it. Theoretically, stronger intentions are assumed to be more stable over time, less susceptible to change when challenged, and to have greater influence of information processing at the cognitive level (Conner & Norman, 2022). In turn, stronger intentions are more reliable predictors of behaviours. In our case, experience emerged as the strongest predictor of behaviour for those who already held high intentions. Past research suggests that experience initially enhances the power of intention to predict action, but as experience grows stronger it weakens the predictive power of intentions via habit formation (Sheeran et al., 2017). We offer further empirical evidence for the role of experience on the intention-action relationship and demonstrate the importance of evaluating the strength of intentions (i.e. not simply as a binary option). To further understand it and develop policy and practitioner recommendations it is necessary to consider the dynamic interplay of intentions and experience, including intention strength.

Critically, we do not mean to argue that studies that have examined intentions are altogether not worthwhile or useful in designing interventions or policies that are aimed at promoting the uptake of sustainable agricultural practices. Rather, we argue that interventions that focus

on variables that are known predictors of farmers' intentions may be relatively inefficient in promoting actual behaviour. Such interventions do not cover the entire decision-making process that culminates in the actual adoption of behaviour, as demonstrated in our study where only the minority of farmers with intentions actually implemented the behaviour.

6.4.1. Limitations and avenues for future studies

A notable strength of our study is combining the use of survey data with an objective behavioural measure collected using a longitudinal approach. Future studies that use longitudinal and experimental methods to close the intention-action gap are imperative for policy design.

We also acknowledge several limitations to our study and additional insights for future research. First, our study focuses specifically on the adoption of cover crops, and whether the predictors of farmers' intentions also predict their actions. The study was framed as a survey on cover crops, and while it explicitly invited participation from farmers with any level of experience with cover crops, there could be selection bias in terms of attracting more interest from those with more experience or interest in the topic (we note, however, that our sample was well representative in terms of observable characteristics and we therefore have minor concerns about this). If this did in fact happen—farmers with more experience self-selected into the study—the uncovered predictive effect of experience with cover crops would be closer to the upper bound and the intention-action gap would likely be even larger. Thus, whereas our study offers supportive evidence of an agricultural intention-action gap and inconsistencies between predictors of intentions and predictors of actions, further studies are

needed to evaluate the exact prevalence and characteristics of the intention-action gap to different agricultural practices and contexts.

While not the core aim of the study, the current analyses could not fully explain when intentions (did not) turn into behaviour. Given that commonly used predictors in the literature did not predict actual behaviour, it may be necessary to consider other types of variables that are not yet examined within the literature. Due to time and monetary constraints and concerns for participant burden we did not conduct a follow-up survey to collect further data, e.g. on economic, environmental, or other factors that influenced their (non-)adoption. Future exploratory studies may therefore be necessary to determine which barriers farmers encounter when they already have a strong intention to adopt a measure, but have not yet turned this intention into action. Qualitative methods may be particularly useful at this stage to determine such barriers, that could relate to e.g. the subsidy application process in terms of administrative hurdles or requirements that hinder application. For example, future studies could randomly select individuals that did and did not adopt the practice and qualitatively examine their motivations and perceptions regarding their behaviour. Such studies should strive to mitigate potential selection bias of farmers that are more interested in or knowledgeable about practices like cover crops or that are more technologically apt. Considering the predictors and consequences of having strong intentions and when they (do not) translate into actions represent enticing areas for research to help inform both policy and practitioner approaches.

We further recognise limitations and weaknesses about our measurements. For one, our behavioural measure, the application for the cover crops subsidy, is not a perfect measure of behaviour. We cannot exclude the possibility that farmers adopted cover crops without applying for the subsidy. For example, they could have forgotten the deadline, not known where to apply, or not wanted to go through the application process (e.g. perceived it as a bureaucratic hurdle). However, given the significant cost of both time and money that farmers must absorb when using cover crops it is unlikely that they would have foregone applying for the subsidy to obtain a refund. We also recognise that the predictors included in our survey are predominantly based on previous surveys used with Norwegian farmers, and that such differences in measurement could also influence the discrepancies we observed from the literature.

Future studies could also specifically address the identified predictors of the intention-action gap to test tailored strategies including application reminders, the communication and framing of policies, other initiatives to overcome bureaucracy, or interventions promoting farmers to collectively sign up for the subsidy. Critically, our results indicate that only the strongest intentions are likely to translate into action, suggesting that interventions based on intentions must shift intentions to the strongest level to influence behaviour.

6.5. Conclusion

Taken together, our findings show that predictors of intentions to adopt sustainable farming practices do not always predict actual behaviour and hold important implications for researchers, policymakers, and practitioners. As intentions may not be predictive of behaviour, our study underlines recent calls to move beyond measures of intention in efforts to promote

behaviour change for climate mitigation and adaptation, and behaviour change in general (Lange et al., 2023; Nielsen, Clayton, et al., 2021). Agricultural climate policies and interventions often rely on individual efforts by farmers, whose collective agricultural practices contribute to climate and environmental change. However, interventions to help farmers implement sustainable practices should not only focus on increasing farmers intentions to do so, but also help them to actually bridge the gap between intentions and behaviours. Supporting this change requires a sound understanding of the factors that motivate farmers to change their practices, and the coordinated and cooperative action required by various stakeholders across sectors and policy domains.

6.6. Author contributions

Andrea Byfuglien: Conceptualization, Methodology, Formal analysis, Investigation, Project administration, Resources, Validation, Visualization, Writing – original draft. **Anne van**

Valkengoed: Conceptualization, Methodology, Validation, Writing – review and editing.

Stefania Innocenti: Conceptualization, Methodology, Supervision, Writing – review and editing.

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7. Chapter 7: Discussion and conclusion

The overall aim of this thesis was to contribute to a more nuanced understanding of the behavioural foundations of sustainable agri-environmental change. The research focused on farmers' adoption of sustainable agricultural practices. In doing so it also sought to contribute further interdisciplinary, policy-relevant insights and methodological advancements for behavioural change in the agri-environmental context. Three research objectives were formulated and addressed in this thesis to meet the overall aim, and each objective was investigated in a separate paper (summarised in Table 7.1).

Table 7.1. Overview of overall thesis objectives.

Thesis Chapter	Paper	Objective
4	1	To examine the role of farmers' relational values in decision-making by investigating how they are shaped by and enacted as a function of a web of actors.
5	2	To evaluate the effects of information provision efforts highlighting calls for mitigation and adaptation on farmers' support for large-scale mitigation policy and adoption of sustainable farming practices.
6	3	To 1) assess the existence of and measure how big farmers' intention-action gap is; 2) test whether predictors of intentions also predict actions; and 3) investigate which predictors can explain whether intentions turn into behaviour.

In this final chapter I consider the findings of the thesis and their implications for this field of research. I first summarise the main contributions of each empirical chapter, then consider their cumulative contributions structured around the research questions to evaluate how the

objectives of the thesis have been met. In the penultimate section of this chapter I consider strengths and weaknesses of the thesis and propose avenues for future research. I then take the opportunity to offer some final considerations of how the interdisciplinary insights from the preceding chapters can help overcome inertia and the intention-action gap to accelerate sustainable behavioural change in the agri-environmental context, thereby concluding the chapter, and thesis.

7.1. Main Findings

Chapter 4 contributes to recent efforts demonstrating that the concept of relational values, which has been proposed to offer more nuanced understandings of the various meanings tied to people's relationships with nature, can also be useful for understanding farm management and agricultural change (Chan et al., 2018; Chapman & Deplazes-Zemp, 2022; Himes & Muraca, 2018; Kreitzman et al., 2022). The results from the semi-structured interviews indicated that farmers hold a set of relational values of significance for their agricultural decisions, and that a web of actors in the agri-food value chain, consisting of for example grocers, consumers, and advisors, interacts with farmers and shapes the opportunities they have for enacting their relational values. The values could be characterised as relational because the respondents focused on non-substitutable relationships with their farmland, nature in a broader sense, and the farming community, that informed their principles and preferences regarding farm management. For example, several farmers shared the significance of working with their land to grow fresh and healthy produce, leveraging their experiences as well as those of farm advisors and other farmers to make decisions and adjustments to their production, that gave them a sense of joy and pride and motivated their farming. The findings

thus support the notion that a relational approach which seeks to explicate how different actors and institutions articulate, prioritise, and enact relational values, and how such insights can lead to points of friction or synergies, can help identify locally salient value articulations and thereby develop policy-relevant insights (Chapman et al., 2019; Eyster et al., 2023; IPBES, 2022).

In Chapter 5 I used a survey-based experiment incorporating video-based interventions with farmers to show that framing a sustainable farming practice, namely cover crops, in terms of offering adaptation benefits can significantly boost farmers' support for agricultural mitigation policy. This suggests that adaptation, which is associated with individual benefits and costs, is not seen as a replacement for mitigation, which instead is associated with collective benefits (but still individual costs). The results also showed that these effects were driven by participants who were already somewhat in favour of the mitigation policy. However, neither of the framings influenced farmers' actual uptake of cover crops in the farming season. Explicitly examining the risk compensation and risk salience hypotheses related to the mitigation-adaptation relationship, these findings offer partial support for a risk salience effect, in that an adaptation frame positively influenced farmers' support for mitigation policy. They offer no evidence for a risk compensation effect, in the case of which the interventions would be expected to reduce subsequent support for mitigation policy (Campbell-Arvai et al., 2017; Carrico et al., 2015; Urban et al., 2021). The chapter underlines the potential for interventions to influence support for climate mitigation policy, but they were not enough to close the gap between intentions and actions or instigate behavioural change.

Finally, Chapter 6 considers the nature and problematic prevalence of the gap between professed intentions and actual behaviour in the context of agricultural change. It draws on the survey data and behavioural data to demonstrate that only one in three participants followed up on their self-reported intentions to adopt cover crops. The analyses revealed that predictors of stated intentions, including past use and knowledge of cover crops, higher perceived need for climate adaptation, and using farm advisors, did not match the predictors of behaviour. Only experience with cover crops reliably predicted actual adoption. Overall, participants' stated intentions were not reliable predictors of behaviour, as only the strongest intentions to adopt had a statistically significant predictive effect on actual adoption. These results underline the need to support farmers in forming strong intentions and experiences, and they question the policy and practitioner insights that can be derived from research designs that predominantly rely on measures of intentions and willingness. When possible, research addressing sustainable behavioural change should strive to include objective measures and collect longitudinal data to examine predictors of actual behaviour and how it changes (or not).

