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Perceived drivers of change among mountain farmers and linkages to agroecological resilience in Norway.

Roland Soisson Selinger
Agroecology, Msc.

We need to return to a perception that considers something rational and reasonable only in relation to the broadest and deepest norms — those that are considered most essential for the individual and society.

- *Arne Næss in "Life's Philosophy" (2002)*

Abstract

Mountain farming is cornerstone to safeguarding traditional agricultural management practices and related ecosystem services necessary for European food self-sufficiency. For Norway, outfield grazing in seasonal pastures is of declining importance for many farmers, yet the drivers of wider scale changes must be understood within a regional context. There is a specific need for conceptualizing agroecosystem changes using the social-ecological systems and resilience framework. Previous studies have relied on farmers perspectives for uncovering farm system resilience, and even for quantitatively assessing their resilience capacities. Further clarity is required for how values underpin farmers' resilience strategies, and especially what drivers of change influence farmers' capacity for system transformation.

Using Q-Methodology, the objective of this study was to describe drivers of change processes in Norwegian mountain farming for the region of Valdres, as perceived by farmers themselves. This mixed-methods approach intended to capture the latent subjectivity among farmers for multiple issues. Two distinct factors – or social perspectives – were described based on 20 participants' Q-Sorts, revealing areas of relative agreement and disagreement towards these drivers.

These in turn were linked to different behaviour-based indicators of agroecological resilience, put forth by Cabell and Oelofse (2012). Corresponding indicators described various changes and phases within farmers' adaptive cycles. Farmers within perspective 1 were found to be more vulnerable to exogenous drivers, particularly to the negative impacts of landscape fragmentation and development in outfields. Farmers within perspective 2 also identified with such vulnerabilities, but their resilience was upheld by their perceived greater life quality.

Multiple conflicting development trajectories suggest potential spatial and temporal idiosyncrasies in resilience capacities within the regional panarchy. Most notably, many participants spoke of the paradoxes in national agricultural policies seeking to promote multifunctional agriculture and efficiency goals. A relational approach to studying resilience uncovered the extent to which farmers perceived these multifunctional goals as achievable in the face of multiple wicked problems, whose impacts are described by participants.

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The travel-related emissions for this research were equal to 0.631 tonnes of CO_2e.

Contents

1 Introduction

1.1 Contextual overview

1.1.1 In search of sustainable food systems

The quest for sustainable food systems in Europe has been ongoing for decades in the face of increasingly important and complex pressures. Food production is a keystone for future landscape changes. It is the nexus between human productive and environmentally dependent interactions at various spatial and temporal scales (Kebede et al., 2021). The European Commission's Farm to Fork Strategy has highlighted the need for a robust and resilient food system, pushing farmers to transform production methods towards future climate and environmental goals (EC, 2020). One challenge facing the European food system is how sustainable transformations are characterised and therefore achieved. The Farm to Fork Strategy has been criticised for emphasizing measurements for individual farm agricultural productivity instead of "describing transformative practices towards the needs and the context of the farm's ecosystem" (Mowlds, 2020).

This in turn calls for transformations in how research for sustainability science is carried out, and how to achieve these goals (Shrivastava et al., 2020). There are notably fewer numbers of studies that focus on actors' paradigms as drivers of systemic change. In effect, research that connects sustainability policies and local-level solutions can help address complexities and better support transformative processes among farms (*ibid*). Little evidence of transformative processes towards more resilient farm systems or their governance systems has been uncovered (Vermeulen et al., 2018). Farmers around the world more frequently adapted to the impacts of climate change as a reactive response, instead of adopting measures set by governing institutions in anticipation of climate change. Instead, transformations have occurred under periods of stress that have made farmers' livelihoods more vulnerable (*ibid*).

According to other research, the onus of adopting adaptation measures, in particular, is placed on actors at the local level (Nightingale et al., 2022). Yet without equipping local actors with the resources needed to deal with climate change impacts, systemic transformations at varying scales become increasingly disconnected by the politics of climate change adaptation. A paradigm shift towards transformative processes that "consider all outcomes of change as essential" has been called for, emphasizing the need to include both uncertainty and unpredictability within our understanding of change (*ibid*).

Social perspectives are integral to understanding systemic change because they describe differences in how people relate to sustainability issues. These perspectives have the potential to shape individual worldviews over generations (Shrivastava et al., 2020). Within the context of food production and farm systems, there is a need to understand the social perspectives of farm actors and their responses enabling positive or negative transformations.

In higher-income countries, agri-service policy measures are key instruments in land use change drivers. Among all OECD countries, farmers in Norway receive the greatest level of agri-service support payments relative to their overall income (OECD, 2021). Yet according to the OECD, these agri-service support measures disproportionately favour food production over "incentives for farmers to improve environmental outcomes."

In fact, Kvakkestad and colleagues have demonstrated how two distinct perspectives emerged among farmers when asked about their attitudes towards multifunctional agriculture, land use, and agri-service payments (2015). According to their study, a majority of surveyed farmers placed greater value on food production goals tied to agri-service payments, compared to a minority of farmers who placed greater value on cultural landscape management goals (*ibid*).

Most importantly, they conclude that attitudes towards agri-service payments "may indicate that Norwegian farmers' views are not fixed," reflecting a clear distinction in how policy environments shape farmers' attitudes. Social perspectives are of further interest then to describe multi-scalar drivers of farmers' attitudes and transformation processes.

1.1.2 Agriculture and food production in Norway

Land-based agriculture in Norway is limited by its topographical and climatic conditions. Since the mid-20th Century, the Norwegian government has promoted region-specific agricultural production in different areas of the country. Low-lying central and eastern regions have been prioritized for grain and crop production, while higher-lying western, central, and northern regions have been prioritized for domestic livestock husbandry (Knutsen, 2020).

Transhumance reindeer husbandry is practiced in the country's northernmost plains and represents a culturally distinct form of livestock husbandry than what is practiced in the rest of the country. In areas with the best grain growing conditions, grain yields per hectare are relatively low compared to other European countries, with no opportunities for sugar crop cultivation. The Norwegian Institute for Bioeconomy Research (hereon referred to as NIBIO) has described "grass-based livestock production as the backbone of Norwegian agriculture" (*ibid*).

Therefore, farm rationalisation has occurred in larger and more fertile regions, compared to agricultural extensification and fragmentation in marginal and less fertile regions. Compared to the rest of Europe, however, the pace and extent of farm rationalisation into fewer and larger holdings has been minor in Norway (Forbord et al., 2014). When observed more closely, developments in the structure of agriculture have in fact been periodic and gradual. In the 1990s, when agricultural policies sought efficiency gains, market prices were cut for livestock feed and emphasis was placed on multifunctional objectives in farming and rural development (*ibid*). During the early 2000s, subsidy payments per land unit increased the profitability of arable and grassland production in the most fertile agricultural regions, particularly south-eastern Norway (*ibid*).

Throughout history, the state has used direct and indirect assistance measures which have retained agricultural holdings across 77% of the country (OECD, 2021). Approximately one quarter of Norway's total land area is made up of mountains and mountain elevations, comprising up to 70 municipalities across the country (NIBIO). Therefore, while just 3% of Norway's total land area is used for cultivation, over 40% is used for extensive livestock grazing. These mountain regions are population sparse, but they make up approximately one-fifth of all farms in Norway (Vareide, 2021). Transterminance has made use of higher elevation, steep terrain, and marginalised fields and pastures, thus fulfilling a vital role in sustaining livestock grazing practices.

1.1.3 Outfield grazing in Norway

Transterminance, hereon referred to as outfield grazing,[1] is a practice defined by seasonal shifts in livestock production and resource availability. For dairy production, summer farming encompasses a seasonal period during which livestock are moved to summer pasture grazing by a shieling,[2] comprised of housing and permanent staff, so as to benefit from additional grazing resources over larger expanses. Activities like haymaking adjacent to the shieling has allowed farmers to save resources on the home farm while maximizing winter forage harvests in marginal areas (Stensgaard, 2019).

