Journal of Rural Studies 96 (2022) 259–269

Contents lists available at ScienceDirect

Journal of Rural Studies

journal homepage: www.elsevier.com/locate/jrurstud

Climate considerations aside: What really matters for farmers in their implementation of climate mitigation measures

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ARTICLE INFO

Keywords:
Agriculture
Farmers
Climate mitigation measures
Motivations
Contextual conditions
Norway

ABSTRACT

The implementation of climate mitigation measures at the farm level is highly dependent on farmers' willingness to make adjustments to their farms. While many studies have identified various barriers to climate mitigation in agriculture – among them farmers' weak interest in climate – there has been less research focused on the different kinds of influences actually leading to the decisions and acts of implementing relevant measures. Hence, we undertook a qualitative investigation of eight Norwegian farms that have employed a range of such measures. Most importantly, our findings show that climate considerations are not an essential driver among farmers who have implemented relevant measures. Instead, climate mitigation measures are mainly perceived as, treated as, and appreciated for offering (farm-beneficial) functions other than climate change mitigation. Consequently, our study displays an opportunity for diffusion of technology and practices often believed to be curbed by the lack of climate-oriented farmers. Further, our findings point to a range of shared, favourable, contextual conditions (robust farm economy/economies of scale; sufficient time for farming; prospects for farm continuation; relevant subsidy schemes; beneficial climate and topography) enabling the implementation of climate mitigation measures on the involved farms. This reflects the reduced ability of farmers to act in climate-beneficial ways when these conditions are absent or exist with a negative sign. The mutual dependency between intrinsic drivers and enabling contextual conditions underlines the need for both research and development strategies that consider the entire picture. This would include targeting both critical enabling conditions for farmers and the message framing employed to promote climate-beneficial changes at the farm level.

1. Introduction

As agriculture represents a significant share of global greenhouse gas (GHG) emissions, many countries intend to reduce emissions from this sector (Fellmann et al., 2018). However, even though specific goals for emission reductions are set nationally and/or at an international level, several studies (Schäfer, 2012; Erjavec and Erjavec, 2015; Grosjean et al., 2018) indicate that little has been done in Europe to achieve the necessary reductions. In Norway – the empirical focus of this paper – actions at the sectoral level (agricultural and environmental authorities) focus on supporting the implementation of climate change mitigation by ensuring the provision of relevant information and consultancy services to farmers. Additionally, subsidies are provided for various climate change-related agronomic improvements. However, as regulatory instruments have yet to be introduced, the implementation of climate measures at the farm level is highly dependent on farmers using their own initiative.

So far, interest in climate change among farmers has shown to be quite weak, both in Norway (Brobakk, 2018; Flemsæter et al., 2018) and internationally (e.g., Prokopy et al., 2015). This is claimed to be problematic for climate change mitigation in agriculture. For example, Barnes and Toma (2012) stated that "(…) perception and acceptance towards climate change is a significant barrier to voluntary adoption of best practice techniques", while Wreford et al. (2017, p. 4) pointed out that, "barriers that stem from farmers' values and attitudes towards the environment and climate change may call for additional engagement." According to Arbuckle et al. (2013, p. 944), "it is critical to develop an improved understanding of farmer beliefs and concerns about climate change (…) in order to minimize the threats that climate change poses to the sustainable production of food and energy." Prokopy et al. (2015, p.

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https://doi.org/10.1016/j.jrurstud.2022.11.003
Received 28 April 2022; Received in revised form 31 October 2022; Accepted 2 November 2022
Available online 17 November 2022

501), too, pointed to the link between weak climate concerns and weak support for mitigation actions and suggested that “these findings may be cause for concern.” The common message from this research is that weak climate consciousness among farmers is an important barrier to farmers’ mitigation actions, and that strengthened climate consciousness is key to a broader transition to low-emission farming.

Mixed reports have emerged on the relationship between climate consciousness and the adoption of mitigation measures. Some studies raise questions as to whether action precedes a change in consciousness or a change in consciousness precedes action (e.g., Brown et al., 2021). Other work has indicated that climate change attitudes and beliefs are associated with intended, but not actual, adoption of mitigation practices in agriculture (Niles et al., 2016). Motivations for implementing relevant measures not related to climate have also been found in previous studies, both in Norway (Burton and Farstad, 2020) and internationally (Davidson et al., 2019; Kragt et al., 2017). In other words, it is difficult to determine the significance of climate consciousness in spurring mitigation responses without knowing why farmers are actually implementing mitigation measures, and whether contextual conditions allow them to do so (regardless of what they potentially aspire to).

In addition to studies looking at the relation between climate consciousness and farmer action, many have focused on identifying various barriers to climate mitigation (e.g., Stuart and Schewe, 2016; Bach et al., 2016; Long et al., 2016; Burton and Farstad, 2020); however, these do not fully reveal how and why climate-beneficial measures *get* implemented. In view of this weak knowledge on actual drivers and enabling conditions of farmers’ implementation of climate-beneficial measures, more understanding of the conditions for farmers’ decisions regarding sustainable adaptation seems needed in this respect. Hence, to fill this gap, we address this through a qualitative exploration of climate-measure implementation on farms where mitigation measures have been introduced. By analysing behavioural and contextual (i.e., structure and culture) conditions, this paper gives a rich account of the role mitigation measures play in the everyday practices of the farm. Importantly, and as we will show, we found that climate mitigation measures are perceived as, treated as, and appreciated for offering (farm-beneficial) functions other than climate change mitigation by the farmers.

The paper is further structured as follows. First, we present relevant theory and research on farmer decision-making – in general and related to innovation, technology and practice adoption. Next, we describe our data and methodology and provide a context for the analysis through a short description of relevant conditions in Norway. After presenting the analysis we discuss how the results might contribute to an enhanced uptake of mitigation measures.