7.2. Cumulative insights

Each empirical chapter addresses the main topic of this thesis—to contribute to a deepened understanding of behavioural aspects of agri-environmental change—from slightly separate angles. In this section I consider the cumulative results of the thesis in light of the broader literature to discuss further insights pertaining to each of the research questions.

7.2.1. RQ 1: How do farmers' relational values inform their experiences, priorities, and farm management decisions? How do other actors in the agri-food value chain interact with the relational values?

The evidence presented in this thesis contributes to recent literature and underlines that approaches to understand farmers' decisions and opportunities for change should consider both internal, individual-level drivers and external, systemic drivers of behaviour. Whereas individual-level drivers are important for change, approaches that place too much emphasis on the individual as the unit of analysis risk ignoring systemic issues that fundamentally shape possible behavioural responses in a given context, including socioeconomic and political conditions (Brown et al., 2021; Castree et al., 2014; Rose et al., 2019; Shove, 2010). A lens that accounts for relational values considers not only individual actors, but also which relations between different actors are conducive to which behaviours (Chan et al., 2016; Eyster et al., 2023). Chapter 4 offers novel empirical evidence showing that whereas farmers are critical actors for sustainable agricultural change, their opportunities for action are bound by a web of other actors. In the context of sustainable agri-environmental change it would therefore be unfair if the responsibilities and costs associated with change fell on individual farmers. Interventions that do target individual farmers to increase uptake of sustainable practices—for which there is also a need—should consider multiple values of farmers' relationships. This includes with agricultural communities and landscapes, values including scenic beauty, heritage, and expressions of ways of life, and how these may be continually unfolding and embedded within a web of other actors (Chapman et al., 2019; Kreitzman et al., 2022). Considering these findings in light of those from Chapter 6, interventions must simultaneously not only focus on increasing farmers' willingness and intentions to change, but consider

predictors of actual behaviour to close the gap between intentions and actions. While not explicitly demonstrated in this thesis, it hints that a relational perspective which embraces the whole of the agricultural system and focuses on relationships could help uncover other relevant drivers of the intention-action gap and respective solutions, such as culturally embedded interventions that inform how and why nature matters to different people, strengthen human-nature relationships, and build sense of community. The findings thus corroborate evidence that advancing sustainable change does not necessarily require a priori environmental values—anyone has the potential to contribute to such change by focusing on particular relationships (Gould et al., 2023; West et al., 2018).

I also consider two other examples from this thesis that demonstrate the utility of integrating relational thinking for advancing understandings of farmers' behaviour. First, this thesis offers evidence that targeted messages can boost farmers' support for agricultural mitigation policy. It is plausible that a relational lens which shifts the focus away from the individual farmer as the unit of analysis can reveal different drivers of behaviour to further inform the development of these interventions. This thesis suggests that such drivers could be anchored in relationships to natural environments, communities, or social networks. Empirical evidence shows that values of care and pride associated with farming can exert strong influence on decision-making, transmission of knowledge, and behaviour (Chapman & Deplazes-Zemp, 2022; Geissberger & Chapman, 2023). In the context of regenerative agriculture in the U.S., farmers' adoption of sustainable farming practices was driven by their desire to achieve positive futures both in terms of economic and environmental outcomes (Frankel-Goldwater et al., 2024). Certain farmers also resist change, for reasons including a desire to maintain individual agency

or economic motivations. This thesis thus offers further evidence to demonstrate that a relational values lens can prompt questions of which relationships are conducive for which values—and subsequent behaviours—rather than considering values as more static properties of particular individuals. It is however important to keep in mind that this does not make it a panacea. Research has shown that values can be slow to change and that attempts to change them often meet resistance (Chan et al., 2020; Gould et al., 2023; Hampton & Whitmarsh, 2023; Nyborg et al., 2016). Drawing also on psychological insights can accelerate the process of change, for example by uncovering and addressing two main dynamics that prevent a rapid transition: individual resistance to change and institutional inertia (Gifford et al., 2018; Gurtner & Moser, 2024). The interdisciplinary approach of the thesis thus enables the insight that targeted messaging informed by relational values and individual priors to ensure alignment with held values could represent a promising leverage point for lasting change in the agricultural context.

Second, a relational values lens can enable deepened understandings of particular contexts. As Chapter 4 of this thesis suggests, accounting for relational values can illuminate how farmers' environmental priorities and concerns could be linked to many kinds of values, including place attachment, stewardship, and livelihoods and traditions (Chan et al., 2016; Chapman et al., 2019), and that these are in part shaped by the actions of other actors. Specifically, the value of "farming with an intergenerational perspective" was frequently articulated as important for farmers' motivations and actions, which is intriguing as it is not one of the most commonly cited values in the relational values literature (Pratson et al., 2023). This may have to do with the cultural context and the long-standing regulatory tradition of the

Odelsrett—passing on farms to the next generation in an improved state—in Norway. The historical backdrop and culture tied to agricultural communities and to the Odelsrett are often accompanied by associations with family pride and livelihoods that have been connected to a specific place for generations (Fuglestad & Palmer, 2019). Thus, one mechanism to leverage in this case for supporting farming communities and encouraging farmers to adopt sustainable practices is the extent to which farmers are able to act in line with their long-term, intergenerational perspectives. Had I not considered relational values I may have missed this context-specific insight.

7.2.2. RQ 2: How does learning about cover crops as a strategy for climate change adaptation and mitigation influence farmers' support for large-scale mitigation policy and adoption of cover crops?

To discuss insights related to the second research question I focus on farmers' heterogeneity, the significance of experience and social influence, and the need to scale up change from individual actions to coordinated, large-scale change at the collective level. Taken together, this thesis demonstrates that farmers are highly diverse, even those growing the same crops in similar regions. For example, it shows important heterogeneous effects related to the risk salience effect that should be considered in interventions that aim to encourage agri-environmental change. These findings corroborate evidence on the relationship between farmers' environmental attitudes and risk preferences and their adoption of mitigation and adaptation strategies (Arbuckle et al., 2013; Jørgensen & Termansen, 2016; Niles et al., 2016). Given that farmers may currently not connect their knowledge of and experience with climate change to their farm management decisions (see for example Jørgensen & Termansen, 2016),

developing a more nuanced understanding of such individual differences and heterogeneous treatment effects could facilitate more targeted and equitable policies and interventions that meet farmers' individual experiences and their needs in navigating transitions.

Notably, more experienced farmers reported stronger support for mitigation policy in the adaptation condition compared to their less experienced counterparts and had higher odds of following up on their intentions to adopt cover crops. The significance of experience for farmers' decision-making aligns with previous literature (Brown et al., 2021; Duinen et al., 2015; Niles et al., 2016) and suggests there is a need to further understand how to strengthen and diffuse experiential learning. For example, that more experienced farmers adopt at higher rates indicates that habitual behaviours are important in the agricultural context—a topic that remains largely underexplored. Habits significantly influence the establishment of new behaviours and continuing the performance of previous ones (Gardner & Rebar, 2019; Verplanken & Orbell, 2022). Moreover, when physical or institutional environments change, the cues that activate habits can be disrupted, providing opportunities to intervene and influence the adoption of new behaviours (Verplanken & Whitmarsh, 2021). These are relevant insights for a sector like agriculture that is targeted for change. Indeed, this thesis underlines that the habits and practices from previous generations are important for farmers' continued management decisions, and that they need to be considered as situated in the wider agricultural system (e.g. Chapter 4).

At the same time, this thesis reveals contrasting results pertaining to the role of social influence. Whereas emphasised in Chapter 4 as critical for exchanging knowledge and

upholding farmers' motivation, the results from Chapters 5 and 6 did not reveal a significant influence of social information or peer effects on participants' policy support, intentions to adopt, or actual adoption of cover crops. These findings align with some studies (see for example Niles et al., 2016), but contrast with others suggesting that it influences farmers' decision-making and encourages adoption of sustainable farming practices (BenYishay & Mobarak, 2019; Dessart et al., 2019; Rust et al., 2020; Skaalsveen et al., 2020). In particular, highly experienced farmers and perceived similarity of conditions have been identified as important for social diffusion. These inconsistencies suggest several possibilities: there could be particularities pertaining to the context of cover crops adoption in Norway, or that a certain level of experience or community cohesion is necessary for social learning which has not been met. Additionally, methodological limitations—such as measurement design, question articulation, or inability to capture the mechanisms or channels through which social influence operates (I discuss this in more detail below)—could contribute to these conflicting results (Foguesatto et al., 2020; Prokopy et al., 2015). Thus, a systematic approach to understand how personal experiences and habits interact with structural change, and how they disperse, could inform how contexts and interventions give rise to, maintain, and disrupt behaviours.

There is a growing recognition of the importance of addressing the complexity of sustainability challenges as characterised by uncertainty, diffuse costs and benefits, long time horizons, and incentives for free-riding, underscoring that a combination of individual and system-level drivers influences any given behaviour (Weber, 2015). Several recent conceptual and analytical frameworks explicitly address the social complexity underlying behavioural phenomena in order to understand how to advance large-scale, collective change (Folke et al., 2021; O'Brien,

2018; Otto et al., 2020; Schill et al., 2019). These frameworks are also useful in the agricultural context where, as this thesis demonstrates, relational values, individual preferences and beliefs, and socioeconomic and structural conditions collectively shape farmers' decisions. Moving forward, this literature could help inform targeted interventions that align with farmers' values and preferences while accounting for interactions with other actors across the agri-food system. Such approaches could foster the adoption of sustainable practices and encourage coordinated support for policies that enable systemic, large-scale change. This represents an enticing area of research which I return to below.

7.2.3. RQ 3: Of what magnitude is the intention-behaviour gap? 2) Are the predictors of intentions also predictors of behaviour? 3) Which predictors explain whether intentions turn into behaviour?