Yet mutton and beef producers may also use shielings for similar operating purposes, so outfield grazing is used throughout this thesis to describe the practice of transterminance in Norway. Farm holdings could have access to more than one shieling, the most proximate to the farm being the home shieling, and the more marginal one being the far shieling. Typically, livestock were brought to the home shieling in the spring for early grazing, in the autumn for late grazing, but were brought to the

[1] *Utmarksbeite* in Norwegian.
[2] *Støl* in Norwegian; a building and infrastructure equipped for producing, storing, and processing raw milk.

far shieling throughout the summer. In certain examples, farmers would utilize multiple shielings throughout the year to make the most of available grazing resources.

The socio-cultural and political dimensions of outfield grazing also require attention. Outfields and their habitat patches (e.g., forests, lakes) are used for hunting, fishing, and recreational opportunities experienced by both locals and visitors throughout the year. The way in which grazing resources and outfield resources are managed depends on whether they are delimited as state commons, rural commons, or privately owned. Similar to agricultural developments in Norway, the configuration of land use and land ownership has undergone complex historical developments.

State commons were historically managed as rural commons by local communities under the former Danish Crown during the 17th Century. In the past, boundaries within these commons were designed based on topographic and geographic utility by type of use, commonly by village associations. However, as early as the 17th Century and as late as the mid-19th Century, portions of rural commons were sold for political and economic motives. This process allowed for the successful demarcation of usage rights in state commons in upland areas by the 20th Century (Arnesen, 2004). A large fraction of rural commons which had not been sold were designated as state commons, while the remaining fraction have been managed by farmer associations until today (*ibid*).

1.1.4 Legal framework for outfield grazing

State commons are managed under a state enterprise[3] but administered through local mountain and public councils. Different kinds of actors hold land use rights on state commons, with outfield grazers falling under the Mountain Law of 1976. Access to grazing rights is conditional on the use of shielings in connection to agricultural properties, not to the farm holders themselves (Eide, 2023). Farmers can extract the maximum amount of resources they need to operate their agricultural activities.

If a shieling has been out of use for a continuous period of 20 years, the mountain council must decide whether it will be transferred to another farm, demolished, or repurposed. All ownership rights are entitled to landowners in Norway and therefore grazing rights depend on farmers' access to outfields. Unless documented, grazing rights are subject to discreditation, which presents a challenge for users whose grazing rights were established through verbal agreements in the past.

Due to their expansive range, the outfields in mountain areas have been exploited by multiple farm holdings, usually corresponding to farm holdings on adjacent valley sides. These grazing cooperatives[4] are governed as associations and were formed to jointly manage things like grazing resources, animal

[3] *Statskog SF* in Norway
[4] *Beitelag* in Norwegian

gathering, fencing, and infrastructure upkeep. Conflicts around grazing rights and land use for both private land and commons land are settled through the Land Consolidation Court,[5] which may change existing boundaries, usufruct rights, or rearrange rights of use according to settlement agreements. Such land use settlement processes can take place over several years, during which time corresponding adjustments to agricultural practices and the use of outfields may be impaired (Sky and Elvestad, 2021).

State regulations can also influence the legal basis for outfield grazing. For example, as of 2022, the minimum length of the outfield grazing period necessary for receiving agri-service payments had been reduced from '8 weeks or more' to '6 weeks or more' (Eide, 2023). For milk production with dairy cows, the requirement was further reduced to a minimum period of 'at least 4 weeks' (Regjeringen, 2021).

The Norwegian government suggests such regulatory changes have been made in an effort to catalyse outfield grazing to maintain agricultural landscapes and safeguard their associated biodiversity (Fløystad, 2022). Whether or not farmers use outfield grazing resources, however, can depend on a multitude of drivers, not limited to farm production intensity, the condition of outfield grazing infrastructure, state regulatory frameworks, local climatic conditions, and both the mental and physical health of the farm managers and their families.

1.1.5 Ecosystem services from outfield grazing

Various ecosystem services have been positively associated with mountain farming in Europe, such as cultural landscape preservation, biodiversity conservation, soil fertility, and wildfire prevention and regulation (Bernués et al., 2022). Mountainous cultural landscapes in Norway are largely shaped through mountain farming practices,[6] as ruminants actively suppress woody tree and shrub vegetation through combined grazing, trampling, and fertilization.

Over 1000 years of outfield grazing – perhaps as far back as the late Middle Ages – have promoted plant assemblages comprised of shade-intolerant grasses and herbs (Prøsch-Danielsen et al., 2020). Examples of grassland species of high biodiversity value in Norway include Bistorta *vivipara* (alpine bistort), Potentilla *erecta* (tormentil), and Viola *biflora* (alpine yellow violet), all of which have been linked to improved milk quality (Bele et al., 2019).

Grazing animals play a key role in managing these habitats because they are, through their ruminant behaviour, active agents in change processes for the landscape. Grazing stimulates the growth of

[5] *Jordskifte* in Norwegian
[6] *Fjellandbruket* in Norwegian.

vascular plants, which are recycled through ruminant digestion and returned to the soil organic matter as fertilizer. Continuous mowing and fertilization reintroduce key micro and macro nutrients to the soil, which in turn promote species richness and reduce the competition of certain grasses (e.g., Bromus *pubescens*).

The relationship between livestock grazing as an ecosystem service and biodiversity may, however, differ depending on management practices and grazing behaviour (Wehn et al., 2018). Landscapes with agricultural features and minimal modern obstructions are strongly connected to Norwegian cultural identity. To this end, the Norwegian government aims for the highest degree of involvement with landowners and the local community in decision-making processes for outfield areas (Regjeringen, 2017). Historical hiking trails and cross-country ski networks throughout the country are in part shaped by ecosystem services derived from outfield grazing.

1.1.6 Norwegian agricultural and climate policies

In June 2016, the Norwegian parliament ratified the Paris Climate Agreement, responding to the call for countries to "increase the ability to adapt to climate change, fostering climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production" (Regjeringen, 2020). That same year, the Ministry of Agriculture and Food established four agricultural policy objectives, namely, to safeguard food security and maintain preparedness; to maintain agricultural production in all parts of the country; to increase value creation; and to ensure sustainable agriculture and lower greenhouse gas emissions (OECD, 2021).

The combined sectorial policy agreements and instruments have created new opportunities and challenges for Norwegian agriculture. According to Norway's Climate Action Plan for 2021–2030, the agricultural sector is only responsible for reducing its emissions by 40% within this period, yet this level of autonomy was granted on the condition that the Government would not increase the level of agricultural subsidies to achieve this goal (Regjeringen, 2019).

The Agricultural Agreement (last revised in 2022) is considered the driving mechanism for implementing regulatory, economic, and information policy instruments. Two focal areas for emissions reductions in the agricultural sector are livestock husbandry and meat production, of which enteric livestock emissions (i.e., methane) and fertilizer emissions (i.e., nitrous oxide) are prioritized. Ruminant livestock production in marginal and upland areas will be supported in recognition of its value to local food production and area efficiency. However, according to Norway's Climate Strategy, there is an inherent contradiction between agricultural and climate goals to this end: reducing

emissions from livestock production while increasing food production for national self-sufficiency (Regjeringen, 2019).

After failing to increase domestic food production in the previous decade, the Norwegian Ministry of Agriculture and Food has proposed increasing self-sufficiency of Norwegian food resources up to 50% by 2030 (Regjeringen, 2011, Regjeringen, 2022). Targeted livestock breeding programs for high-yielding qualities, fodder developments for reduced enteric emissions, biofuel switches for tractors with large engine capacities, and precision fertilization equipment are seen as necessary climate measures to achieve these emissions reductions. At the same time, the Government has recognized the importance of indirect measures for emissions reductions, such as using locally available grassland resources (Regjeringen, 2019).