2. The many influences on farmers’ decisions

Knowledge on farmer decision-making is essential to reduce emissions from agriculture. While there are theoretical approaches to farmer decisions that mainly consider behavioural factors – such as the theory of planned behaviour (e.g., Burton, 2004a; Bagheri et al., 2019; Despotovic et al., 2019) – and others that mainly consider contextual factors (such as approaches based on transition theory, e.g., Wilson, G.A., 2008; Martin et al., 2012) – decision-making is generally viewed as a combination of both factors (e.g., de Boon et al., 2021; Engler et al., 2019). For example, Darnhofer et al. (2010) pointed to various previous studies and detail that while practical, everyday farm management is shaped by economic frameworks, social norms, local agro-ecosystems, and material farm structure, it is also heavily influenced by the farmer’s perceptions, preferences, and risk aversion. Furthermore, within these various material, cultural, and subjective frames, Darnhofer et al. (2010, p. 194) underlined that farmers’ decisions are not mainly based on rational and science-informed choices, but rather “hinge [s] on the farmer’s goals and values, the potentials as perceived by the farmer and the obstacles expected by him or her”. Farmers’ intuition also plays an important role in this respect (Nuthall and Old, 2018). In other words, different interpretations lead to different responses. In addition to the range of various farm-related conditions, farmers – as with other entrepreneurs – need their business to generate a lifestyle in which the needs of family, income, and a way of life can be balanced (Jaafar et al., 2011).

Examining both behavioural and contextual conditions has also proved relevant when it comes to farmers’ decisions regarding climate-response and environmental actions (e.g., Brown et al., 2021). Sutherland et al. (2012) argued that major changes to established farm practices are often activated by a “trigger event” (positive or negative) that leads the farmer to assess new farm solutions. Hence, Sutherland et al.‘s study pointed to how contextual conditions activate behavioural dispositions. Other studies have emphasised the significance of the networks wherein farmers engage with farm management and innovation decisions (Cofré-Bravo et al., 2019; Oreszczyn et al., 2010), thus reflecting the importance of the social environment. Additionally, a *process-relational perspective* on farming (Comi, 2020; Darnhofer, 2020) takes the combination of behavioural and contextual factors one step further by addressing its underlying complexity. Focusing on relational flows, this perspective accentuates, among other things, how farmers are involved in “a diverse and changing set of dynamic relationships with a host of human and non-human entities, whose responses are often uncertain, leading to outcomes which always have unexpected (side-)effects” (Darnhofer, 2020, p. 514). In short, farmer decision-making is affected by a multitude of possible influences, which calls for open and explorative research methodologies.

2.1. Implementation of climate mitigation measures as innovation adoption

Most climate mitigation measures can be considered innovations – albeit at various stages of development and diffusion. The OECD (2013) suggested a broad definition of innovation as the creation or adoption of something new to the firm, the market, or the world. In the case of agriculture, most innovations are new to the firm/farm (Läpple et al., 2015), i.e., products (e.g., technologies) and practices may be considered innovations providing they are new to the persons (or farms) adopting them (de Boon et al., 2021). Thus, farmers’ implementation of climate mitigation measures falls broadly within the category of innovation adoption[1] (Moerkerken et al., 2020; Lioutas and Charatsari, 2017).

The degree of and determinants for farmer innovativeness has been explored in several studies. Läpple et al. (2015) found innovation occurred most frequently among larger farms, farms with intensive production, farms with access to credit, and among farmers with an agricultural education. In contrast, engaging in off-farm work and increasing age were associated with lower levels of innovation. In their presentation of a tool for predicting adoption outcomes for new farming practices, Kuehne et al. (2017) identified two overarching factors influencing the adoption process with the relative advantage of the innovation (technology and/or practice) being the main determinant of adoption, while the effectiveness of the learning process influenced the time lag between being informed and deciding to adopt. Kuehne and colleagues further suggested a multitude of variables which can impact the strength of these overarching factors, including characteristics of the innovation, characteristics of the farm/farmers, context, material conditions, and subjective perceptions and values. Similarly, de Boon et al. (2021) identified both actors’ adaptive and innovative capacity and other psychosocial factors, and the immediate context of the actors as foundational for the agricultural innovation adoption processes.

[1] Which is one of the key concepts in Rogers’ (1962) well-known theory on diffusion of innovations.

When examining the decision-making process with respect to implementing emission-reducing measures, existing literature thus points to the potential significance of both *intrinsic drivers* (i.e., motivations, including climate-related concerns) and *contextual enabling conditions* (e.g., material farm resources, network of advisors, subsidy schemes), together with the influence of trigger events and the characteristics of the specific innovations. At the same time, this literature also highlights the need to look at drivers and contextual constraints that prevent other farmers from implementing the same measures.

3. Methodology and study context

3.1. Methodology

This study was part of a research project focusing on conditions that enable the implementation of climate mitigation measures at the farm level in Norway. To identify and analyse the management changes, innovative processes, and interactions involved in this, we undertook in-depth, semi-structured interviews with farmers from eight farms where various relevant measures had been implemented. Our choice of what constituted a "climate mitigation measure" was based on previous research and formal state recognition through subsidy schemes or general climate mitigation information to farmers. Among them are cultivation of legumes (Dequiedt and Moran, 2015); use of catch crops (Valkama et al., 2015); conservation agriculture[2] (Powlson et al., 2014); improved drainage of cultivated land (Carstensen et al., 2020); precision spreading of fertilizers (Snyder et al., 2009); settling of manure during spreading (Webb et al., 2010); improved quality of self-produced coarse fodder (Knapp et al., 2014); and production of renewable energy such as chip heating (for buildings) and solar panels on the barn/roof.[3]

Farms were identified through consultation with the extension services and farming journals (where mitigation activities are occasionally reported). While a mix of age, production, farm size (yet no small farms), and localisation were achieved, recruiting women proved difficult.[4] Some interviewees operated the farm in collaboration with their spouses, but in all but one case the male did the interview alone. To understand the interactions between farmers and their support networks, and to gather information from actors with extensive knowledge of the situation, we conducted an additional eight interviews with supporting actors[5] as key informants – representing governmental management, technology providers, extension services, and interest organizations at various levels.

To ensure anonymity – particularly given the fact that many of the implemented measures are not yet widespread – we are required to withhold detailed characteristics of each individual farm and farmer. However, we are able to give generalised details about the sample such as where farms are located in the country; either Eastern Norway, north-western part of Norway, or mid-Norway. Farmers were also between 20 and 60 years old and their professional backgrounds varied. While one of the farmer's educational background is unknown, none of the others have traditional agricultural education, but two of the interviewees were educated at an agricultural university, and a couple of interviewees were agricultural mechanics. The involved farms had, according to Norwegian standards, quite large to very large productions (arable land from 40 to 400 ha, where most of the farms were closer to the lowest size), and most of the farms combined plant and livestock production.