To discuss further insights that pertain to the third question, I focus on the methodological issues addressed and discussed throughout this thesis and their implications. Specifically, a large portion of the literature that seeks to understand behavioural change and propose policy implications has thus far relied on measures of willingness and intentions to adopt sustainable farming practices, often focusing on one or few practices (Swart et al., 2023). This is problematic considering the prevalent gap between intentions and actions across social science literatures (Conner & Norman, 2022; Laffan et al., 2023; Zhou et al., 2023), which has also demonstrated that measures of intentions are not necessarily accurate representations of behaviour (Blake, 1999; Kollmuss & Agyeman, 2002; Moerkerken et al., 2020; Niles et al., 2016). Moreover, the urgent need to advance sustainable agri-environmental change requires a more holistic approach and the widespread adoption of sustainable farming practices

(Gosnell, 2021; Nielsen et al., 2024). While this thesis helps move in this direction, it underlines the need for further collaborative and interdisciplinary approaches to enable the design and evaluation of interventions that account for diverse predictors of behaviour involving psychological, relational, social, and structural and institutional factors.

Both theoretical and methodological advancements are needed to address behavioural and social change processes. As our understanding of these processes become more sophisticated, strengthening interdisciplinary efforts is critical to overcome the intention-action gap and realise change both at the individual and collective levels (Eyster et al., 2022; Graham et al., 2023; Nielsen et al., 2024). Such efforts require not only collaboration but also a deeper understanding of the focus, assumptions, and limitations of other disciplinary approaches. The important thing is not the disciplinary labels, but rather which theories and methods they use to understand human behaviour and the insights they derive (Clayton, 2024). For example, psychological theories often focus on a narrow set of individual cognitive processes, like attitudes and beliefs (e.g. the Theory of Planned Behaviour, TPB) and emotional responses (e.g. Protection Motivation Theory). The TPB which is widely used in environmental decision-making research emphasises behavioural intention as a key variable but tends to omit other critical factors such as habitual, social, economic and other structural constraints (Bagheri et al., 2019; Zhang et al., 2020). In agricultural contexts, extensions of the TPB are often used to account for a wider set of influences on farmers' intentions (see for example Sok et al., 2021; van Dijk et al., 2016). These adaptations illustrate the need to move beyond simplified models and incorporate a wider array of variables to better capture the realities of decision-making. Attempts to understand agricultural decision-making should thus be transparent about the

chosen theoretical framework, focal variables, and measurement approaches. This transparency is vital for validity as well as to ensure comparable data (Foguesatto et al., 2020; Prokopy et al., 2015; Sok et al., 2021).

It can also help enhance interdisciplinary dialogues and foster integration across fields and methodological approaches to illuminate the complexity of sustainability transitions. This thesis demonstrates several complementary insights into agricultural decision-making by combining qualitative and quantitative approaches. For example, the semi-structured interviews (Chapter 4) provided nuanced and in-depth insights into farmers' motivation and lived experiences, highlighting social influence from peers and farm advisors as influential for their farm management. In contrast, they did not emerge as significant predictors of farmers' policy support or adoption of cover crops in the regression analyses (Chapters 5 and 6). Such discrepancies are important to consider from methodological, theoretical, and contextual perspectives. It could be that social influence is more prominent for certain farmers, such as those with larger and more experienced networks (Kreft, Angst, et al., 2023) or for those who more strongly identify with or trust their peers (BenYishay & Mobarak, 2019). Alternatively, it could be that the channels of influence—such as local learning dynamics—were not captured in the survey.

Methodologically, these findings demonstrate that different approaches can offer unique yet complementary perspectives. Qualitative methods enable deeper understandings of farmers' relationships, experiences, and the role of trust and values in their decision-making. Conversely, quantitative methods test the generalisability of findings and identify predictors

across a broader sample. The integration of these approaches, particularly in interdisciplinary settings, provides a more holistic understanding of behavioural processes and highlights potential gaps or limitations in existing methods. As demonstrated, relational approaches, which emphasise systemic perspectives and social and ecological relationships as motivators, can complement more narrow theoretical models, such as those focused on individual cognitive processes.

However, interdisciplinary teams remain inherently more challenging to form in terms of various understandings of methods and concepts, and currently tend to earn less capital than disciplinary work (Gurtner & Moser, 2024; Wullenkord & Hamann, 2021). By embracing different approaches—in doing so leveraging strengths and recognising limitations—truly interdisciplinary projects could help foster the productive dialogues between disciplines that are needed to further advance understandings of human behaviour as well as social change processes (Clayton et al., 2015; Nielsen et al., 2022; Schill et al., 2019; Travers et al., 2021). Such approaches could also help produce insights that are relevant for a broader range of important actors—including policymakers, NGOs, and social movements—and responds to the call for more impact-oriented (psychological) research (Gurtner & Moser, 2024; Nielsen, Cologna, et al., 2021). This thesis moves in this direction and thereby reinforces the need for integrated approaches that consider both individually oriented interventions and systemic interventions (Chater & Loewenstein, 2023).

These insights which the thesis helps bring forward are summarised in Figure 7.1.

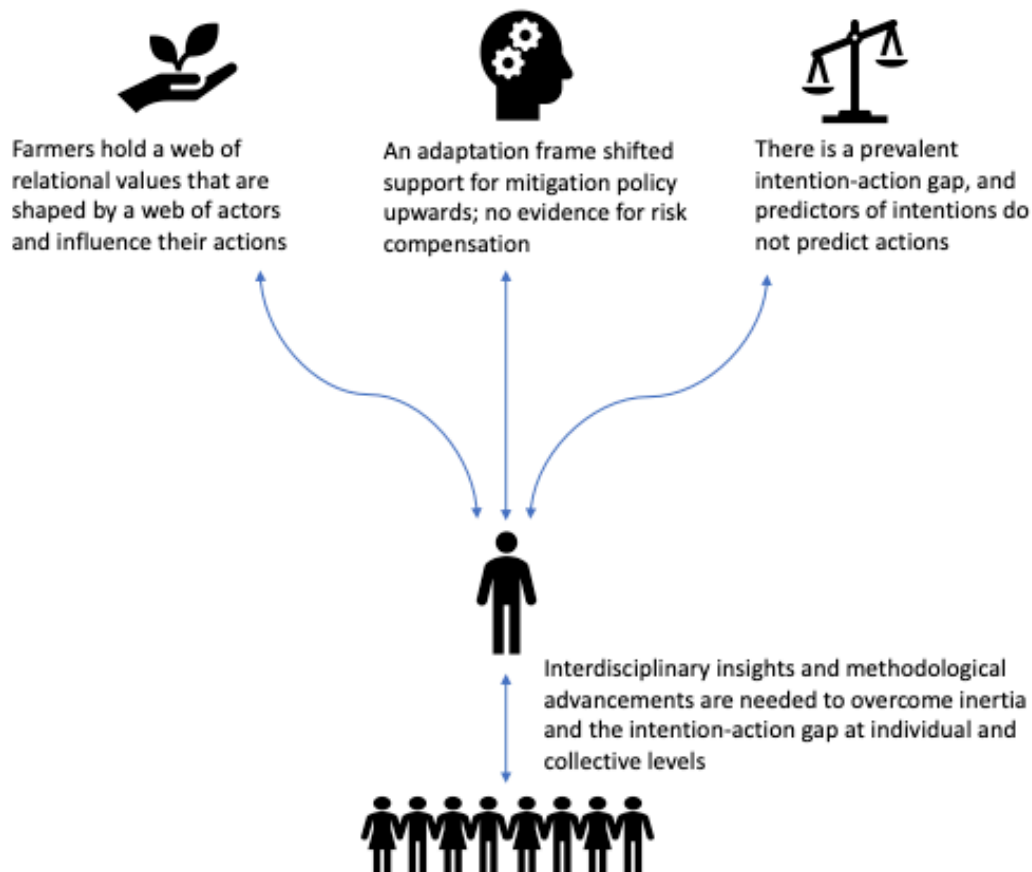


Figure 7.1. Summary of research insights from the thesis.

7.3. Limitations and future avenues

Notable strengths of this thesis include the use of mixed methods and drawing on interdisciplinary insights to better understand the behavioural predictors underpinning farmers' decisions. In doing so it sheds light on the institutional environment that impacts their decisions and actions, considering both individual-level and systemic influences on behaviour. I also invested significant efforts to involve multiple stakeholders, leverage various connections, and combine outreach approaches to sample farmers in sufficient numbers to help answer the research questions in each empirical chapter. I use language relatively free of acronyms and jargon to make them as accessible as possible to readers from various disciplines

and backgrounds. However, there are aspects related to both logistics and my personal abilities that place limitations on this work. Those specific to each paper are discussed in the respective chapter. In what follows I consider four overall limitations that merit discussion, that I also hope can offer insights for next steps in this research area. First, I did not continue the focus on relational values from Chapter 4 in the subsequent chapters. Instead I considered other theoretical and methodological approaches, accounting for different variables at the individual level of decision-making. While it enabled additional insights, e.g. into different predictors for farmers' support for mitigation policy and the intention-action gap, it does not exhaustively explicate the process of agri-environmental change (nor was it expected to). Further studies are needed to explore the plausible effect of other psychological and structural variables, and their interactions.

This brings me to my second point regarding the methodological design adopted in this thesis. While it incorporates a longitudinal approach and combines qualitative and quantitative methods, the results demonstrate the need for additional methodological advancements. As discussed, the semi-structured interviews (Chapter 4) provided nuanced and in-depth insights into farmers' motivation and lived experiences, which contrasted with some aspects of the survey data. Moreover, by including a longitudinal element in the survey and considering an objective measure of behaviour this thesis advanced understandings of how framed information interventions may (or may not) influence farmers' preferences and behaviours, as well as the relationship between their intentions and actions (Chapters 5 and 6). The different methodological approaches, each with their respective strengths and weaknesses, thus offer separate insights and avenues for future research. For example, while the qualitative data in

this thesis represent a snapshot in time, further studies could adopt longitudinal approaches to examine e.g. how variables such as relational values change over time, respond to external shocks like a pandemic or extreme weather events, or interact with other actors. Similarly, beyond collecting behavioural data I did not follow up on the survey. Future studies could conduct a follow-up survey or collect additional qualitative data to examine the process and conditions under which intentions turn into actions. Such contributions could also help clarify the link between individual-level differences and pro-environmental behaviour, offer additional evidence on the role of various predictors in possibly bridging the intention-action gap, and offer recommendations about interventions that are informed by values (Pratson et al., 2023). Mixed-method approaches could be particularly useful in this regard, to yield a more comprehensive understanding of the complex dynamic underlying agricultural decisions.