Among Norway's efforts to promote multifunctional goals, the market price and direct payment incentives for agricultural production have met criticism by the international community. The OECD suggested that incentives for preserving agricultural landscapes with specific production types have contributed to "food security in Norway at an unnecessarily high cost" (2021). Yet the OECD also claims that in order for Norway to maximize its GHG emissions reductions, changes in the structure of livestock production towards improved feed and livestock efficiencies must be made, increasing the productivity per animal rather than the number of animals altogether (*ibid*).

Cattle represent the ruminant livestock system undergoing the greatest rationalisation in Europe (Petersen et al., 2013). Consequently, an increasing percentage of livestock excreta are not deposited while livestock graze, but are rather collected and stored as slurry for later fertilization. At the same time, it was reported that manure management was the largest agricultural emissions source in Norway, with cattle being the largest source of ammonia emissions (Carbon Limits, 2020).

Combined structural and environmental developments in Norway have the potential to transform landscapes and influence farm systems for generations to come. Greater focus on understanding how emissions reduction efforts, such as those presented in Norway's Climate Strategy for 2030, affect different kinds farming practices are needed (Rønningen et al., 2021).

1.1.7 Addressing systemic change holistically

Multiple researchers have warned that policy measures towards efficiency gains for achieving emissions reductions in Norway are encouraging farmers to pursue increased productivism (Vik et al., 2019, Rønningen et al., 2021). The compounded effect of these development trajectories further creates regional disparities in farm performance and adoption of new farm technology (Alem, 2021). So, there is a risk that performance-based policy directives could further marginalize mountain farms

that are not equipped to adopt technology and efficiency measures as readily as more rationalised farms.

The OECD has even acknowledged that extensive food production such as livestock grazing may experience competing relationships between agricultural policy and environmental policy objectives (2021). Particularly for multifunctional agriculture like outfield grazing, farmers' perspectives can be leveraged to better orient policy measures seeking to remedy complex systems change. Farmers' perspectives – defined as the individual and collective worldviews mutually influenced by dynamic value-matrices – are used as the basis for assessing key issues facing mountain farming, specifically outfield grazing in Norway.

As will be described in the next chapter, a growing body of literature has used resilience as a conceptual tool for researching systemic changes in farm systems. In asking whether farmers' perspectives complement resilience towards changes in mountain farming, this thesis also attempts to integrate resilience as a conceptual framework. Yet every one farmer and their respective farm systems describe different sets of cultural, environmental, material, social, and technological relations. The results discussed in this thesis examine relations embedded in mountain farming systems to analyse systemic change holistically.

1.2 Theoretical background

1.2.1 Farms as social-ecological systems

Farm systems vary widely in their ecological and social organizations. Farm managers have varying degrees of interaction between farm levels and among farm components. Their practices determine ecological outcomes on the farm, which have positive or negative consequences for the wider ecological network. Social-ecological systems (or SES for short) describe systems where anthropogenic relations are embedded in ecological networks (Berkes et al., 1998).

Using SES to describe farm systems takes one step further in analysing relations in food production holistically. These relations range in their components, from soil type to farm holding structure, from cultural tradition to production outputs. Particular importance has been placed on actors and governance systems in SES, especially the processes shaping relations and their combined decision-making power (Dwyer et al., 2018).

1.2.2 Resilience in farm systems

Farm systems are self-organized in such a way that they can determine multiple outcomes, depending on which processes are enabled (Holling, 2001). The resilience of SES, including farm systems, is exhibited through its capacity to respond to disturbances through dynamics that minimize its vulnerability and promote desirable change processes (Darnhofer, 2014).

Identifying resilience in farming systems remains relatively subjective, as it is not static state. It is a dynamic process which is largely enforced by our combined understanding of what constitutes a desired system state. So, depending on the self-organization of the actors involved, farm systems can have convergent or divergent development trajectories. Resilience theory identifies all farm actors (e.g., farmers, their families, their neighbours) as key decision-makers in achieving desirable change processes. Resilience occurs at multiple levels, at multiple spatial and temporal scales, and describes various change processes, some of which may even overlap (Holling, 2001).

Resilience may occur as an emergent property of farm systems from the relations between system components across scales. It may also be transferred from other systems (e.g., institutional protection against competitive food imports from abroad), or may be embedded within the farm system itself (e.g., skilled farmers). The relative benefit of different kinds of resilience are most evident as the farm develops, especially following a disturbance, which "differ in their intensity, duration, and frequency of impact" (Groot et al., 2016). It is important to understand these distinctions because change processes can result in paradoxical outcomes throughout the farm's development.

When described altogether, farm resilience is a feedback process determined by farm actors' assessments of their capacity for change (Darnhofer, 2010). Studying farm systems in the context of resilience is particularly needed for understanding land use changes at larger scales, which will be described later on. Fostering resilience at varying levels may eventually create system linkages with feedback dynamics that enable sustainable food production while addressing parallel complexities.

1.2.3 Adaptive cycles and panarchy

Change in complex systems is theorized to occur throughout several inter-linked phases. The adaptive cycle describes how systems pass through these phases and persist, or change over time. Farm management interventions may be taken if they are within the agency of connected farm actors (Groot et al., 2016). However, if the system is able to transform in such a way that it becomes resilient to novel disturbances, it enters a new adaptive cycle.

Several inter-linked adaptive cycles at varying levels are called a panarchy (Holling, 2001). As part of everyday farm management, a farm manager must continuously reflect on enabling or diminishing

properties within the farm system. Management decisions that promote desirable change processes are dependent on exogenous realities (e.g., resource availability) and endogenous realities (e.g., perceptions) (Bay-Larsen et al., 2018). Particularly when looking beyond the farm system, farm managers whose decisions are reflected at various scales are actively engaged in panarchy thinking.

Yet the true adaptive capacity of a farm system will largely depend on its degree of connectivity with other systems and their respective adaptive capacities (Allen and Holling, 2010). This is easily visualised in their illustration of a tri-system panarchy, shown in Figure 1, below. A resilient farm will navigate this adaptive cycle and reorganize itself for the next growth phase, maintaining or severing connection points between adaptive cycles at different scales (Darnhofer, 2014).