The semi-structured interview schedule for farmers identified a number of core topics around which the discussions were based. These were: what measures had been implemented; motivation for implementation; barriers encountered (and how they had been overcome); circumstances that enabled them to implement the measures; and what forms of support or assistance they saw as convenient for their implementation of the relevant measures. Supporting actors were asked about their role in promoting the uptake of mitigation measures and how the farmers responded to their involvement. The majority of interviews were conducted via video-link due to corona-related restrictions in place at the time. The interviews were carried out between late autumn 2020 and autumn 2021, lasted 60–120 min, and were recorded and later transcribed in full.

Analysis was conducted using the qualitative analysis software NVivo. First, each interview was categorized by grouping quotations with regard to thematic content as an inductive process (resulting in 31 categories in total). Closer inspection of the categories identified the 'motivations' category as particularly interesting since we observed that climate mitigation was repeatedly *not* mentioned as the main reason for implementing climate mitigation measures. To explore this, we focused the remaining analysis on the internal drivers involved in the decision to implement measures and contextual enabling conditions – analysing the situation by applying a framework based on the ideas and concepts from the literature described in Section 2.

3.2. The Norwegian context

Norwegian agriculture is small-scale by most European standards, with an average farm size of 25,5 ha in 2020 and an average dairy herd size of around 30 cows (SSB, 2021). Norwegian agriculture is multi-functional, technology-intensive, and characterized by high investment. Norwegian farmers benefit from relatively high subsidies, toll barriers, and highly regulated agricultural policies (Vik, 2020). Policies and programs directed towards climate mitigation in agriculture involve a high degree of cooperation. In 2019 the two farmers organizations and the governmental authorities agreed on a letter of intent on GHG reductions and carbon sequestration for the period 2021–2030. The largest organization, Norges Bondelag [Norwegian Farmers Organization], put forward a plan in April 2020 to cut emissions by 5 million tons CO2-equivalents by 2030, and presented a range of different measures (e.g., improved animal health and breeding, phasing out fossil fuels in machinery and heating, improved fertilizing and developing biogas facilities) (Landbruks-og matdepartementet, 2019; Norges Organisation). The Ministry of Agriculture and Food and the central farmer organizations also agreed to include climate advice as part of the regional agricultural subsidy schemes – assisted by the application of a newly developed climate calculator to estimate emission levels on the farm. These efforts are again supported by Landbrukets klimaselskap SA – a company owned by 17 different agricultural organizations. Additionally, various regional authorities manage programs and projects with the stated aim of educating and motivating farmers to turn their farms in a more climate-friendly direction (Statsforvalteren i Agder, 2021). Overall, the current communication is gain-framed (cf., Ngo et al., 2022) and climate-centred in the way that it mainly emphasises the climate-mitigative advantages of making various farm-individual changes. In addition, it often points to the state–agriculture agreement.

Despite the above-mentioned efforts, the current interest for climate change among farmers has shown to be quite weak in Norway (Brobakk, 2018; Flemsæter et al., 2018; Melås, 2020). Still, a recent report from a national farmer survey (Melås, 2020) showed that climate-beneficial measures have been implemented to certain degrees on Norwegian farms. Measures like precision spreading of artificial fertilizers,

[2] Conservation agriculture is a cultivation system combining minimal soil disturbance, permanent soil cover, and crop rotation (Hobbs et al., 2008). Several of these measures receive subsidies in Norway in recognition of their environmental benefits.

[3] Important to note: our study did not verify the value of the various measures based on estimations of emission reductions but was instead focused on the premises for farmers' proneness to make climate-beneficial changes on their farm, notwithstanding what kind of measures that would be recommended.

[4] We managed to identify several, but none of those we approached accepted our query regarding participation in the study, unfortunately.

[5] Some of them were identified by the interviewed farmers, some through the internet, while others were identified through the authors' professional networks.

improved coarse fodder, improved drainage, and dropping of manure are relatively widespread (i.e., implemented or planned to be implemented), while measures like production of biogas, switching to biofuels for transportation, and the use of biochar to improve soils and store carbon is much less extensive.

4. Findings

Drawing on the literature presented in section two, we divided the analysis into two sections: internal drivers (4.1) and contextual enabling conditions (4.2).

4.1. Internal drivers

In this section we present farmers' intrinsic drivers behind the adoption of climate mitigation measures. We explore their main motivations, how their climate consciousness relates to their motivations, and how farmers share a common intrinsic trait that seems to strengthen their initiatives.

4.1.1. Various main motivations for climate-beneficial farming

All interviewees were asked to outline their motivations for implementing climate-relevant measures. This resulted in the identification of a number of types of motivation involved in the decision to engage with the measures.

Farmer 1 and his wife had recently built a new cow barn with an automated milking system, integrating several climate-relevant improvements as part of the investment, namely; a new, large manure tank to enable the spreading of manure at the most favourable times of the year, the hiring of a contractor with an umbilical system[6] for manure application, and the implementation of a system of crop rotation. He explained the reason for these climate-beneficial changes:

> I want to do the agronomic work on my farm in the best possible way, and that's where I think it [the motivation] lies. I think it's fun to be able to improve from year to year and to see that what I did one year maybe could have been done a little bit differently. "Maybe I could have done it more optimally in another way." That's what drives me, I think. (Farmer 1, manure management, crop rotation)

This farmer's motivation for adopting climate-friendly technologies and practices was founded in agronomic reasons; to manage to find the agronomically best way of running the farm, i.e., to optimize the craft of farming.

A grain farmer, having converted his large farm into conservation agriculture, explained his motivation in a somewhat different way:

> If you deplete the most important resource on a farm, which is the soil, that is completely wrong. So, the fact that we are building up and getting a more fertile soil for the future, that is indeed the strongest motivation. (…) I also think it's fun to make money. And my goal is, as I said, to maintain the crops – good crops, because by Norwegian standards we have very good crops. And if we can do that, and drive less, use less diesel, and extract a relatively large amount of grants, then it is not a bad economic arrangement. (Farmer 2, conservation agriculture, considerable draining, chip heating)

This farmer highlighted his own conviction about the significance of sound soil health – to also keep the soil fertile for the future. This was partly motivated by economic reasons, as he mentioned the good economic results following from reduced inputs as a rewarding co-benefit. The desire to build-up rich and lasting soil likewise motivated Farmer 8 to pursue conservation agriculture. Another grain farmer (Farmer 3) employing the principles of conservation agriculture pointed to the logic appeal of this particular way of farming: "to work in harmony with nature instead of constantly fighting against it, that seems very convincing and sensible".