Third, care is needed when interpreting the results of this thesis and deriving policy implications since they may be specific to the Norwegian context. I focused on a narrow segment of farmers, namely horticultural farmers, who in Norway predominantly farm on small areas (compared to farmers in e.g. the EU or the United States). These farmers self-selected into participation, either by accepting my request for an interview or by responding to the survey. Further insights across contexts are necessary to understand whether the findings from these studies are generalisable. This applies to geographic contexts, i.e. other countries; other farming practices, for example changing tillage practices or fertiliser management; and to other farming types, such as cereals or animal husbandry. Other types of farmers could interact differently with other actors in the agri-food value chain and operate in different markets. Findings from further studies in this area will be valuable to provide a more

complete picture of what supportive and productive institutional contexts for agricultural change look like.

Fourth, and finally, the empirical chapters focus on individual farmers. Through coordinating and collaborating with other farmers, larger agri-environmental objectives could be achieved. While I drew on diverse perspectives incorporating relational values, individual differences, and contextual drivers to further explicate farmers' decision-making and behavioural change, I did not consider farmer collectives as the units of interest or group-level dynamics and interactions, or how they evolve. The literature demonstrates that such interactions can facilitate knowledge sharing and mutual learning (Kreft, Huber, et al., 2023; Milliet et al., 2024; Rizzo et al., 2024), and farmers have strong potential for vicarious learning, in particular those that belong to a sustained inquiry-focused learning community and engage with agricultural researchers (Bandura, 2006; Sewell et al., 2014, 2017). It could thus be useful to consider how group-level collaboration, exchanges of best practices, and knowledge sharing could facilitate mutual benefits and support widespread adoption of sustainable practices. Strengthening collectives could also be useful for bridging the intention-action gap. As discussed in Chapter 6, relying on peer information was associated with stronger intentions to adopt, but not actual adoption of cover crops. However, I could not explicate how information spreads in farmer networks, how they evolve, or exactly if and how this could bridge the intention-action gap, for instance by further enhancing capacity building and knowledge exchange, and/or by fostering stronger intentions. Future work is therefore necessary.

7.4. Understanding behaviour for sustainable agri-environmental change

Given the urgent climatic and environmental challenges facing society in general and agriculture in particular, this thesis suggests that a more nuanced understanding of farmers' behavioural change (or lack thereof)—one that accounts for relationships among people and nature as well as individual preferences and differences—is necessary to move forward. My own relational thinking and academic understanding of agri-environmental change were only emerging when planning the research for this thesis and evolved throughout conducting it. Based on the findings and keeping their limitations in mind, I here offer some final thoughts on the related implications and possible next steps that, I believe, are interesting from an academic perspective, important for policy, and necessary to advance sustainable agri-environmental change in ways that appreciate and empower farmers as co-creators of solutions.

There are several opportunities to operationalise insights from this thesis on the complex interplay of behavioural drivers in the context of agricultural change. First, it would be useful to recognise relationships as important empirical subjects. This entails stronger consideration of what relationships pertain to humans and non-human entities, and how they influence behaviours, both directly and indirectly (Eyster et al., 2023; Klain et al., 2017). Chapter 4 showed that values such as stewardship, pride, and intergenerational considerations help drive farmers' motivations, even though many do not actually generate sufficient income through their farming to support their livelihoods. Research on farmers' decision-making is not new, but it is still rare to see farmers' values, knowledge, and experiences front and centre in national or international agri-environmental policies, let alone climate policies (Rust et al.,

2022). Only in 2023 did the international negotiations on climate change (UNFCCC COP 28) result in an agreement for food and agriculture, signed by 159 parties before the end of the summit⁸. Farmers frequently self-organise around their own values, as well as in response to values articulated by other actors, sometimes to align with them and at other times to contest them (Chapman et al., 2020; Milliet et al., 2024). The findings of this thesis demonstrate that farmers' relational values and their past experiences influence e.g. their decisions to engage in community initiatives and implementing farm-level change. In the face of climate change and food security goals, perhaps the most important task for policy and practitioners moving forward will therefore be to understand how to support and strengthen farmers' values and experiences, and how they diffuse, to encourage adoption of sustainable farming practices. An approach that integrates relational thinking with psychology and social change perspectives seems particularly apt for doing so. It may suggest that it does not necessarily entail setting up further vertically oriented approaches such as agricultural extension services. Instead, focusing on farmers' relationships—particularly those that strengthen experiential learning—could help support farmers in sustainable change (Allen et al., 2018; Soubry et al., 2020).

Policy must also more strongly support research and development. Considering all possible relationships and predictors in full would be impossible and seems counterproductive. The significance of farmers' accumulated experiences, interactions with other actors, and the other knowledge gaps outlined above demonstrate that there is much that still needs to be understood in the context of agri-environmental change, and how relational thinking and value pluralism can reconcile conflicts and improve implementation processes for sustainable

⁸ <https://www.cop28.com/en/food-and-agriculture>

change. Methodological advancements are also needed to improve the detection of effects, their longevity, and to understand discrepancies in results that have important practical implications for interventions (Howe et al., 2021). For example, I have shown that targeted messaging holds potential for boosting farmers' mitigation policy support, and that it needs further empirical attention to be developed. There is currently limited funding for the social sciences, and even more stringent budgets for interdisciplinary research. Structural barriers within and beyond the academic system prevent interdisciplinary work and instead maintain departmental silos and status quo funding schemes. These must be overcome to realise the full potential for the social sciences to address climate change (Gurtner & Moser, 2024; Nielsen et al., 2024).

Finally, I would like to briefly reflect on one point that is more implicit in this thesis but that I hope will be a priority for science and policy going forward, namely farmers' wellbeing and how to strengthen and support it. This thesis has pointed to major systemic obstacles that prevent farmers from following up on their intentions and their enactment of their relational values such as care, joy, and pride, to the point where many express demotivation, frustration, and consider exiting farming. This corroborates evidence from the literature that farmers face increasing pressures from economic, political, and social change resulting in low profits and growing mental health issues including anxiety, depression, and suicidal ideation (Brown et al., 2021; Rose et al., 2023; Wheeler & Lobley, 2022). It is urgent to improve policy and practitioner understandings of the various predictors of farmers' wellbeing while simultaneously considering how sustainable production systems can be encouraged and supported.

Farmers are continuously responding to changing environments, both biophysical and social-institutional. The urgency of adapting agriculture to climate change cannot be overstated, particularly in the context of added stress from political unrest and other shocks such as pandemics. At the same time it is critical to mitigate emissions to prevent further warming, and ensure prosperous livelihoods for farmers as well as efficient food production. To realise sustainable agri-environmental change it will be necessary to consider a broad range of behavioural predictors and to co-develop and evaluate possible interventions with farmers. This thesis moves in this direction, however further efforts are needed that centre farmers and strengthen relationships across the science-policy-practitioner interface.

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Appendix A: Supplementary Information to Chapter 4

Table A.1 provides further example quotes supporting the relational values. The quotes are categorised under one relational value, however several quotes intersect and overlap between the relational value categories.

Table A.1. Example quotes.

Relational value	Example quote
Care	“I learned from my father. He was one of the ones who was out in the field, on his knees, studying the plants, to check how they were doing. Now I am like that too, kneeling, head down in the field to see how they really are doing. Because understanding that, and employing the right tools at the right time, is critical for the crop, the soil, and for the environment.” A3A
	“We wouldn’t have been doing this [farming] if we didn’t care about the environment. We have a circular view on everything, packaging and the like, and we try to have minimal impact on nature concerning the production we do. [This consideration] is always there.” C3
	“A main challenge is that [farmers] are governed by the grocers, [farmers] are so dependent on the production plans they are offered. Grocers are not concerned about crop rotations, or the agronomic conditions. We see several crop diseases becoming more prevalent, many of which can be prevented with crop rotations. But farmers remain locked in [...] and there is little willpower by grocers to listen to the experiences of farmers.” Advisor 3
	“[In this area] there is a lot of competition to access soil [...], I feel that is one of the largest challenges for us. It is to the extent where people are not afraid to go out of their way to obtain something at the expense of others.” B4
Respect	“To work together and build each other stronger is essential for a good production here. [...] There are guidelines for production plans, the distribution of quotas and so on, and you have to respect these and cannot for example take the quotas from one producer [in one part of the country] and move it [to this part], there should be predictability for everyone.” C5
	“The main ambition is to make money to make the factory go around. [...] For main concerns, it is definitely the

	<p>economic aspect – we have to make a living. In our sector, even though costs are going up for everyone, we can't just raise prices of what we produce. When you open the newspaper and read about increasing food prices, that is not going to us." A1</p> <p>"It is about being in front and handling [challenges that arise]. Developing in knowledge and size. If you invest in better equipment than your neighbour you can make a better offer [to the grocer]. Because it will be a competition with him." A1</p>
Joy and pride	<p>"I calculated the amount we produce here, and there is of course something to it, pride in what we produce, it equals what [municipality] eats in a year—we supply our community with what we produce. And we are the only ones around here doing this [...]. There is nothing like walking in a [crop] field in spring, and watch [crop] mature once you remove the covering, it is beautiful, that is actually what is behind everything we do, you feel like you are doing an important job and that the landscape looks nice, that you are doing a good job." C6</p> <p>"It is fun to watch [crops] grow, getting response on what you are doing, caring for the plants, that is fun. It is also fun to try out new crops, to learn something new, and maybe that will also bring economic benefits, to develop in that sense." B5B</p> <p>"As a producer you really lack agency, you knock on the grocers' doors, and they are completely free to say 'we don't want this,' 'this quality is too poor,' 'we don't need that.' Which is wrong [of them]. We offer prime produce. It is true that some of it is not optimal all the time, some years, due to weather for example, there will be lots of small onions. Then, grocers should be on our side and help with marketing, like 'this fall we have delicious small onions on sale' and things like that." A4</p> <p>"In the grocery store, I see that people pick [crops] presented in one way more than the other, when the other is half the price, because of the way they are presented. And I stand there as a [crop] farmer and know that they grew right next to one another, they come from the same field, from the same efforts. The stores can really sell whatever." C3</p>
Cooperation	<p>"To succeed in your production you have to understand the plant, and what it needs. [...] It is almost strange to say out loud but to place yourself in the position of the plant, to understand what it needs, to work together, I think is very exciting." C4</p>