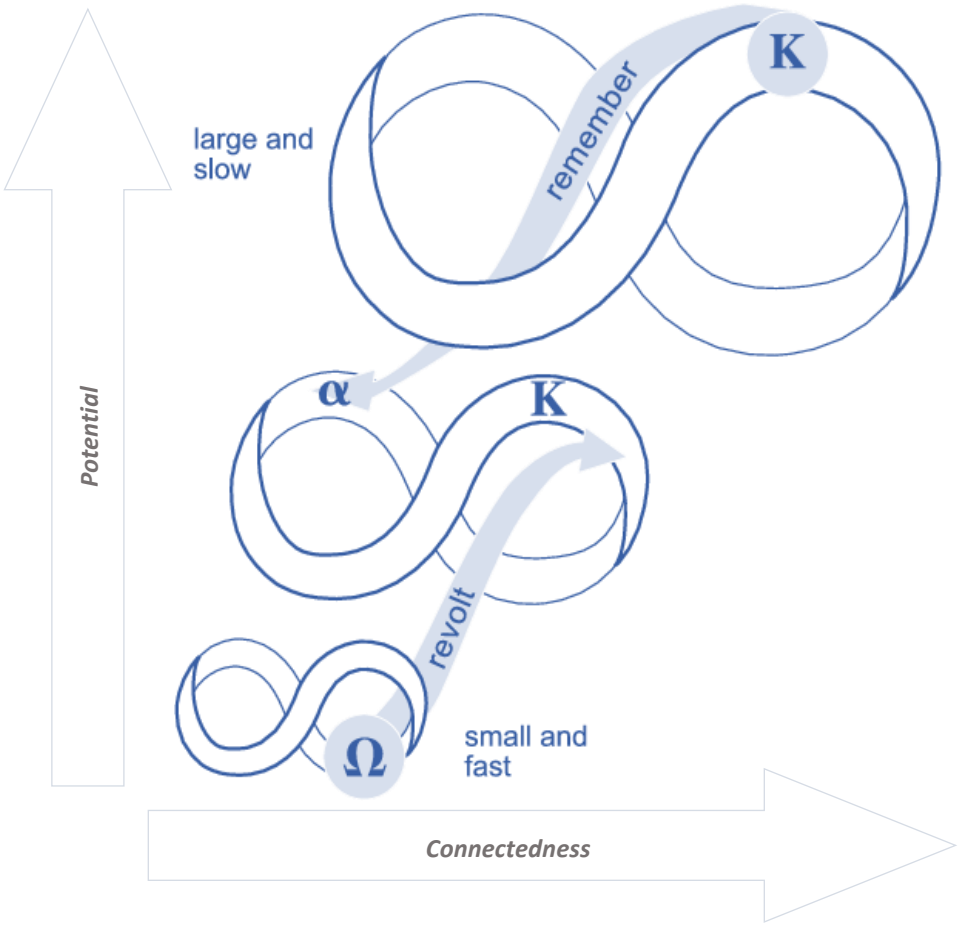

*Figure 1: tri-system panarchy linked in different stages of each adaptive cycle. The cycle at the middle scale may undergo a phase of re-organization **(α)**, renewed at a larger scale and slower period of conservation (**K**) (i.e., remember). Similarly, the cycle may undergo a phase of release (**Ω**), critically changed at a smaller scale and faster period of release (i.e., revolt). The adaptive capacity of the farm system is created and maintained through these two key connection points.*

For example, as previously described, there could be a mismatch between the adaptive capacity of individual farms to reduce their GHG emissions, compared to the adaptive capacity of the nation to self-organize towards a low-emissions state. A resilient farm may navigate an agri-service incentive scheme for emissions reductions by investing in lighter machinery. More time may be needed for this renewal, especially for budgeting, accounting, and repurposing of old equipment.

Similarly for emissions reductions, a resilient farm may dry off their dairy herd for part of the winter, reducing the required amount of overwinter forage, resulting in fewer enteric emissions. Less time is needed for this critical change, for example by reducing seasonal grass yields or opting out of buying additional round bales for winter.

1.2.4 Approaches to studying resilience in farm systems

In a recent review by Darnhofer, three separate approaches aimed towards (i) linking indicators of resilience to farm system components; (ii) assessing adaptive or transformative change based on farmers experiences, and (iii) highlighting the characterization and framing of resilience among key interest groups, were identified (2021). The premise of the review was that studies focussing on defining or recommending pathways towards resilience capacities could potentially overstate the importance of predictability in farmers' everyday decision-making. Yet by doing so, farmers' creative capacity to enable transformation could be undermined (*ibid*). Instead, capturing farm system change found in relations, "not least through different beliefs, values, perceptions, and expectations," describes the novelty of this approach (*ibid*).

Studies relying on farmers' experiences have linked their social perspectives and their resilience capacities (Perrin et al., 2020), which effectively illustrates different relations embedded in the adaptive cycle of the farm system. Yet these authors have emphasized how there "is still potential for further research, in particular with respect to perceptions and expectations of farmers" (Spiegel et al., 2021). A recurring knowledge gap in resilience studies is why farm transformations are recognized as necessary yet how farmers perceive their capacity for transformation as relatively low (Meuwissen et al., 2020).

Nonetheless, the nature of change and transformation can be difficult to assess. For example, at what point has the system adapted to specific disturbances – like substituting inputs and altering farming practices – or transformed itself altogether – like developing a novel farm production. To humbly approach farm system complexity, I follow two recommendations to integrate a relational worldview. First, I recognize the issue of change processes in Norwegian mountain farming as 'wicked,' for which there are multiple explanations to the issue, with no one solution. Second, I commit to understanding

farm system phenomena as (a) characterized by the relations of and between their component parts; and (b) their relations as dynamic unfolding processes (Selg et al., 2022).

A relational approach emphasizes “how farmers' values matter” by recognizing farmers as both agents and subjects of change (Darnhofer et al., 2016). Therefore, I consider change processes in mountain farming as a wicked problem driven by a complex and ever-changing set of relational dynamics within and across farm system levels.

Farmers' social perspectives complement change processes in outfield grazing systems because they are both agents and subjects of change (Bay-Larsen et al., 2018). A relational approach may create better understanding of the drivers affecting outfield grazing, which in turn sheds light on whether outfield grazing is believed to contribute to multifunctional goals in Norway.

1.2.5 Integrating a relational approach

Previous resilience research in Norway has been carried out using qualitative methods, addressing farm household and farm community resilience to either climate and/or structural changes in livestock farming systems. In 2012, Eriksen and Selboe studied a mountain farming community in Øystre Slidre (Innlandet County) to assess their social organisation of adaptation to climate variability and global change. Their study included 42 farmer and non-farmer participants, which were engaged through interviews and survey questionnaires. Their results showed how multiple forms of social collaboration were necessary for farmers to navigate climate events and variability, which were as important as the individual farmer strategies themselves (*ibid*).

In 2014, Svedal Jørgensrud used a double exposure framework of climate and structural change to assess the farm household vulnerability and adaptive capacity of farms in the Rauma municipality in Møre and Romsdal County. This study was also based on semi-structured interviews with 17 farmers, and through triangulation methods the author found structural changes were undermining the adaptive capacity of farmers to adapt to climate change (*ibid*).

Most recently, Beitnes and colleagues used a resilience lens to investigate how Norwegian farmers in the Sør-Fron municipality (Innlandet County) responded to the dry summer of 2018. Based on semi-structured interviews with 13 farmers, the authors described how farmers aimed to enhance their buffer capacity (i.e., endure the shock), with most participants having expressed “that the current development in agricultural policy is much more precarious than climate change.”

Building on previous efforts, Daugstad studied resilience in Norwegian mountain farm systems using a relational approach (2019). She interviewed 15 farmers in Oppdal Municipality in Trøndelag County, Norway. The author assessed, among other issues, the motivations of the farmers to remain in

farming, structural and climate changes, as well as their ability to cope with change. Her conclusions demonstrated how farmers exhibited three key capabilities linked to resilience, namely pragmatic actions, securing sufficient income, and changing mode of production or exiting farming altogether. The relational approach in Daugstad's study proved useful in identifying how resilience could be applied as a conceptual tool to studying mountain farms holistically.

The triangulation assessments in these resilience studies could be complemented by quantitative assessments in their inherent subjectivity. Building on these studies, there is a need to further dimensionalize farmers' perspectives based on their level of agreement with one another, while simultaneously assessing the subjectivity inherent to their perspectives.

1.2.6 State of the art

The objective of this study was to describe change processes in mountain farming based on farmers' social perspectives through the following research questions:

(1) How do farmers' perspectives on drivers influencing changes in mountain farming converge and diverge?

(2) Can emergent social perspectives be linked to indicators of agroecological resilience to describe change processes?

This mixed-methods study relied on aforementioned qualitative studies as part of a wider literature review, in which I thoroughly identified key drivers influencing changes in Norwegian farm systems. By asking farmers to engage with and reflect on a collection of statements describing different levels and characteristics of change processes, participants are deliberately introduced to panarchy thinking. As was previously mentioned, resilience is by degree a subjective concept, reinforced by paradigms, institutions, technologies, and processes.

Quantitative approaches to measuring the ecological resilience of future landscape change at multiple scales has been successfully developed (Cushman and McGarigal, 2019). Likewise, previous research has quantitively examined farmers' motivations by linking farm characteristics and drivers of change (Bernués et al., 2016), as well as beneficiary valuations of ecosystem services from European mountain farming (Muñoz Ulecia et al., 2022).