Improving the agronomy may also be motivated by a clearer economic rationality, as illustrated by a quote from a dairy farmer producing his own coarse fodder:

> We have enough arable area as of today, and enough coarse fodder, so we want to produce coarse fodder of the best possible quality to be able to use less concentrated feed and be left with more on the [economic] bottom line. (Farmer 6, improved coarse fodder quality)

Farmer 7, whose farm included a range of relevant measures, had also implemented a chip heating unit and was about to establish a biogas system on his farm. When asked about his motivations, he replied that, "it is mainly because subsidy schemes make it profitable", while also listing a few practical benefits. The same farmer had also invested in GPS (global positioning system) equipment to allow precision farming, which he again justified as economic rational: "As a rule of thumb, I save ten percent on everything. I do the same work ten percent faster, I save ten percent on diesel, I save ten percent on manure, and I save ten percent on seed corn."

A farm couple with a suckler-cow herd was in the process of improving the coarse fodder quality, an action that they justified on the basis of the potential to add value to their product by marketing its environmental qualities:

> We believe there is a demand for locally produced meat, and if we also calculate the climate impact from the production, that could provide added value for consumers. (Farmer 4a, improved coarse fodder quality)

These farmers were the only interviewees in our study who implemented climate-relevant measures for any reason related to climate-change and, even so, the motivation was financial rather than being based on intrinsic concern for the climate.

Farmer 5 had installed a large solar panel at his farm, however, as a result of limitations in the local power grid, he did not generate as much income as he had hoped when making this decision. However, he did not regret his action, as he had fulfilled much of what he wanted to achieve from this innovation adoption:

> The house mark of the farm has inspired me all the time as a farmer; that this farm should be in better condition when I give it away than it was when I took over. (…) In addition to producing quite a lot of energy as milk and meat, I will produce energy as electricity as well. (…) And part of the reason is that, as I said, it requires little work. Once you have installed it, it should actually just work and produce for a lifetime. (Farmer 5, solar panels)

The farmer was still happy and sure that he had made the farm economically more robust and easier and, hence, more attractive to a potential successor.

As the findings described above show, the farmers' motivations for implementing climate-relevant measures were thus generally related to the meaningfulness of improving agronomic work (whether it primarily concerns yields, soil health, or both), improving the farm for future successors, and/or economic return. In other words, the measures seem to be the result of the continuous assessments and decisions that farmers make in their everyday practices on the farm. Hence, the implementation of climate mitigation measures appeared to happen independently of potential climate concerns among the farmers.

4.1.2. The extent of farmers' climate consciousness

During the interviews we explored the role farmers' climate consciousness played in the decision to implement measures. Some farmers

[6] A manure-spreading system where liquid manure is fed, by use of a transport hose, from the manure store to a self-propelled in-field applicator with trailing hoses, set up behind a smaller tractor and allowing band spreading (Sørensen, 2003).

explicitly stated that climate concerns were not a significant motivation behind their mitigative adaptations, for example:

> I do not think that I am more concerned about climate than very many others. I think, it is more that I want to do the agronomic parts on my farm in the best possible way. I think that is the reason. (Farmer 1, manure management, crop rotation)

Another farmer emphasised, even more directly, that climate relevance was not intended:

> The fact that we are building and obtaining more fertile soil for the future, that is really the strongest motivation. It is also the luck of the devil that it fits well into the climate debate and everything today. So, it's just nice to feel that it brings about something right on behalf of more people. (Farmer 2, conservation agriculture, chip heating)

While these two farmers, after all, appeared to be quite well informed about the climate aspects of farming, one of the conservation agriculture farmers (Farmer 3) additionally expressed a more personal interest for the climate issue:

> [I am] very interested in what this has to do with the challenges we face and solutions to it, (…) I think a lot about what needs to be changed and what is to blame for the challenges we have. Such as, for example, that methane from livestock production is only in a cycle whereas for fossil fuels CO2 emissions exist more permanently. Of course, again, you make arguments to defend what you are doing, but I feel that we are very aware of that. (Farmer 3, conservation agriculture)

Farmer 3, running a combination of suckler cow beef and grain production, observed public criticism of emissions from meat production, and noted that he had reflected a lot upon agriculture's role in the carbon budget in this regard. As such, he was highly conscious of the topic.

Farmer 4a had extended knowledge on climate due to a previous job that included climate counselling for farmers:

> [Through external activities] I have gained insight into which factors are important [for GHG emissions from farming]. Then, it will be very exciting to somehow try since we have that knowledge. (…) Coarse fodder is one thing, but I am also very curious about biochar. I find it exciting. (…) Imagine if you could somehow add biochar and maybe implement some additional measures so that you can actually say that this farm is climate neutral! If it is possible, that would be exciting. (Farmer 4a, improved coarse fodder quality)

With the thought of selling suckler cow beef directly to the consumers, he and his partner planned to use this knowledge to run the farm in a way that made it possible to label the farm as climate neutral. In this case, knowledge about climate mitigation measures was linked with the potential of adding value to the products.

The climate consciousness of Farmer 6 was revealed when he was asked to comment on the climatic changes his farm had experienced over recent decades:

> Whether they [the weather changes] are man-made or climate-related [sic.] I will not comment on, because there are divided opinions about that, but we must in any case adapt to the climate. That is probably what you can do, and livestock production and plant production is a circle, it is not *there* … I wouldn't claim that *we* are the ones responsible for the climate problem. (Farmer 6, improved coarse fodder quality)

In this comment the farmer displays a degree of scepticism concerning the human or natural origins of climate change, but does not believe, in either case, that agriculture plays a significant role.

The above quotes indicate varying degrees and contents of climate consciousness among farmers who have implemented climate-beneficial measures. If climate concerns were the primary driver of climate friendly investments on the farm, we would have expected to see a different pattern here, with most farmers showing high levels of climate concern. Once again this, and in line with the various farm-related benefits main motivations, confirms that climate-related concerns are not a prerequisite for the implementation of favourable measures at the farm level.