	<p>“The goal is not necessarily to grow in size, because that would be at the extent of other farmers, but to work with and make the most out of the land and conditions you have... you know, if farms grow too much, that will only increase risks for everyone, economic and climatic. A more robust system has more legs to stand on.” A7</p>
	<p>"If you are not part of the social milieu, you must have a great inner drive to do this. Like this year, for example, it's been a special year, a maximum amount of weeds and a lot of rainfall, poor yields... If nothing else, you might blow out frustration, then maybe someone pats your back and says they're experiencing the same. It may not be that much of consolation, but someone who is in it with you. So the social environment must be highlighted. [...] We help lift each other up." A3A</p>
	<p>“Farmers [in this area] work together and stand up for one another, we have a common understanding that we need to be united, and we get incredible help from the advisory service. One of them, [specific advisor] arranges meetings so we can discuss across delivery points, like if there is a challenge with a specific crop, or during Covid when expenses skyrocketed and we really had to form a united front to demand higher prices, this helped us all agree that we would demand a pre-set price or not sell [produce] at all.” C5</p>
	<p>“[In this area] there is a lot of competition to access land [...], I feel that is one of the largest challenges for us. It has gotten to the extent where people are not afraid to go out of their way to obtain something at the expense of others.” B4</p>
	<p>“Community in agriculture is more important than many are aware of, that we can discuss challenges with other farmers is extremely important. [...] Everything we work with is alive. The experiences of one farmer are different from the experiences of another, and all [our experiences] can be discussed and shared between colleagues.” C2</p>
	<p>”To us [producers] it seems like we have to obey any instruction so that the grocer wants to buy our produce, while they can do whatever they want and without a second thought go to the next producer or even choose imported produce. It is hard to think that they have a morality to buy Norwegian produce and support Norwegian agriculture, money is what matters the most to them and as long as they are free to do whatever they want that’s what is going to happen. It is like we are now reduced to a number in an algorithm and they can do</p>

	whatever [and freely choose] import over Norwegian produce.” C3
Intergenerational thinking	“To produce something, knowing that all your efforts result in produce that you can sell, and knowing that in this area people eat what you managed to cultivate yourself, that is valuable. We also have two small children, and it is very nice to have them stumbling around our feet and to offer them that upbringing and perspective on life, that is a key part of my motivation.” C3.
	“We work all the time to improve what we are doing, to maintain the resources we have, and the land. This is about short-term goals of a plentiful yield this year, but also for ensuring that will be possible in five years and in ten, and for the next generation.” A7
	“I’m not worried about my farming or economy, but that’s because I’m in the situation I’m in. But it is clear that for a younger farmer there will be other challenges, such as access to labour, how [grocer] acts in relation to the desire for Norwegian production versus imports, and costs, which are different for someone who is just starting out compared to someone who has been established for many years.” B2
	“I think I live in the most amazing place in the world, subjectively of course, and I really want to make sure that this place is even nicer and that the next generation will take over. I think not just of nice buildings, but also that the land is taken care of. [...] I have to admit that it would be great, but if it's like now, I'm not sure I'd recommend my son take over [the farm business].” A5

Appendix B: Supplementary Information to Chapter 5

B.1 Dependent measures and descriptive statistics

In addition to our main outcome variable, Policy Support, and our secondary outcome variable, Adoption, we also measured participants' stated intentions to apply for the cover crops subsidy in the 2023 growing season on a 7-point Likert scale (Intention to Apply). The exact wording for the dependent measures in our study and their descriptive statistics are provided in Table B.1.

Table B.1. Dependent measures and descriptive statistics.

Variable name	Definition	Description	Mean	SD
Application	Binary = 1 if applied for subsidy	Post-intervention decision to adopt cover crops in the 2023 growing season as measured by applying for subsidy	0.16	
Policy support	7-point Likert scale	The Agricultural Climate Plan is a followup to the memorandum of understanding on climate targets between the Farmers' Union, the Smallholders' Association and the government signed in 2019 to reduce greenhouse gas emissions from agriculture by 5 million tonnes of CO ₂ equivalents in the period 2021-2030. To what extent do you support the agreement?	4.73	1.43
Intention to apply	Binary = 1 if 5 or higher on 7-point Likert scale	How likely are you to apply for a subsidy to establish cover crops in 2023?	4.18	1.95

B.2 Survey structure

Figure B.1 illustrates the survey structure.

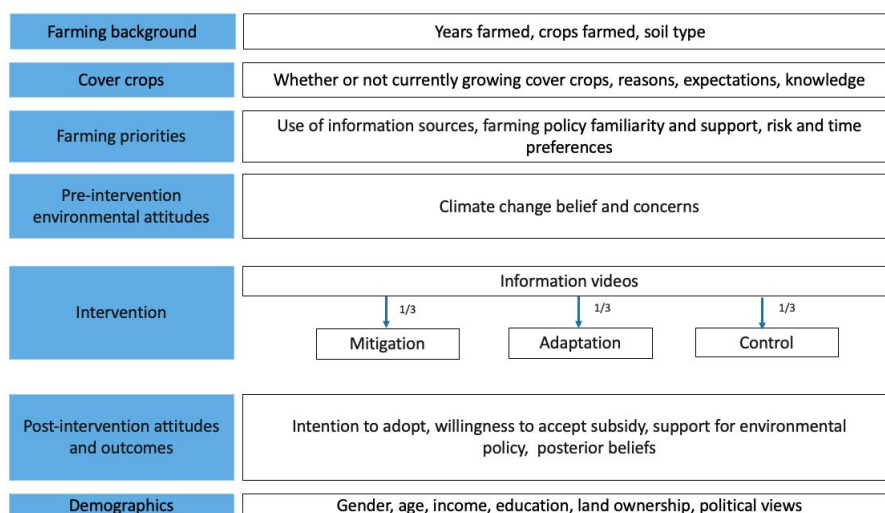


Figure B.1. Survey structure.

B.3 Sample characteristics and baseline measures

Table B.2 shows a comparison of key characteristics of the population of farmers in Norway (surveyed via the National Bureau of Statistics, SSB, 2024) and the sample in this study.

Table B.2. Population statistics and sample characteristics.

Variable	Population (SSB)	Sample (current survey)
Age	55.9	53.2
Gender	82.7% male	82.4% male
Area farmed (mean)	262 daa	395 -- median=246 daa
Farm Income	NOK 275 100 (average)	NOK 300k-399k (median)

Baseline attitudes and beliefs

Regarding participants' pre-intervention support for the Agricultural Intention Agreement to reduce greenhouse gas emissions, our baseline measure of mitigation policy support measured on a 7-point Likert scale, the sample was on average in favour of the plan ($M = 4.64$, $SD = 1.37$) with no significant difference across conditions ($F(2, 355) = 1.97$, $p = .14$). We observed substantial differences across individual level characteristics (Figure B.2). Notably, support was higher among females, those who were concerned about climate change, held a university degree, oriented to the political left, and for those who were risk seeking and more future oriented.

Prior to being exposed to the video interventions we also asked about respondents' knowledge about cover crops and their perceived suitability of their soils for growing them. Results indicated that 71% ($n = 327$) of participants currently did not use cover crops, but 94% considered their soils to be suitable (Figure B.3). Moreover, most participants (70%) declared at least some level of knowledge of cover crops (Figure B.4).

Figure B.2 displays the pre-intervention support for the national agricultural mitigation policy by demographics.