Such survey designs have proven useful in assessing the perspectives of multiple actor groups on multi-dimensional issues but lack a relational approach. This study employs Q-Methodology, a method for measuring participant's subjective understanding of a topic, highlighted through an elaborated concourse, by measure of relative agreement.

Most recently, Q-Methodology has been employed to identify four social perspectives on landscape sustainability tied to various outcomes of corresponding SES (Torralba et al., 2023). Findings from this study also revealed differences between the means of achieving sustainability outcomes based on local contextual drivers, like drivers of change and constellation of actors in the various SES.

In understanding perspectives for achieving sustainable farm systems, a resilience framework could reveal similar differences in attitudes and beliefs, as well as constellations of actors towards shaping functional outfield grazing areas in Valdres. I adopt mountain farms in Valdres as the focal system for my study and decidedly analyse them at a territorial scale. Mountain farms are comprised of individual farm holdings, their associated shieling operations and outfield areas, as well as the connective landscapes they are embedded in.

1.3 Study area

1.3.1 Biogeography

Valdres is a regional district in central southern Norway covering over 5,400km², formerly located in Oppland County, which then became part of the larger Innlandet county in 2020.[7] The regional district comprises six municipalities along its valley, namely Etnedal, Nord-Aurdal, Sør-Aurdal, Øystre Slidre, Vestre Slidre, and Vang (see Figure 2, below). In the north, its physical geography is characterized by the *Jotunheimen* mountains and *Valdresflye* mountain plateau. Expansive tracts of spruce forest extend from central to southern Valdres, sheltered by the neighbouring *Golsfjellet* mountain ridge in the southwest, with several fjord lakes are found between mountain ridges throughout the district.

Figure 2: Map of Valdres (bottom), as indicated by red mark in map of southern Norway (top-right). Source: Norgeskart.no and Kilden.nibio.no

[7] Valdres was formerly part of the Oppland county, which was merged with Hedmark to become a larger county called Innlandet in 2020.

There are clear regional patterns in the geomorphology in Valdres, with richer bedrock (e.g., containing phyllite) in the north and poorer bedrock (e.g., containing sandstone) in the south, with respective differences in soil profiles and hence vegetation types. Altitude also affects plant species compositions. In southern Norway, semi-natural grasslands, boglands, and boreal forest may be found between 800 and 1000 meters above sea level (masl), whereas natural grasslands and alpine tundra may be found over 1000 masl (Løkken et al., 2019).

1.3.2 Changes in livestock husbandry and outfield grazing

Relative to the country as a whole, summer farming in Valdres has persisted with small farm operations. The average dairy cow herd size in Valdres is 18 (Bunger and Haarsaker, 2020), compared to the national average of 28 (Bye and Bjørlo, 2023b). Bunger and Haarsaker found around half of surveyed summer farm users in Valdres were producing less than 100,000L of milk per year (2020), well below the national average of 128,000L per holding per year in 2020 (Landbruksdirektoratet, 2020). Intraregional differences in livestock husbandry exist within Valdres. In 2020, Nord-Aurdal had the highest number of cattle and sheep grazing in outfield areas, while Etnedal had the lowest. Alternatively, Vang has the highest number of winterfed and outfield grazing dairy goats (Bye and Bjørlo, 2023c).

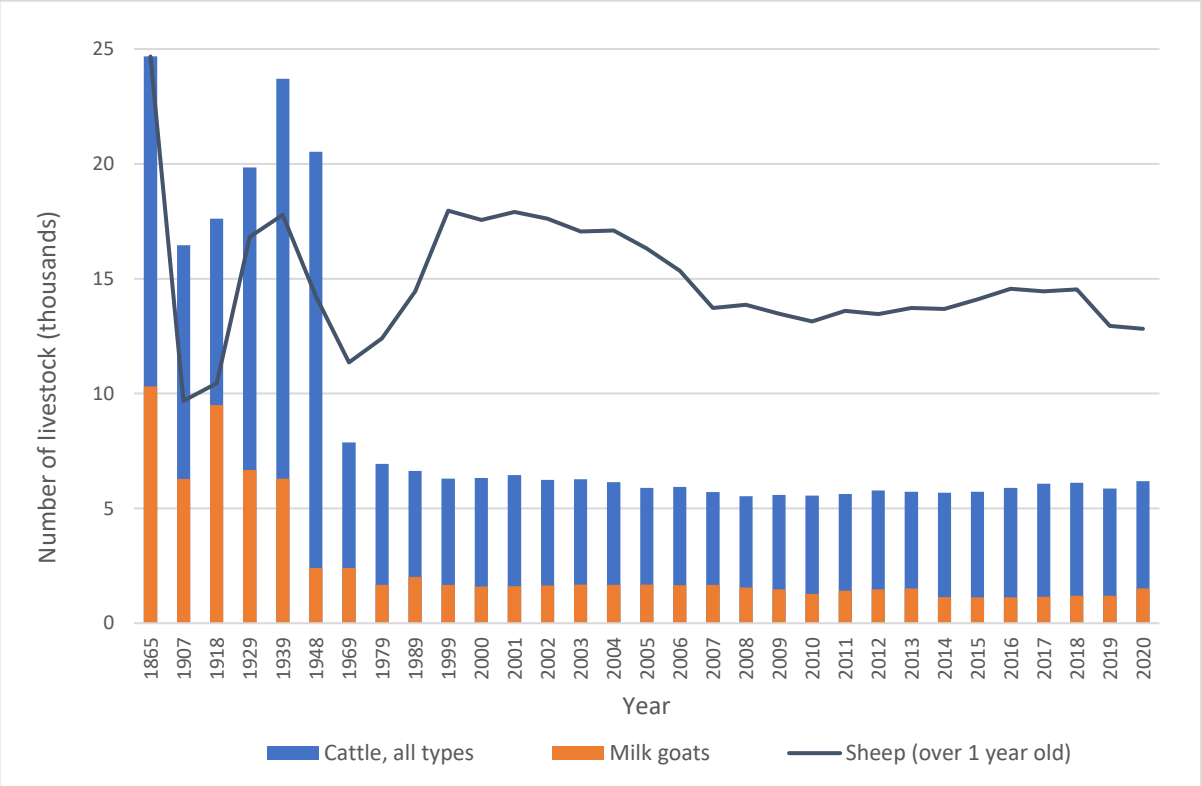

Figure 3: Total number of cattle, milk goats, and sheep in Valdres (1865-2019). Note that the years preceding 1999 are discontinuous periods. Total cattle include calves, suckler cows, dairy cows, and beef cattle.

Historical data on livestock husbandry in Valdres is available for non-consecutive years between the 19th and 20th Centuries, and onwards from 1969 for different livestock types (Berg, 1950, Bye and Bjørlo, 2023b). In 2020, there were almost half as many sheep than there were in 1865, with a steady reduction of almost 30% between 1999 and 2020. Comparatively, the number of milk goats fell sharply between the mid-19th and 20th Centuries, further declining by over one third between 1969 and 2020 (see Figure 3, previous page).

Following these declines, the total annual milk production in Valdres has fallen by almost 2,000,000L in the last decade (Gro, 2023), during which time the number of nurse cows has doubled, and the number of dairy cows has fallen slightly (see Figure 4, below). Similar trends can be found in neighbouring regions and across the country.