4.1.3. A shared opportunity-seeking orientation

In addition to being motivated by various farm-beneficial outcomes from the implementation of relevant measures, the farmers in our study reflected a more general propensity to innovation – investigating interesting opportunities as they emerged. Most displayed knowledge and curiosity about other relevant measures available in addition to those they had implemented. For example, Farmer 1 and his wife, who practiced crop rotation and had implemented climate-beneficial manure management in relation to their new barn, were assessing several additional measures such as solar panels and carbon sequestration. Farmers 4a and b, who wished to make their farm climate neutral to promote product sales, were likewise open to many different measures:

> Both [improved] coarse fodder and biochar could be exciting. And, of course, in addition, you have all these other things such as solar cells on the barn roof and biodiesel. (Farmer 4b, improved coarse fodder quality)

Farmer 2, who had converted to conservation agriculture and combined this with both extensive draining and chip heating, explained the joy he felt from implementing these kinds of measures:

> We think it's fun to be self-sufficient in energy. Heating all the buildings and such with bioenergy and drying all the grain with bioenergy, it is great fun. And you really feel that it is a bit future-oriented, and I feel the same about cultivating the land with conservation agriculture. (Farmer 2, conservation agriculture, chip heating)

Farmer 3 pointed to the driving power of following up on what appears to be good solutions:

> I think I can say that we are quite open-minded, so it is easy for us to jump on things we believe in, at least. (…) Also, it's a bit like when I start believing in something, I only look ahead. Both for better and for worse, I test things that I believe in. (Farmer 3, conservation agriculture)

In general, the farmers seemed to have certain personality traits that made them take the role of early adopters (Rogers, 1962) of promising innovations/practices. This may also explain why no real trigger events were highlighted as decisive in the farmer interviews. Further, their steady, opportunity-seeking orientation made the farmers in our study follow new ideas, where they found the relevant measures and involved the right actors to be able to complete the implementation and reach their self-created goals. As Farmer 8 (conservation agriculture) mentioned, "if you are outreaching, you will find the right people". Some even went abroad to find the information and contacts they needed.

Although these farmers often purposefully sought out the supportive resources they needed elsewhere, our findings highlight that they also found help and inspiration in their local and regional surroundings. Several of the interviewees reported they had access to rewarding cooperation with other farmers in the local community. Among other things, one of them mentioned having access to an umbilical system for manure application through the local machinery ring. Most farmers also used and valued the agricultural extension services in their region, together with the support and knowledge they found elsewhere. Nevertheless, our findings demonstrate that these farmers have not been persuaded by their local agricultural environment to implement mitigation measures. Rather, they have been scanning for opportunities, setting their own goals and building the networks needed for what they have decided to do.

Farmer 6 described his opportunity-seeking orientation as a hunt for solutions that would benefit the farm and farmer in different ways, both economically and related to his wider work-life balance. This was also confirmed by Farmer 4b, who commented on the opportunities related to different measures: "But, all things considered, there are costs against benefits, I would say." As a shared opportunity-seeking orientation appears to be an important driver for the farmers involved in our study, this last comment reminds us about the necessity of measures to fit well in and contribute to the wider farm framework to get implemented – which is the main focus of the following section.

4.2. Contextual enabling conditions

This subsection delves into contextual enabling conditions for climate-mitigation. Here, we present what other resources, besides motivations and an opportunity-seeking orientation, these farmers seemingly have benefited from, which not all farmers hold.

4.2.1. Farm continuation

Prospects for farm continuation appear to be an important condition in this respect. None of the farmers in our study had significant concerns related to the future continuation of their vivid farms. Some had already integrated one or more of their grown-up children in the farm business, while others had children too young to consider their future choices. Some of the farmers were clear on an alternative solution to ensuring farm continuation independently whether or not their own children wanted to become successors. Farmer 2, who still made large-scale investments and developments on the farm, and whose children were preparing to take over most of the business in short time, elaborated when asked if something would have been managed differently if he knew his children wanted other careers instead:

> Obviously. But since they started at school, we have always said "follow your heart and become what you desire." No-one should feel that they have to work within agriculture. If all [of my kids] wanted to do something completely else, they should be allowed to do so. (…) Then, maybe we would run the farm for 15 more years. I still think it is really fun. And then, we could rather hire out the land to someone who wants to cultivate it. It is possible to manage a property well, even when you do not do farm work. (Farmer 2, conservation agriculture, chip heating)

In Norway, having the farm pass on within the family to the next generation has been traditionally ascribed with strong values (Haugen, 1998), and while one strand of farmers is more concerned about the possibilities for keeping the farm property within the family, with or without active farm work, another strand of farmers mainly emphasises the importance of sustaining and continuing the utilisation of land and the developed farm system. While a focus on family farm succession may disturb some farmers' prospects for farm continuation and, hence, also hamper their willingness to invest in climate-relevant measures, another threat against prospects for farm continuation is the perceived economic sustainability of the farm in the years to come. If the farmer already struggles economically, it is more obvious to plan for phasing out than for new developments and the involvement of new generations.

4.2.2. Economy

A general overall feature underlined by the interviewees was that economy played a significant role in determining investment or effort put into instigating the various climate mitigation measures. Although being somewhat obvious, the interviewees argued that their financial situation rendered climate mitigation possible. However, this touches upon the most crucial finding in the material. As it encompasses every aspect of the everyday life of farmers, and especially their decision-making when it comes to farm practices beyond what is considered routine, a few instances to show how it plays out is justified. For example, Farmer 3 explained how changing from conventional to conservation agriculture requires replacement of most of the farm equipment, and commented:

> When you then have to make such a large replacement and such large investments, you must know for sure that this is what you want. So, it's a barrier, absolutely. And it is a barrier especially perhaps for many smaller producers who do not have the same opportunity to invest in such expensive equipment. It is probably easier if you have some land to distribute costs on. (Farmer 3, conservation agriculture)

As pointed out, not all farmers have the possibility of "distributing" costs throughout a high total land area in this respect. Large farms usually have more financial resources to make profitable investments, and investments on large farms will also be more profitable due to the scale of the operation as compared to small farms. Another farmer attributed economic leeway to supplementary income sources on the farm, like rental earnings on farmhouses and storage facilities:

> Interviewer: How have you managed to make this financially sustainable?
>
> Farmer 2: There is no doubt that we have a lot of rental income. (…) So, to make some investments, there is no doubt that the rental income has helped us to take those steps and do what we have done. It's long term, you know. You will not become abruptly rich by being a grain farmer. It is very long-term. (Farmer 2, conservation agriculture, chip heating)