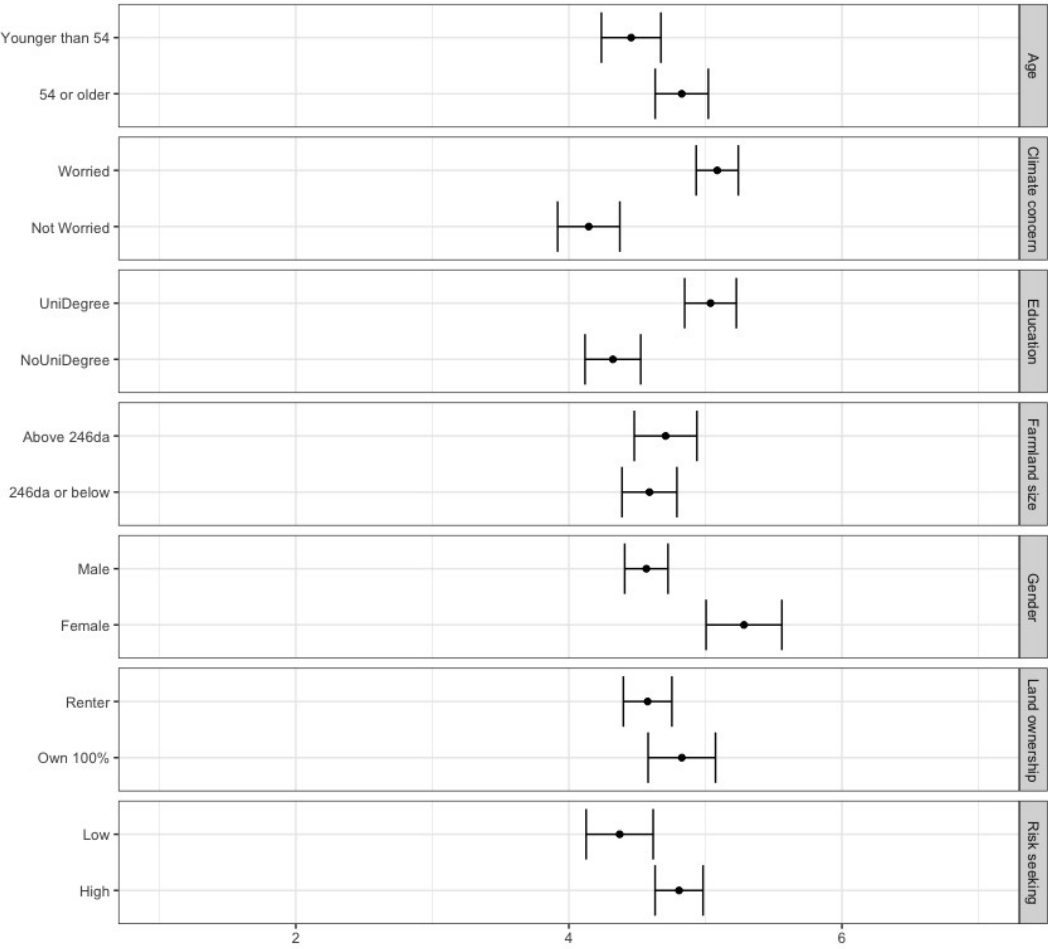


Figure B.2. Baseline policy support. The points indicate mean scores and bars represent 95% CI. The outcome variable indicates support for the agricultural Mitigation Intention Agreement measured before the experimental intervention on a 7-point Likert scale. The predictors are coded as binary variables where the right-hand panel indicates the specific variable for each panel and the left-hand legend denotes the dummy-coded level of the variable.

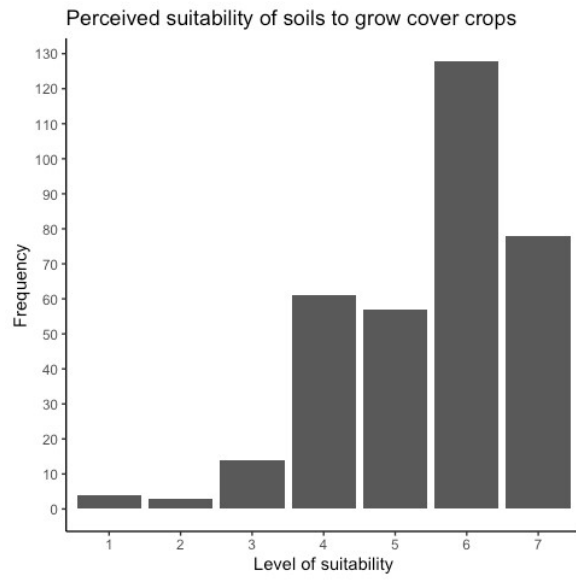


Figure B.3. Participants' perceived suitability of their soils to cover crops (n = 345).

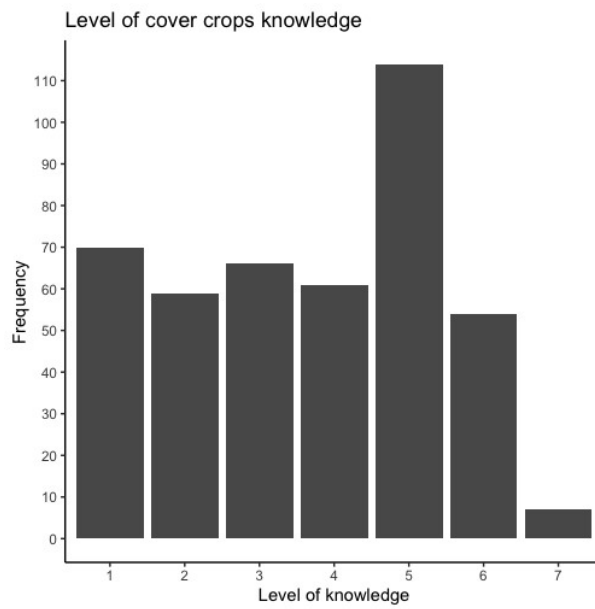


Figure B.4. Participants' level of knowledge of cover crops (n = 431).

B.4 Robustness check of main analyses (Policy Support)

Table B.3 shows the effect of the experimental intervention on Policy Support measured as a binary variable, using OLS models. We observe similar effects as in the results reported in the main section of the paper. Notably, we also observe an effect of the Adaptation condition when excluding strong prior supporters as shown in column 3 (those who scored 6 or 7 on the 7-point Likert scale).

Table B.3. Support for agricultural mitigation policy measured as a binary variable.

	Dependent variable: Policy support (binary)		
	(1)	(2)	(3)
Mitigation	0.54 (0.27)	0.64* (0.29)	0.54 (0.29)
Adaptation	0.91** (0.28)	1.05*** (0.30)	0.70* (0.31)
Observations	369	272	342
Excl. strong prior opposers		Yes	
Excl, strong prior supporters			Yes
AIC	471.03	375.30	409.65

Note: * $p < .05$; ** $p < .01$; *** $p < .001$. DV is support for mitigation policy measured as a binary variable (coded as 1 if scoring 5 or above on the 7-point Likert scale). Column 1 shows the full sample. Robust standard errors in parentheses.

B.5 Moderation analyses

B.5.1 Climate concern, risk preference, and farming-specific risk preference

To further examine how the effects of our interventions may have been moderated by pre-intervention climate concern and risk preferences we partitioned the sample into individuals with high (scoring 5 or above on the 7-point Likert scale) and low (scoring 4 or below) levels of the relevant variable. Regression results of the LMs are reported in Tables B.4 and B.5. They show that individuals with high concern for climate change show significantly higher levels of policy support in both the Mitigation and the Adaptation treatment condition, and that participants who are risk seeking show significantly higher levels of policy support in the Adaptation condition. Table B.5 reports moderation analyses by age (columns 2 and 3); size of farm, whether it is larger than 246 ha (column 3) or equal to or smaller (column 4); education level of the farmer (columns 5 and 6); land ownership, whether land is owned (column 7) or rented (column 8); and income level (columns 9 and 10). Overall, the Adaptation condition increased mitigation policy support for participants that are older, farm on larger areas, hold a university degree, rent land, and that have higher incomes. Notably, the Mitigation condition exerts stronger effects among those with a university degree and who rent land. We did not find any evidence to suggest the interventions caused lower support for mitigation policy compared to the control condition or baseline levels of policy support.

Table B.4. Policy support: Moderation effect by climate concern and risk preferences.

	Full sample	High concern	Low concern	Risk seeking	Risk averse	Risk seeking in farming	Risk averse in farming
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mitigation	0.33 (0.18)	0.48* (0.19)	-0.01 (0.28)	0.37 (0.21)	0.23 (0.31)	0.33 (0.19)	0.39 (0.37)
Adaptation	0.44* (0.18)	0.50* (0.21)	0.08 (0.30)	0.54* (0.21)	0.26 (0.35)	0.43* (0.20)	0.42 (0.38)
Observations	369	206	163	232	132	260	106
R ²	0.02	0.04	0.00	0.03	0.01	0.02	0.02
Adjusted R ²	0.01	0.03	-0.01	0.02	-0.01	0.01	-0.00

Note: * $p < .05$; ** $p < .01$; *** $p < .001$. Robust standard errors in parentheses. DV is mitigation policy support measured on a 7-point Likert scale. Column 1 shows the full sample. Columns 2 and 3 pertain to participants with high and low concern for climate change, respectively, and columns 4 and 5 to those who are risk seeking and risk averse, respectively. Column 6 shows individual who are risk seeking in their farm-specific activities and column 7 shows participants who are risk averse.

Table B.5. Additional moderation effects on support for mitigation policy.

	Age (<54) (1)	Age (>=54) (2)	Area (>246) (3)	Area (<=246) (4)	No uni degree (5)	Uni degree (6)	Land owner (7)	Land renter (8)	Income (>=500k) (9)	Income (<500k) (10)
Mitigation	0.41 (0.27)	0.24 (0.25)	0.44* (0.26)	0.14 (0.29)	0.29 (0.25)	0.50** (0.24)	0.06 (0.31)	0.45** (0.23)	0.46 (0.28)	0.33 (0.30)
Adaptation	0.39 (0.27)	0.52** (0.25)	0.53** (0.25)	0.45 (0.31)	0.37 (0.26)	0.58** (0.24)	0.21 (0.33)	0.56** (0.22)	0.67** (0.29)	0.41 (0.30)
Constant	4.32*** (0.19)	4.60*** (0.19)	4.32*** (0.18)	4.60*** (0.22)	4.14*** (0.18)	4.82*** (0.17)	4.79*** (0.23)	4.32*** (0.16)	4.23*** (0.20)	4.53*** (0.22)
Num. obs.	172	188	174	157	199	166	117	248	158	152
AIC	624.75	658.87	613.72	572.55	716.27	550.66	410.42	893.04	575.36	559.98

Note: * $p < .05$; ** $p < .01$; *** $p < .001$. Results from the linear regression analysis with the dependent variable as mitigation policy support (measured on a 7-point Likert scale). Robust standard errors in parentheses.

B.6 Mediation analyses

To understand the underlying mechanisms through which the Adaptation and Mitigation treatments impacted policy support we conducted mediation analyses to explore how the interventions may have worked through farmers' concern for local climate change, i.e. regional impacts of climate change, and the extent to which they prioritise making profits from their farm business (both measured on a 7-point Likert scale following the intervention). Results (Table B.6) show that the effect of the Adaptation condition on Policy Support was in part driven by an increase in concern for local climate change. We observed no significant effect of the measure on profit priority.

Table B.6. Mediation analyses.

	Concern for local climate change impacts	Prioritising making profits from farming
	(1)	(2)
Mitigation	0.29 (0.21)	-0.01 (0.15)
Adaptation	0.41* (0.21)	-0.17 (0.15)
Constant	4.27*** (0.14)	5.43*** (0.11)
Observations	395	391
R ²	0.01	0.004
Adjusted R ²	0.01	-0.001

Note: Note: * $p < .05$; ** $p < .01$; *** $p < .001$. Column labels indicate the dependent variable in each column, measured on a 7-point Likert scale. Robust standard errors in parentheses.