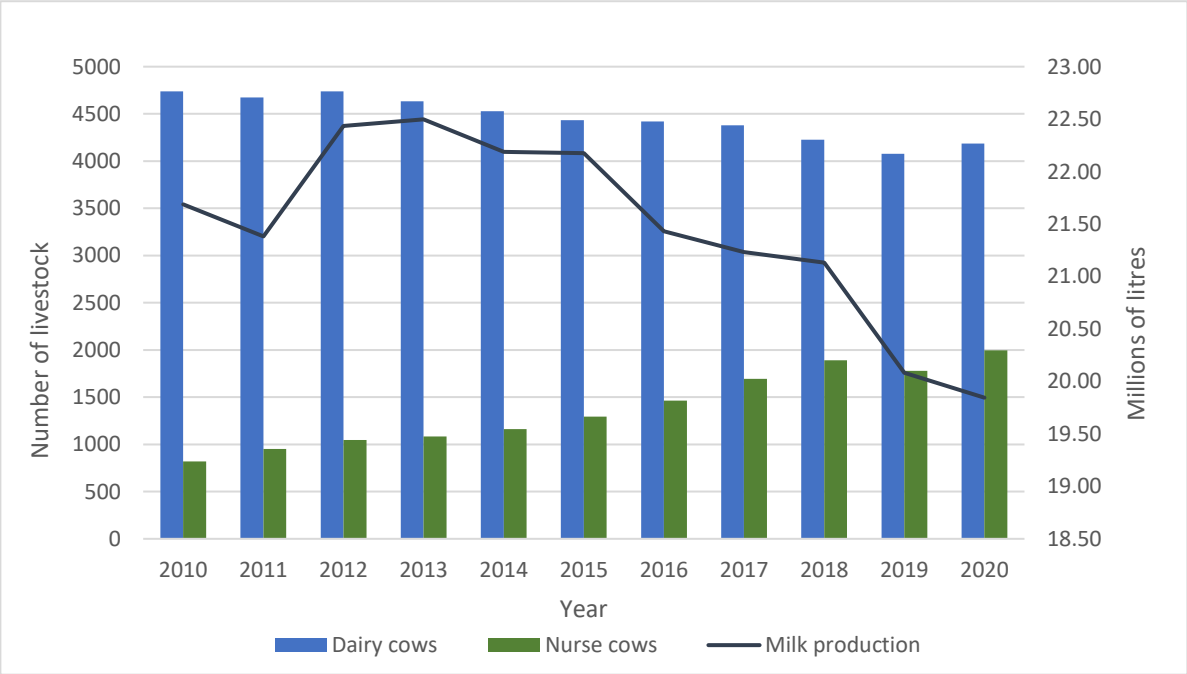

Figure 4: Total number of dairy and nurse cows vs total milk production in Valdres (2010-2020).

At the County level between 1998 and 2019, the number of dairy cows has declined over 30%, while the number of nurse cows increased by nearly three times (Bye and Bjørlo, 2023b). A similar trend is described for Norway (Knutsen, 2020), where dairy cows are selected for high-yielding traits, herd sizes decrease, and the management costs for maintaining smaller herds becomes too high. Losses in livestock husbandry in Valdres mirror those found in livestock on outfield pastures (Bye and Bjørlo, 2023c). Between 1995 and 2020, the number of farm holdings using outfield pastures fell by over 50%, outpacing the 22% decline in the number of livestock animals on outfields during the same period (*ibid*).

In Norway there were 60% fewer dairy farms in Norway with active summer farms in 2018 than there were at the turn of the millennium (Bunger and Haarsaker, 2020). New regulations in Europe for free-stall barns are considered a major driver of summer farm cessation (*ibid*). To respond to the regulations, which come into effect in 2034, farms are required to upgrade their barns from tie-stall to free-stall holding. An exception is granted by the Norwegian Food Safety Authority to farmers with at least half of their herd being traditional livestock breeds, such as Vestlansdk Fjordfe, which have conservation status in Norway (Eide, 2023). As of 2020, only one third of active shieling users in Norway had upgraded to free-stall barns. Mountain areas in Norway, such as Valdres, represent the regions with the fewest barn upgrades (Bunger and Haarsaker, 2020).

So, with the exception of Oppland County since 1998, the number of livestock grazing in outfield areas has seen sharp and steady declines on a regional and county level. The decline is especially evident with dairy cows and dairy goats. Moreover, these trends are in tandem with both reduced usage of outfields grazing resources and ceased shieling operations, at regional, county, and national levels.

Fewer livestock grazing pressure in outlying areas impacts the plant assemblages and vegetation cover across the landscape, and variations in the associated impacts on grazing quality within Valdres. More high-quality sheep grazing pasture is found in high-altitude grazing areas in Vang, northern Valdres compared to the former Oppland County at large, while the largest share of good quality grazing pasture is located in Nord-Aurdal, southern Valdres (Mobæk et al., 2022).

Some high-quality pastures have already been lost, making it very labour intensive and difficult to re-establish them. From a management perspective, the labour inputs and costs required to re-establish or maintain high quality pastures may outweigh their eventual benefits. Current studies are underway to determine the extent of grazing pressure impact on vegetation species and composition turnover, particularly for semi-natural hay meadows of high biodiversity value (Bär et al., 2021). Areal data reveals that the largest potential for overgrowth in outfield areas could possibly occur in central and north-eastern Valdres, with large overlap in areas considered to be of high cultural landscape value (Bryn, 2023).

1.3.3 Structural developments

The cumulative effect of ceased outfield livestock grazing in mountain areas is well-documented across Europe and is often accelerated by rural abandonment, dwindling economic opportunities, increasingly marginalized communities, and better living standards in near-urban areas (Herrera et al., 2017). Changes in farm structure, farm holdings, and land use are indicators of such developments. More agricultural area has been put to use through transfer of ownership and renting. While farm

holdings in Valdres declined by ~40% between 1999 and 2019 (Reid, 2023), the proportion of holdings renting agricultural land has risen, as shown in Figure 5, below (Bye and Bjørlo, 2023d).

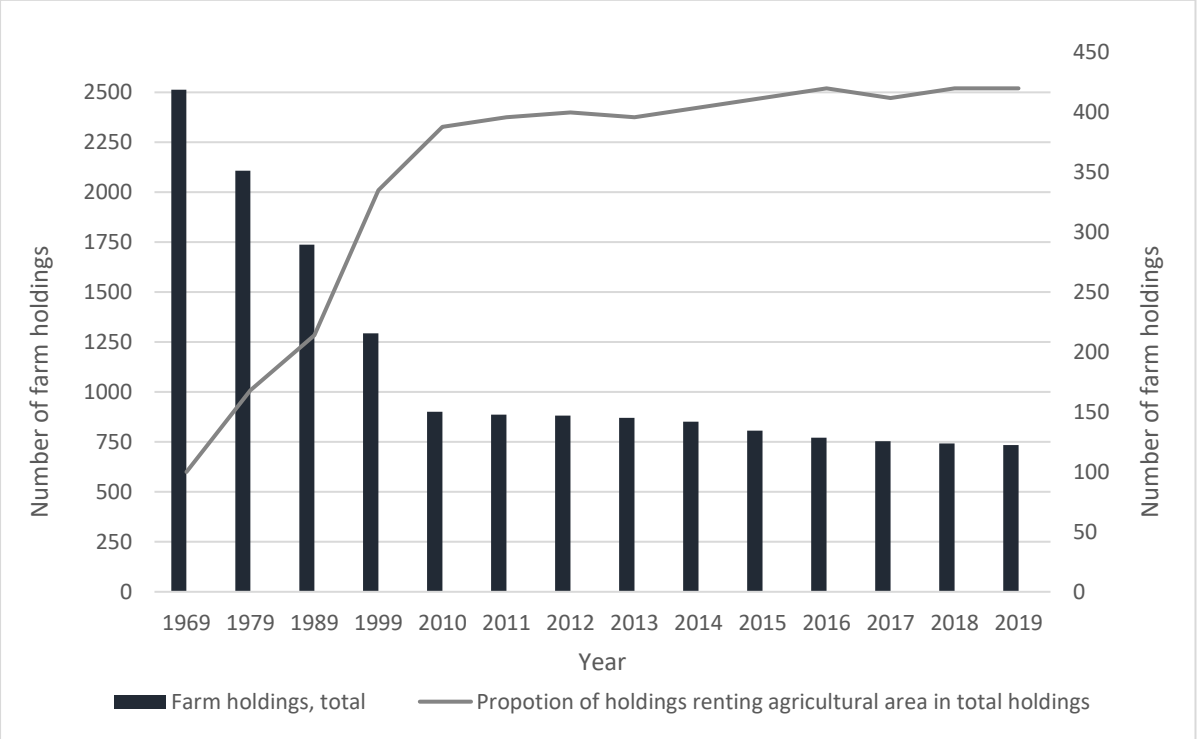

Figure 5: Total number of farm holdings vs proportion of farm holdings renting agricultural land in Valdres (1969-2019).