Either way, this granted the farmers the opportunity of investing money in the machinery or investing time in the farm practice that allows for implementation of various – and, in this case, climate-beneficial – measures. They viewed this as a prerequisite for their actions. Alternatively, this also goes the other way around. The farmer below had already invested in a larger manure tank that enabled him to store manure longer and thus spread when conditions are best:

> Interviewer: Is it common knowledge among farmers that manure should be spread during the growing season, in order to get the best possible utilization of it?
>
> Farmer 1: It's about economy, that's the reason. That is, when we had that [smaller] manure cellar, then it had to be emptied in the autumn. And I see colleagues who do not have a new manure tank, they do that as well. And, simply, they do it and know that "this is not the smartest thing I can do either climatically or environmentally or to make the best use of the manure". So, it is not out of malice, but it is simply that they have no place to put it until they can use it in the best possible way. (…) It's really a loss. (Farmer 1, manure management, crop rotation)

He recognized how this sunk cost allowed him to make both agronomically and environmentally good farming decisions, and how this may be a barrier for farmers not in his position. He held that despite the other farmers knowing what the most beneficial practice is, the farm management becomes non-optimal due to limited material resources.

Another economic reality affecting farmer decisions was the amount of debt and how this affects decision-making and perceived leeway. Farmer 3 partly subscribed their climate mitigation adoption to their flexible financial situation:

> After operating for 25 years, we have repaid a lot of our debt, so we feel that we have relatively large financial freedom of action. The potential small adjustments that must be made do not prevent us; we mainly go for what we believe is right. (Farmer 3, conservation agriculture)

When reflecting on economic considerations the farmers all addressed how the expected long-term benefits of, and return on investment in, implementing different measures were significant for their decisions, even including time frames surpassing their own expected horizon as farm managers. This also touches upon succession issues, as mentioned earlier, and how potential farm successors motivate action to enhance the farm operation.

4.2.3. Subsidy schemes

In Norway, public subsidies are provided for a range of different climate-related agronomic improvements. Several of these are justified by environmental regards, but there is often an overlap between environmental measures and climate mitigation measures. For instance, subsidies are provided for using an umbilical system for manure application; settling of manure; use of catch crops; drainage of cultivated land; various renewable energy establishments; and even for receiving climate counselling. While Farmer 7 mentioned the profitability from the subsidies as his main motivation for implementing relevant measures, other farmers emphasised how subsidies enabled *their* implementation of similar measures: "There is no doubt that this is included in our calculations. So, it's important and I think it's very important if it should have some extent, too" (Farmer 2, conservation agriculture). The direct effects of these subsidies on famers' practices were also reflected in our material, here in a quote from the interview with Farmer 8:

> The two last years, at least, there have been subsidies for what is called subculture, where you receive subsidies for sowing clover and perennial rye grass in the grain field (…). And this year, they initiated flower stripes, that means pollinating stripes of flowers. I have sowed a great deal of these, and that was very economically beneficial, 5000 NOK [500 EUR] per decare to sow it, and that is quite a good stimulus, so I have sowed it on the maximum size of land where I can use it. (Farmer 8, conservation agriculture)

4.2.4. Sufficient time for farm work

In addition to seeing the gains of undertaking changes, implementation of new measures often depends on both interest and time to invest in making changes on the farm. The farmers in our material had used a lot of time to map out and learn about the opportunities related to a range of different measures. Some of the relevant measures also continuously require time spent to follow up the already implemented measures, here illustrated by a quote from Farmer 2:

> The right-timing effect is important within agriculture, and particularly within this system [conservation agriculture]. It is not easy if you have a full-time position outside the farm. To arrive home at 5 O'clock in the afternoon, and then an afternoon shower appears outside. That is not easy. So, being at the right place to the right time is maybe most important. The timing. (Farmer 2, conservation agriculture, chip heating)

He underlined the need for being flexible in farming, not least because sound agronomy depends highly on varying weather conditions. That sufficient time to invest in farming is an enabling condition for implementing changes was also highlighted by one of the key informants:

> I believe that they who have agriculture as their most important income, they do most, while those who say "Oh, that's true, I also have some arable land that I am supposed to manage in addition to the other things I'm doing", they are not that set on making an extra effort. (Key informant, regional level, responsible for promoting climate mitigation measures)

This informant pointed at what is likely to happen when the time spent on farming is limited, i.e., when there is not enough time available to enable the efforts of introducing changes.

4.2.5. Climatic and topographic conditions

Several of the farmers also commented on the climatic and topographic conditions as being significant to certain relevant measures, such as improved coarse fodder quality and conservation agriculture:

> There are certainly bigger challenges in many other places, in terms of type of production and local reallocation and other things. It is clearly an advantage here, as we have areas that are well suited for it, in that there are large nice flat areas without a lot of mountains and such. We certainly have very nice and good soil. (Farmer 3, conservation agriculture)

Even though they were able to see even better conditions in other countries and, for some of them, further south in Norway, the farmers appreciated their own location when comparing it to the situation of farmers further north in the country. As shown, this is yet another of several identified favourable circumstances jointly enabling the implementation of climate-beneficial measures on the farms involved in our study.

5. Discussion

Undertaking a qualitative study of successful farm cases where various climate mitigation measures have been implemented has enabled a holistic approach with the potential to intercept different kinds of influences leading to the decisions and acts of implementing these measures. In this section we further discuss relevant aspects of the analysis.