B.7 Application for subsidy

We further examine the impact of our treatments and control variables on the adoption of cover crops, measured as a binary variable (coded as 1 if an application for the cover crops subsidy was submitted, 0 otherwise) using GLMs (Table B.7). For interpretation we focus on odds ratios (OR) and 95% confidence intervals. The stepwise regressions revealed no significant effects of the treatment on farmers' adoption of cover crops. We observed that having previously grown cover crops was a significant predictor of adoption.

Table B.7. Regression analysis on Adoption of cover crops (OR and 95% CI).

	(1)	(2)	(3)	(4)
Mitigation	1.11 [0.62; 1.95]	1.30 [0.67; 2.55]	1.27 [0.64; 2.52]	1.68 [0.79; 3.67]
Adaptation	1.02 [0.56; 1.80]	1.27 [0.64; 2.52]	1.25 [0.62; 2.52]	1.55 [0.71; 3.47]
Cover crops knowledge		0.14 [0.95; 1.38]	1.16 [0.96; 1.40]	1.10 [0.89; 1.38]
Previously growing (No)		3.33* [1.84; 6.11]	3.27* [1.75; 6.19]	4.05* [2.00; 8.38]
Climate concern			0.86 [0.66; 1.11]	0.77 [0.56; 1.04]
Risk preference			0.92 [0.74; 1.15]	0.85 [0.67; 1.10]
Policy support (pre)				1.20 [0.93; 1.56]
Observations	513	431	412	351
Log Likelihood	-223.68	-168.90	-164.85	-138.84
AIC	453.36	347.79	343.71	293.67

Note: * p -value outside the 95% CI. DV is Application for the cover crops subsidy.

B.8 Links to video interventions and script in English

Mitigation video: <https://vimeo.com/795273096>

Adaptation video: <https://vimeo.com/795622521>

B.9 Comparison of video scripts

Below we present a transcription of the video interventions with the main differences highlighted in yellow.

Mitigation	Adaptation
<p>An increasing population and climate change add pressure to natural resources. In the future agriculture will face increasing challenges due to extreme weather, drought, and precipitation.</p>	<p>An increasing population and climate change add pressure to natural resources. In the future agriculture will face increasing challenges due to extreme weather, drought, and precipitation.</p>
<p>Norwegian agriculture contributes to jobs, value creation, and food sovereignty and security. But, it is a source of the greenhouse gas emissions which drive climate change.</p>	<p>Norwegian agriculture contributes to jobs, value creation, and food sovereignty and security. But, it is vulnerable to the consequences of climate change.</p>
<p>Cover crops can help society mitigate emissions and prevent dangerous levels of climate change.</p>	<p>Cover crops can help the farm adapt to these changing growing conditions with their numerous benefits.</p>
<p>Cover crops are planted to keep soil covered after the main crop is harvested. They can remove carbon via photosynthesis, and have deep roots which can remove additional carbon by binding it into the soil. If adopted by many farmers, cover crops provide social benefits reducing greenhouse gas emissions by 74 000 tons CO2 equivalent by 2030.</p>	<p>Cover crops are planted to keep soil covered after the main crop is harvested. They have deep roots which can bind nutrients and organic matter in soils, improve soil structure, and prevent erosion. This provides local benefits to the farm making its soil more productive and resilient to climate change.</p>
<p>Despite the benefits that cover crops bring, many farmers face limited time and an economic barriers in using them on their farm. Therefore, there is a public subsidy to help farmers to</p>	<p>Despite the benefits that cover crops bring, many farmers face limited time and an economic barriers in using them on their farm. Therefore, there is a public subsidy to help farmers grow cover crops, adapt to climate change,</p>

<p>grow cover crops, mitigate climate change, and generate societal benefits. Because, cutting emissions for the community happen with collective action.</p>	<p>and make their own farm more resilient.</p> <p>Adapt your farm to climate change, using cover crops.</p>
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Appendix C: Supplementary Information to Chapter 6

Sample characteristics

Table C.1 shows an overview and comparison of key characteristics of the population of farmers in Norway (surveyed via the National Bureau of Statistics, SSB, 2024) and the sample in this study.

Table C.1. Overview of key sample characteristics and population characteristics.

Variable	Population (SSB)	Sample (current survey)
Age	55.9	53.2
Gender	82.7% male	82.4% male
Area farmed	M=262 daa	M=395 /median=246 daa
Farm Income	NOK 275 100	NOK 300k-399k (median)

Further statistical analyses of predictors of intentions and actions

We performed additional checks of our regression models to ascertain that missing values did not bias our results or interpretation thereof, and the inclusion of additional control variables. Table C.2 reports results of our main regression models of Intention to apply for the cover crops subsidy including additional demographic control variables to check for consistent effects, and Table C.3 reports on Actual application for the subsidy. We note that the results are largely similar as those reported in the main results section.

Table C.2. Intention to apply for the cover crops subsidy, including demographic controls (linear).

	(1)			(2)			(3)			(4)			(5)			(6)		
	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>b</i>	<i>SE</i>	<i>CI</i>
Cover crops knowledge	0.25***	0.07	[0.11, 0.40]	0.16*	0.07	[0.02, 0.30]	0.15*	0.07	[0.01, 0.29]	0.18*	0.07	[0.03, 0.32]	0.16*	0.07	[0.01, 0.30]	0.22**	0.08	[0.06, 0.38]
Perceived soil suitability	0.23**	0.09	[0.06, 0.40]	0.08	0.08	[-0.09, 0.25]	0.06	0.08	[-0.11, 0.22]	0.06	0.09	[-0.12, 0.23]	0.10	0.09	[-0.07, 0.28]	0.07	0.10	[-0.11, 0.26]
Past use				1.39***	0.22	[0.96, 1.83]	1.31***	0.22	[0.88, 1.74]	1.35***	0.23	[0.90, 1.80]	1.41***	0.23	[0.97, 1.85]	1.39***	0.24	[0.91, 1.87]
Climate belief							-0.26	0.15	[-0.56, 0.03]	-0.35*	0.16	[-0.67, -0.04]	-0.27	0.16	[-0.58, 0.04]	-0.31	0.17	[-0.64, 0.03]
Climate concern							-0.01	0.13	[-0.26, 0.24]	0.06	0.14	[-0.22, 0.34]	-0.005	0.14	[-0.28, 0.27]	0.06	0.16	[-0.25, 0.36]
Perceived need for adaptation							0.32***	0.09	[0.14, 0.51]	0.27**	0.10	[0.07, 0.47]	0.24*	0.10	[0.04, 0.44]	0.29**	0.11	[0.07, 0.50]
Risk preference							0.17*	0.08	[0.02, 0.33]	0.17*	0.09	[0.005, 0.34]	0.20*	0.08	[0.04, 0.37]	0.23*	0.09	[0.04, 0.41]
Considering peers										0.12	0.10	[-0.07, 0.31]	0.13	0.09	[-0.05, 0.31]	0.06	0.10	[-0.15, 0.27]
Using information from peers										0.08	0.07	[-0.07, 0.22]	0.003	0.07	[-0.14, 0.15]	0.09	0.08	[-0.06, 0.25]
Using advisors													0.27***	0.08	[0.12, 0.42]	0.19*	0.08	[0.03, 0.35]
Age																-0.02*	0.01	[-0.04, -0.002]
Education																-0.09	0.24	[-0.57, 0.38]
Income																-0.30	0.23	[-0.76, 0.16]
Constant	2.16***	0.49	[1.19, 3.13]	2.75***	0.47	[1.82, 3.68]	1.62*	0.70	[0.24, 3.00]	0.93	0.88	[-0.80, 2.66]	-0.43	0.93	[-2.25, 1.39]	0.76	1.14	[-1.46, 2.99]
Observations		304			294			286			260			252			214	
R ²		0.08			0.20			0.25			0.26			0.31			0.35	
Adjusted R ²		0.08			0.19			0.23			0.23			0.29			0.31	

Note: Results from the linear regression on participants' intention to adopt including demographic controls. * $p < .05$; ** $p < .01$; *** $p < .001$. The dependent variable Intention to apply for the cover crops subsidy, measured on a 7-point Likert scale. Past use is a binary predictor, for which 0 (no past use) is the reference category. Education is a binary predictor signifying holding higher education or not, for which no higher education is the reference category. Income is a binary predictor signifying household income, for which under 499k is the reference category.

Table C.3. Application for the cover crops subsidy, including demographic controls (logistic).