Combined rates of farm closures and tenancy in agriculture suggest that structural rationalisation of farm units has occurred to some extent in Valdres, although it is unclear if this corresponds to an intensification of agricultural practices. Renting land can be an important way of securing sufficient fodder resources on holdings with minimal infield resources. This trend can also be seen at a national level, as farm closures open up the opportunity for persisting farms to make use of their infield resources (Dramstad and Sang, 2010).

Entrepreneurial diversification also influences land use change in Oppland County. More agricultural land has been repurposed for other uses, while an increasing minority of farmers earn most of their entrepreneurial income from farming (Bye and Bjørlo, 2023a, Aarstad, 2023). As farmers become more engaged in non-agricultural entrepreneurial activities and become increasingly pluriactive, so too have farm holdings and farm infrastructure become repurposed for other uses than farming.

Tourism, trade, service, and construction employ over half of all residents in Valdres, which is the highest proportion to total labour in all regions of Innlandet County (Alnes et al., 2015). It has even been argued that Valdres cannot be considered a functional living and working region when considering the time residents spend in traveling large distances between municipal centres (*ibid*).

An especially prominent land use trend has been holiday home development, which has resulted in more holiday homes than there are residents in Valdres (Mathiesen and Takle, 2023). A near majority of holiday homeowners in the region aren't local residents (Lerfald et al., 2022), which creates a need for infrastructure to accommodate seasonal influxes of visitors throughout the year. NIBIO has estimated that for counties with challenging outfield topographies, such as those in Valdres, holiday homes and near-urban areas can remove at least 10% of usable grazing area from livestock (Eide, 2023).

In a parallel landscape development, more outlying areas in Valdres have come under protection since 2021, most notably in Sør-Aurdal and in Øystre Slidre (Reid, 2023). Since 2018, the Ministry of Climate and Environment has set in motion the process of land under national protection in an effort to create robust wildlife corridors. This would effectively merge lower-lying areas of high conservation value to connect the Jotunheimen national park in northern Valdres with the *Utladalen* landscape protection area to the East (Statsforvalteren, 2022).

The restrictions for different types of usage in protected areas do not apply to grazing animals and should not affect the farmers' ability to use outfield pastures. Yet the indirect consequences could impair farmers' ability to use outfields under protection, such as increased visitor traffic disturbing grazing animals.

1.3.4 Regional and national climate variations

Both maximum seasonal temperatures and annual precipitation levels for Oppland County have increased by the same rate between 1901 and 2020. Local variations in climatic data are in any case geographically distinct at the local level. While the climate data from local weather stations in Valdres is incomplete, long-series data from several stations indicate annual temperature warming trends in the past Century (NCAS, 2022, NCCS, 2023).

According to the Norwegian Climate Services Centre, areas where precipitation levels are expected to increase may lead to increased rates of evapotranspiration, specifically during greater hydrological surges in the summer (I. Hanssen-Bauer et al., 2017). Based on several projections, Oppland County is expected to be one of several regions with future aggravated drought conditions, with expected overall declines in summer groundwater at the end of the Century (*ibid*). Considering that declines in summer precipitation could have major impacts on drought characteristics, the future ability to both produce winter feed and graze livestock in outfields is at risk.

The Norwegian Climate Services Centre also suggests that the need for climate adaptation in Oppland County will be necessary for a future scenario with high precipitation levels, increased flood and

stormwater damage, and worsened flood and landslide conditions (NCCS, 2021). Between 1900 and 2100, estimations show Oppland County will experience an average annual temperature increase of 4.0°C, with disproportionately higher temperatures in winter than in summer. Moreover, the number of days with heavy rainfall in Oppland County is estimated to increase by 20% in the same period, with higher amounts of rain than snow in winter (*ibid*).

The implications of this warming scenario on mountain farming are manyfold. Warmer winters will lead to reduced snowfall and shorter periods with snow coverage. This has subsequent consequences on terrain quality and farming conditions, with variable freezing temperatures increasing the risk of surface ice build-up and injury for livestock with outdoor access (NCCS, 2021).

An earlier snowmelt in the Spring combined with increased precipitation levels could create wetter and thus unfavourable soil conditions early in the growing season. Fungal and bacterial outbreaks will be more common in wetter growing conditions (I. Hanssen-Bauer et al., 2017). Such combined climate effects could encourage farmers to plough fields more frequently and increase their use of herbicides/fungicides to help guarantee winterfeed requirements.

2 Materials and methods

2.1 Q-Methodology

Q-Methodology (hereon referred to as "Q") is a mixed methods approach to exploring the social perspectives of participants on a given issue. Using qualitative statements extracted from a broader concourse (in this case, from scientific literature), participants must respond to individual Q statements according to their level of agreement (Brown, 1980). The collection of responses is considered as the participant's viewpoint on the topic, which may be quantitatively analysed to examine degrees of separation between participants' viewpoints.

Q-studies consider the researcher as an active participant throughout the study, meaning the extrapolation of the statements are linked to the researchers' knowledge of the system (Webler et al., 2009). As such, the purpose of my systematic literature review is simultaneously to draw out relevant statements that in part comprises the content of the Q study.

Critical reflection was at the core of this study since study participants were mountain farmers themselves. This Q-Study intentionally explored the perceived relationships between facts and values of resilience in mountain farming through participants' self-awareness (Zabala et al., 2018). Scientific

findings were operationalized in a present progressive tense with the understanding that they were open and non-conclusive statements on key issues facing mountain faming. As is shown by the literature review section in the appendix, the scientific consensus on change processes among mountain farming is incomplete and therefore yields no right or wrong answer, but simply better or worse outcomes for Norwegian agriculture (Selg et al., 2022).

Put simply, the content of the statements "highlight the ambiguity and openness of real life, as well as the context-dependency and complexity of intertwined processes" (Darnhofer, 2021). Depending on how farmers choose to sort these statements, social perspectives may emerge revealing their reflections on the assemblages of relations that drive change processes within farm systems.

2.2 Literature review

In order to conceptualize resilience for selected issues in mountain farming, statements were categorized according to indicators of agroecological resilience put forward by Cabell and Oelofse their paper "An Indicator Framework for Assessing Agroecosystem Resilience" (2012). These are behaviour-based indicators of resilience built on previous theoretical interpretations with the goal of establishing relevant facilitation processes for farmers.

Indicators were used as a surrogate to understand resilience in farm systems, while also enabling further analysis throughout the various phases of the adaptive cycle, as each indicator corresponds to separate yet interlinked phases. Depending on the value participants place on certain statements, it was hypothesized that further analysis may reveal areas of resilience that describe change processes occurring within the adaptive cycle. A graphical representation of these interlinked phases is provided in Figure 6, on the next page.