5.1. Farm-optimizing (climate mitigation) measures of interest

First, and perhaps most importantly, our findings show that climate considerations are not necessarily an essential driver among farmers who have implemented relevant measures. Instead, climate mitigation measures are mainly perceived as, treated as, and appreciated for offering other (farm-beneficial) functions than climate mitigation. What characterized the farmers' approach was a pragmatic, unidealistic[7] undertaking of adopting relevant technologies and practices as a means of improving their farm management, which could mean enhancing yields, improving the work situation, cutting costs, and the like. Climatic benefits resulting from their endeavours were often considered to be a positive side-effect, but not centre-stage. While to varying degrees the farmers acknowledged the value of making climate-beneficial changes in agriculture, unsurprisingly their focus on economic viability and farm continuation prevailed. This corresponds to the survey-based results in a Canadian study (Davidson et al., 2019), indicating that motivation for climate mitigation measures does not originate in climate consciousness nor a sense of responsibility for mitigation, but rather in the co-benefits they bring. According to our findings, weak climate consciousness among farmers is not an important barrier to farmers' mitigation actions, as climate-beneficial measures were implemented regardless of the farmers' thoughts of and around climate. It would perhaps influence the total implementation of relevant measures to some degree if all farmers were idealists who felt strong personal responsibility for solving climate challenges, following Niles (2014, p. 121), who found that perceiving the risks of climate change "directly affects behavioural change and policy support". In any case, our findings demonstrate that taking personal responsibility for mitigating climate change is not a *prerequisite* for achieving the goal of a transition to a more climate-friendly agriculture. Thus, lack of climate consciousness or ideological conviction does not constitute a definite barrier to the implementation of relevant measures, as one strand of previous research literature claims. Taking climate action is, in this sense, a "by-product" of investments in innovation to improve farm management and performance.

[7] Although, farm-beneficial goals may also be associated with certain values, such as the value of being a "good farmer" through farming efficiently, continually improving the farm, and by leaving the farm/land in better condition than when they began farming (see Burton, 2004b, 2012).

5.2. The driving force of an opportunity-seeking orientation

Furthermore, our findings showed that the adoption of new solutions is mainly realized by farmers with an opportunity-seeking orientation. All the farmers in our study were actively looking for new ways to improve farm management; they found relevant measures and the necessary knowledge and networks, and they completed the implementation. This seems to align well with the psychological concept of proactive behaviour, which mainly is characterized by "acting in advance" and "intended impact" (e.g., see Grant and Ashford, 2008), and which may be associated with a proactive personality (Seibert et al., 2001; Fuller and Marler, 2009). Hence, together with the perceived farm-related benefits of relevant measures, we also found the shared opportunity-seeking orientation to be an important driver for actual implementation of various (relatively new and not yet so wide-spread) climate-beneficial measures.

In line with much previous research (de Boon et al., 2021; Engler et al., 2019; Brown et al., 2021), our findings reflect that successful cases result from both intrinsic drivers and contextual enabling conditions, and that both of these factors need to be action-promoting. However, as indicated in section 4.1.3, we did not find so-called trigger events (Sutherland et al., 2012) to play an important role for our sample of farmers. This is perhaps because implementation of most of the various climate-beneficial measures is not considered a major change as such, except from the change-over to conservation agriculture as a more fundamental process. However, with regard to these farmers' opportunity-seeking orientation and their pragmatic adoption of relevant technologies and practices to improve their farm management in various ways, this openness to new opportunities appears to be a steady personal characteristic and driver independent of potential triggering events.

Nor did we find social relations to be of high relevance for the implementation of climate-beneficial measures in successful farm cases, unlike several other studies (e.g., Cofré-Bravo et al., 2019; Oreszczyn et al., 2010). The farmers in our study needed and valued both support, exchange of experiences, and supply of new knowledge – like most farmers. However, as with the absence of trigger events, it was not a social or professional network that pushed them into this way of developing their farm. As previously mentioned, their opportunity-seeking orientation made the farmers in our study follow new ideas, and they searched for and involved the right actors to be able to reach their self-set goals. The conservation agriculture farmers, for instance, were unable to find the needed knowledge in their near environments, which made them seek networks and information abroad.

5.3. Enabling conditions – as constrictions when absent

Other research's (e.g., Arbuckle et al., 2013; Wreford et al., 2017) call for strengthened climate consciousness to activate climate mitigation in agriculture risks to overshadow the significance of contextual conditions to farmers' potential for changing practices. Our findings demonstrate a range of shared and favourable circumstances enabling the implementation of climate mitigation measures on the involved farms: prospects of farm continuation; sufficiently robust farm economy/economies of scale; established subsidy schemes for most of the relevant measures; sufficient time for farm work; and favourable climatic and topographic conditions. These beneficial circumstances, partly identified and mentioned explicitly by the farmers and partly identified through our interpretations of the interview data as a whole, appear to be important for the implementation of relevant measures. The contextual conditions identified as enabling implementation of climate-beneficial measures reflect, at the same time, the reduced ability of farmers to act in climate-beneficial ways when these conditions are absent or exist with a negative sign. The latter seems to eliminate a significant share of farmers as potential adopters of climate mitigation measures, no matter how willing or interested they would possibly be to implement relevant measures. Consequently, when enabling conditions are not present, neither climate consciousness nor interest in other benefits from development will be relevant. In a similar way, an enabling context alone will not generate change without the occurrence of any driving motivation to make the necessary efforts in this respect. This mutual dependency underlines the need for both research and development strategies that consider both parts of the total picture.

5.4. Which farmers will possibly contribute to the further innovation diffusion?

Our study indicates a defined category of farmers most relevant to the implementation of climate-beneficial measures, regarding drivers and enabling conditions that need to be present. While different contextual conditions provide very different situations and capacities on Norwegian farms, farmers further have different perspectives, goals, values (Darnhofer et al., 2010), and intuition (Nuthall and Old, 2018). This personal variation implies that, while some farmers – among them, those involved in our study – see obvious benefits from implementing climate mitigation/farm-optimizing measures (i.e., the measures relevant to our study), other farmers do not. More negative assessments of the measures may include the farmers not having sufficient faith in the measures' positive effects on yields or farm economy, or they see more problems (e.g., increased workload and additional expenditures) than benefits related to the measures. Furthermore, while some farmers have an opportunity-seeking orientation, always trying to improve their farm operations, others are happy as long as things appear to work sufficiently well and then see no need for assessing the possibility of introducing new changes on the farm; in other words, the level of ambition varies (see also Klerkx et al., 2017). Summarized, diffusion of climate mitigation measures on Norwegian farms depends on a highly diverse population of farmers and farms. Hence, how can we make most of these farms develop in the same direction when it comes to mitigating climate change?