	(1)			(2)			(3)			(4)			(5)			(6)			(7)		
	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI	OR	SE	CI
Cover crops knowledge	1.42 **	0.12	[1.13; 1.81]	1.36 *	0.13	[1.06; 1.77]	1.34 *	0.14	[1.03; 1.77]	1.43 *	0.14	[1.09; 1.92]	1.40 *	0.14	[1.07; 1.88]	1.32	0.15	[1.00; 1.78]	1.46*	0.18	[1.04; 2.13]
Perceived soil suitability	1.14	0.14	[0.88; 1.52]	0.98	0.15	[0.73; 1.34]	0.99	0.16	[0.73; 1.36]	1.04	0.17	[0.76; 1.47]	1.06	0.17	[0.76; 1.50]	1.03	0.18	[0.73; 1.47]	0.90	0.19	[0.62; 1.34]
Past use				4.09 ***	0.39	[1.96; 9.10]	3.70 **	0.40	[1.74; 8.37]	3.93 **	0.41	[1.82; 9.04]	4.12 **	0.41	[1.89; 9.59]	2.57 *	0.45	[1.08; 6.36]	3.32*	0.51	[1.24; 9.39]
Climate belief							0.93	0.25	[0.57; 1.53]	0.85	0.26	[0.50; 1.42]	0.83	0.27	[0.49; 1.40]	0.92	0.28	[0.53; 1.59]	0.89	0.31	[0.48; 1.64]
Climate concern							1.01	0.21	[0.68; 1.53]	0.97	0.23	[0.62; 1.54]	0.97	0.23	[0.61; 1.55]	0.95	0.24	[0.59; 1.54]	0.95	0.27	[0.55; 1.64]
Perceived need for adaptation							1.04	0.15	[0.78; 1.42]	1.08	0.16	[0.79; 1.51]	1.09	0.17	[0.79; 1.53]	1.02	0.17	[0.73; 1.44]	0.87	0.20	[0.59; 1.30]
Risk preference							0.98	0.14	[0.74; 1.30]	1.01	0.15	[0.75; 1.38]	0.99	0.15	[0.74; 1.36]	0.91	0.16	[0.66; 1.25]	1.01	0.20	[0.69; 1.52]
Considering peers										0.99	0.16	[0.72; 1.35]	0.98	0.16	[0.72; 1.34]	0.93	0.16	[0.68; 1.29]	1.10	0.20	[0.74; 1.65]
Using information from peers										1.20	0.12	[0.95; 1.54]	1.22	0.13	[0.95; 1.59]	1.23	0.13	[0.95; 1.62]	1.17	0.16	[0.86; 1.63]
Using advisors													0.94	0.13	[0.72; 1.22]	0.86	0.14	[0.65; 1.14]	0.80	0.17	[0.57; 1.11]
Age																			1.03	0.02	[0.99; 1.08]
Education																			1.85	0.47	[0.75; 4.75]
Income																			0.53	0.47	[0.21; 1.31]
Intention to apply																1.45 *	0.14	[1.13; 1.92]	1.43*	0.15	[1.07; 1.98]
Constant	0.02 *	0.83	[0.00; 0.09]	0.02 *	0.88	[0.00; 0.12]	0.03 *	1.26	[0.00; 0.33]	0.01 *	1.60	[0.00; 0.22]	0.02 *	1.73	[0.00; 0.47]	0.02 *	1.81	[0.00; 0.50]	0.00	2.28	[0.00; 0.26]
Observations		328			318			291			263			254			252			214	
AIC		278.42			249.89			246.82			232.54			228.23			220.79			183.29	

Note: Results from logistic regression models on Application for the cover crops subsidy including demographic controls. * $p < .05$; ** $p < .01$; *** $p < .001$. The dependent variable is the Actual application for the subsidy, a binary measure (0 if did not apply). Past use is a binary predictor, for which 0 (no past use) is the reference category. Education is a binary predictor for which no higher education is the reference category. Income is a binary predictor signifying household income for which under 499k is the reference category.

Visuals of the strength of intention' effect on actual application

Figure C.1 shows an alternative visualisation of the intention strength effect, indicating that those who hold the strongest level of intention (i.e. 7 (“very high”) on the 7-point Likert scale) have a higher probability of following up on their intention and actually applying for the cover crops subsidy.

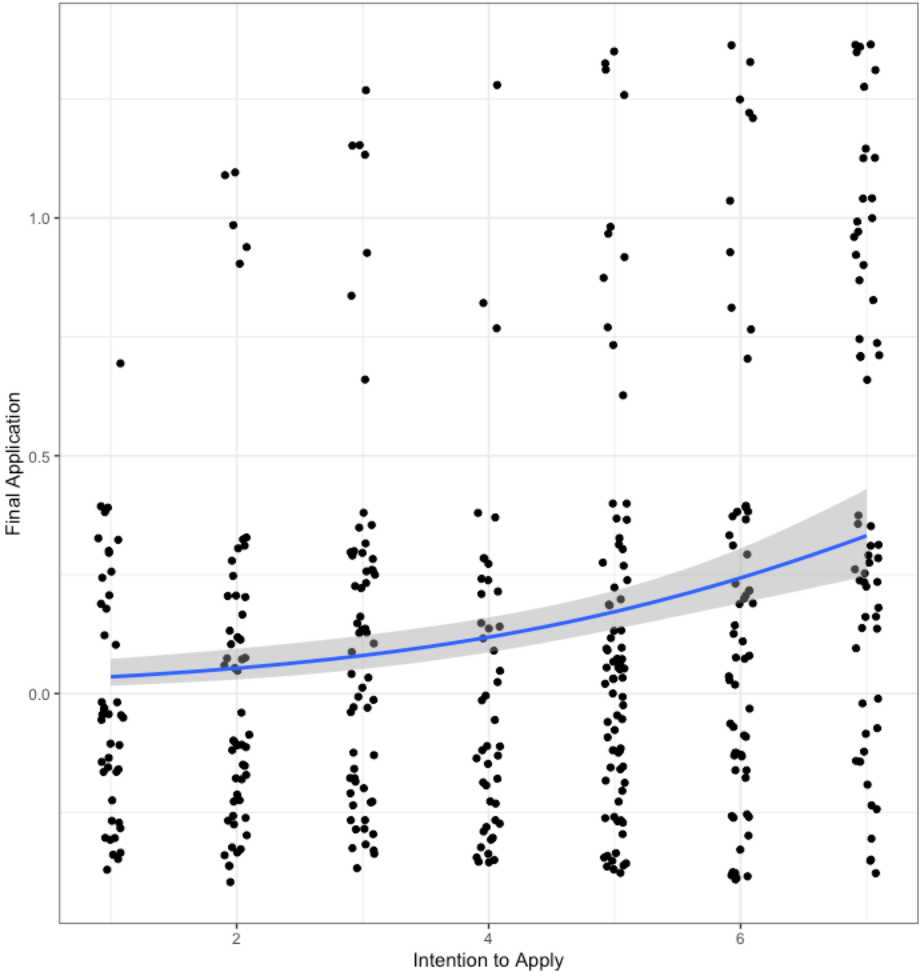


Figure C.1. Probability of applying for cover crops subsidy based on participants' intention to apply as measured on the 7-point Likert scale.

Figure C.2 shows the raw counts of participants' strength of intention by application submission status, showing a largely similar pattern as the figure based on percentage of respondents which is displayed in the main text (Figure 6.2).

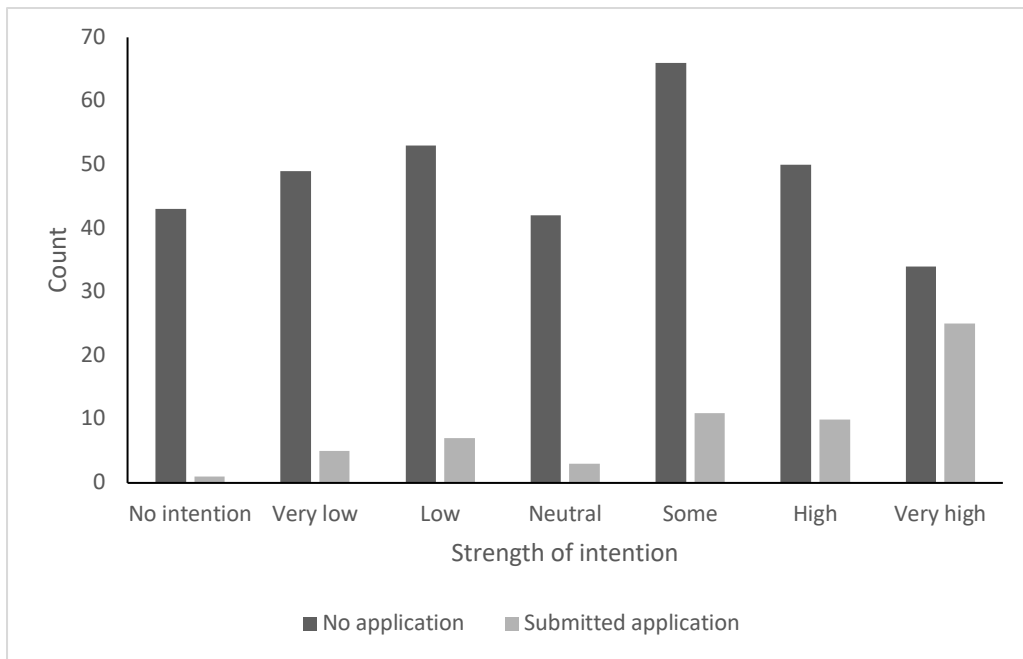


Figure C.2. The relationship between strength of self-reported intention to apply and final application. The X-axis represents participants' intention strength (measured on a 7-point Likert scale), and the Y-axis represents the count of respondents.

Interaction effects

In exploratory analyses we performed linear regressions including interaction terms to further understand the relationships between the predictors and their effects on participants' intention to adopt (Table C.4). Analyses revealed a significant interaction effect between cover crops knowledge and past use (coef. = 0.27, 95% CI [0.03, 0.50]), suggesting that the effect of cover crops knowledge on adoption intention is strengthened among those who have used cover crops in the past. We did not have a priori hypotheses and interpret these effects with caution.

Table C.4. Interaction effects on Intention to adopt (measured on a 7-point Likert scale).

Predictor Variable	Estimate	Std. Error	95% CI
Perceived need for adaptation	0.22**	0.08	[0.07; 0.38]
Risk preference	0.29***	0.08	[0.14; 0.44]
Cover crops knowledge	0.15*	0.07	[0.02; 0.27]
Using advisors	0.36***	0.08	[0.20; 0.52]
Past use	1.29***	0.21	[0.89; 1.69]
Perceived need for adaptation * Risk preference	0.06	0.04	[-0.01; 0.13]
Cover crops knowledge * Using advisors	0.02	0.03	[-0.05; 0.10]
Perceived need for adaptation * Past use	-0.21	0.12	[-0.46; 0.04]
Risk preference * Past use	-0.03	0.14	[-0.30; 0.24]
Cover crops knowledge * Past use	0.27*	0.12	[0.03; 0.50]
Using advisors * Past use	-0.18	0.14	[-0.45; 0.09]
Constant	3.68***	0.11	[3.47; 3.89]
Observations	360		
R ²	0.38		
Adjusted R ²	0.36		

Note: Results from linear regression models on participants' intention to apply for the cover crops subsidy including interaction effects. * $p < .05$; ** $p < .01$; *** $p < .001$. The dependent variable is Intention to adopt. "Past use" is the only binary predictor, for which 0 (no past use) is the reference category.