As emphasised, our study reflects that climate mitigation measures get implemented based on various farm-optimizing motivations and expectations, e.g., such as improved soil health and/or increased farm economy. This relates to the work of Kuehne et al. (2017), where the relative (as well as subjectively perceived) advantage of the practice appears as a main driver for the decision to adopt. Norway has recently seen an efficient innovation diffusion process in practice when it comes to the adoption of AMS (automatic milking systems – i.e., milking robots) (Hansen, 2015; Sigurdsson et al., 2019 in Rajala-Schultz et al., 2021), due to the great lifestyle effects provided by this innovation.[8] Based on the successful innovation diffusion process of the milking robot, one could expect that *climate-relevant* measures would likewise diffuse among the farms with an enabling context when the (farm-related) advantages were experienced by early adopters, who would further spread a positive reputation within the social system of agriculture (cf., Rogers, 1962). In this respect, the question is if any of the relevant measures can provide farm benefits that are sufficiently strong and convincing enough to attract more than only farmers with an opportunity-seeking orientation to implement them. In cases where other benefits from the measures (e.g., better soils; better crops; saved working hours, etc.) do not appear as sufficiently convincing, the

[8] Norwegian dairy farmers invest in AMS mainly to get more time flexibility for family life and leisure. As AMS takes care of the milking, this technology releases dairy farmers from being stuck in the cowshed at critical times of the day, as distinct from dairy farmers without AMS (Burton and Farstad, 2020; Hansen 2015).

economic gains from implementation may always be increased by adjusting relevant subsidy schemes.[9]

Further, Kuehne et al. (2017) pointed to the effectiveness of the process of learning as influential to the time lag before decisions on adoptions are made. Based on our findings, it seems more effective to mainly highlight the agronomic and economic advantages of the climate mitigation measures, which have proved to be of actual interest to farmers, than to communicate their climate-relevant aspects when working towards farmers' implementation of measures. Hence, this indicates the need for better targeted policies, programs, and campaigns with different message framing and a connection to the farm-related benefits of relevant measures, instead of promoting changes at the farm level mainly by referring to climate change mitigation.

5.5. Limitations

Having recruited a sample as diverse as possible through several sources and from different parts of the country, and combining the farmer interviewees' own perspectives with the general insights of the key informants whose work is oriented towards farmers, our data cover a multitude of different farms and farmers. Still, since the interviewees were *visible*, either to the agricultural extension service or to anyone through the media, they may be above average resourceful farmers in various ways. Thus, one limitation of this study may be that we are missing the perspectives and stories of more "silent" farmers in this respect. Unfortunately, the data also largely lacks the perspectives of women farmers, which may or may not have influenced our findings compared to if we had obtained a more diverse sample.

Given the interviewed farmers' interest in other functions of climate mitigation measures than climate mitigation, as reflected in other Norwegian (Burton and Farstad, 2020) and international studies (Kragt et al., 2017; Davidson et al., 2019), we feel confident that our findings in this respect are not a unique case, and that the implications of this study also extend within and beyond Norway. At the same time, we cannot exclude that there are individual farmers whose actions are more heavily influenced by climate concerns. This diversity in the farmer population may have not been captured in the present study due to our modest sample.

With regard to the national context of our study, Norwegian agriculture is often perceived as an « exceptional case» (Vik, 2020, p. 1), among other things because labour and land are limited while the capital is ample (Forbord and Vik, 2017 in Vik, 2020). Expectedly, there will be even less chance for widespread diffusion in countries that do not have the same opportunities to subsidize climate mitigation measures to the same degree (to make them all the more attractive to the farmers), and/or that do not make further efforts at the national level to obtain the baselined GHG emission reductions.

6. Conclusion

In this study we examined farm cases of interest for their implementation of various climate-beneficial measures, to learn what generates climate-promoting adjustments at the farm level. Our findings demonstrate that increased climate consciousness and climate considerations are not necessarily an imperative way towards widespread climate mitigation measure implementation in agriculture, something proved here by farmers who have made climate mitigation adjustments on their farm. On the contrary, it was other farm-related advantages of the measures that motivated the farmers to implement them. Consequently, our findings display an opportunity for diffusion of technology and practices often believed to be curbed by the lack of climate-oriented farmers. The significance of contextual conditions (farm economy/economies of scale; available time for farming; prospects for farm continuation; available subsidy schemes; climate and topography) to farmers' opportunities to make changes further underlines that, in many cases, it is less relevant to ask for a change of attitude among farmers (see also Runhaar et al., 2017). Hence, it is important to combine a structural approach with the behavioural approach. If climate mitigation measures prove to bring large enough and convincing benefits for the farm/farmer, a positive rumour is further likely to spread in the farming community, and, expectedly, those who are favourably enabled will gradually follow, in line with the diffusion of milking robots in Norway (Hansen, 2015) and other successful innovations (Rogers, 1962).

What this further points towards, in terms of strategies for governments and extension services for inducing climate-beneficial adoption, is, firstly, to tailor critical enabling conditions for farmers. This again touches upon more broad and general issues of agricultural policy like e.g., farm income, structural development, subsidy levels, and food prices – aspects being more deeply studied in other research (e.g., Eastwood et al., 2017; Vik et al., 2021). Secondly, as climate change was not the main trigger for the implementation of climate-beneficial measures, this indicates the need for better targeted programs and campaigns emphasising the farm-related benefits more than the climate-mitigative advantages of climate mitigation measures, i.e., communication framed differently from what seems to be the case today. This also brings implications for the appliance of related subsidy schemes and extension services targeting climate mitigation in Norwegian agriculture.

We would like to encourage similar qualitative studies in other countries, allowing comparisons and potential identification of differences in the reasons behind successful farm cases elsewhere. It would also be valuable to further explore, through quantitative methodologies, the extent to which our findings on farmers' main motivations are reflected in wider farmer populations. Further, our findings indicate that developing more knowledge on how to diffuse the implementation of various climate-beneficial measures may be at least as targeted with (both qualitative and quantitative) research on farmers' valuation of and actual proneness to implement relevant measures as studying farmers' climate consciousness and climate considerations.

Author statement

Maja Farstad: Conceptualization, Investigation, Writing – Original Draft, Project administration. **Anders Mahlum Melås:** Investigation, Writing – Original Draft. **Laurens Klerkx:**Conceptualization, Writing – Review & Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Acknowledgements

This study was financed by The Research Council of Norway, through their programme on climate research (KLIMAFORSK, project number 301702). The article has benefited from useful anonymous reviewer comments.

[9] Yet, based on the farm-specific context different mitigation measures will nonetheless affect climate, agronomy, and farm economy differently. Thus, expectations around implementation rates for the various measures must be adapted accordingly.

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