The issues that are identified and selected form the concourse towards a relational approach. A search string filter was used to systematically identify relevant literature tied to mountain farming in Norway, forming the basis for the statements which farmers engaged with. Local and territorial-level studies were prioritized in Norway, whenever possible. The search string was composed of keywords from each indicator, combined with the focal system (e.g., Norwegian mountain farming), while maintaining the option for different word endings.[8]

Reflexivity was used throughout this selection process. Hence, in my literature selection, I studied its content and reflected on my interpretation thereof. This allowed me to examine the scientific literature (i.e., findings, conclusions, recommendations, limitations) within the proposed theoretical

[8] For example, the indicator "socially self-organized" was used to generate the search string: *("social*" AND,OR "organiz*") AND ("farm*" OR "agroeco*") AND ("Norw*" OR "mountain*").*

framework. The search was done in two scientific databases with institutional access, namely Web of Science and Oria Library Database. The requirements for selecting the literature were: (1) the applicability of keywords or relevant topics within the conceptual framework; (2) the recentness of the literature, prioritizing contemporary publications; and (3) the site-specificity of the literature, with extensive livestock farming being the main focus of selection.

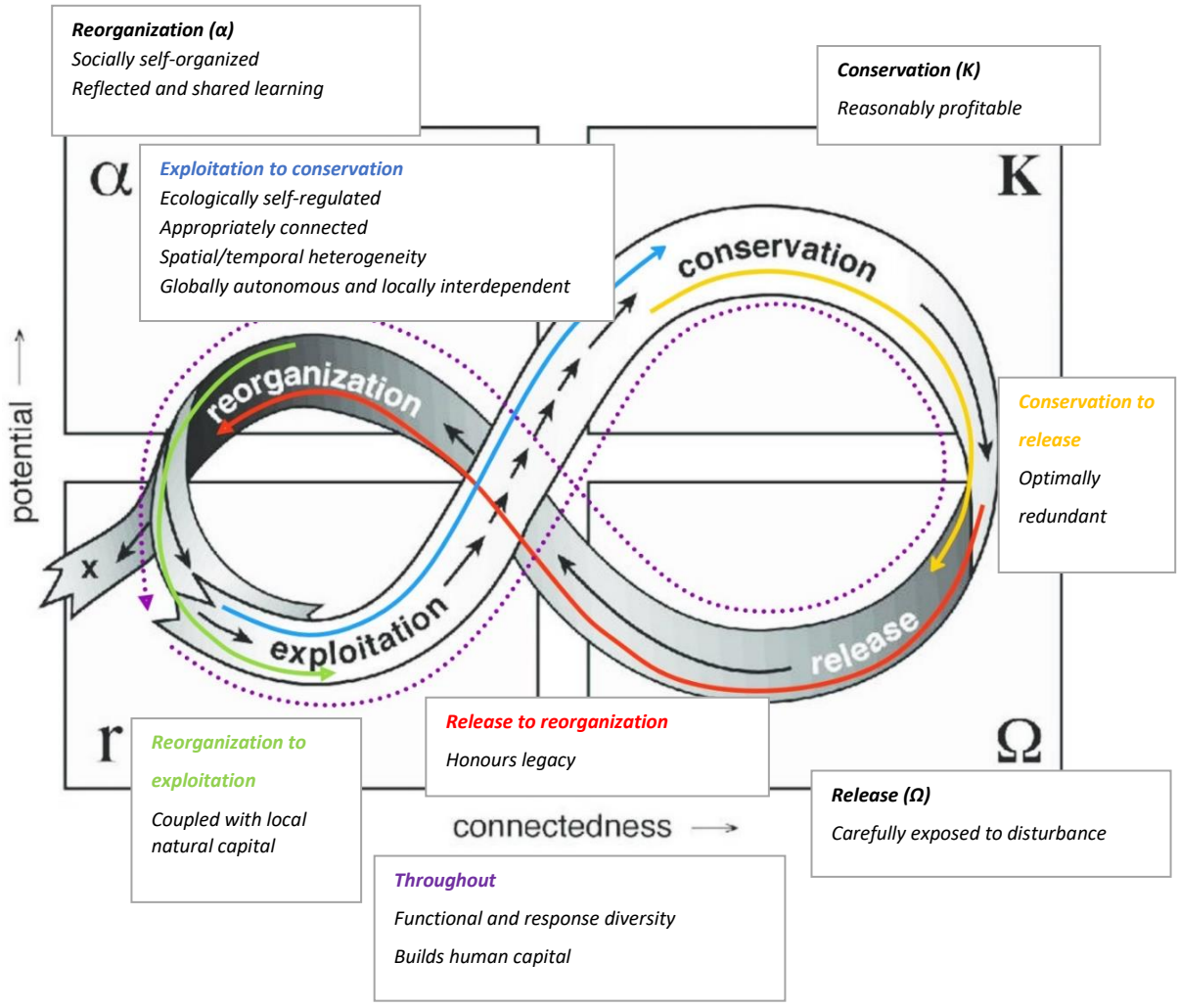

Figure 6: the adaptive cycle and points of influence across different interlinked phases among the 13 indicators of agroecological resilience by Cabell and Oelofse (2012). Adapted from Holling (2001).

For example, literature exploring agroecological resilience in unrelated focal systems that did not meet the third criterion and was not included. If literature exploring an indicator of agroecological resilience was found that had not been identified using the search string filter, the article was chosen and categorized based on remaining criteria. Furthermore, compounding the search results allowed me to identify related literature that was cited among selected papers, lending to a snow-ball sampling method of literature selection.

The final literature list comprised of over 100 scientific papers, ranging from previous masters' theses to highly cited publications. The content from the literature was summarized in an annotated

bibliography and altogether 49 statements were formulated for the Q-Study (see appendix). According to the Q-literature, the content of Q statements should be concise and accurately represent the broader discourse on the issue.

Further, statements that draw out saliency through their "excess meaning" (i.e., are able to be interpreted in multiple ways) are ideal for a Q-Study (Webler et al., 2009). Translation of the statements from English to Norwegian was provided by Valborg Kvakkestad (NIBIO), who is Norwegian herself and has considerable knowledge of mountain farm systems and research thereof. Translations were proofread by multiple other native Norwegian speakers to build internal validity and overcome any linguistic misunderstandings.

2.2.1 Internal validity

Because the final formulation of the Q statements varied depending on the kind of literature that was selected, my subjective interpretation of the content, and its degree of applicability to the study context lent to the validity of the Q concourse. Yet to further ensure validity, statements underwent several revision processes. One of the principal authors behind the agroecological resilience indicators (Cabell and Oelofse, 2012) was asked to revise the applicability of the statements to proposed indicators. In addition, several authors of key literature informing the content of the statements were contacted for clarification on specific issues, particularly in areas involving discussion within the literature. The final formulation of the statements was revised three times by my co-supervisor Valborg Kvakkestad before being tested in a pilot study.

Selective and snow-ball sampling was used to recruit four farmers for the pilot study, based on my own and my co-supervisor's personal contacts. Two respondents were located in Gol municipality (Hallingdal County), and Avdal municipality (Østerdalen County) in Norway. However, due to resource limitations, the statements were not tested in a Q-Study but rather in survey design using *SIKT*.[9] Some important feedback from participants was that the statements encouraged more agreement than disagreement, and that the content from some statements bore little relevance to participants' local contexts. The Q statements were revised accordingly and their final categorization into resilience indicators occurred before the actual study.

[9] SIKT is the Norwegian Agency for Shared Services in Education and Research, the central agency for ethics review for research in Norway.

2.2.2 Site selection

The results presented in this thesis were used to inform research by NIBIO under the ongoing project *Changes in outfield grazing: causes, impacts and measures*.[10] Among multiple research questions, this thesis has contributed to answering *what influences farmers' choice to use or not to use outfields for grazing and summer dairy farming?* The project identified Valdres and Nord-Østerdal/Røros as regions of interest for answering this question. Valdres was chosen for this study due to its ease of access and less challenging winter climatic conditions, as this thesis study was conducted over a 10-day period at the end of January 2023.

2.2.3 Participant selection

Selective sampling was employed in the first round of recruitment for the Q-Study. The criterion for participant selection was whether the farmer had applied for subsidies linked to animals grazing on outfield pastures in the year 2021, which was found in the latest agri-service payment registry data[11] prior to the study. More specifically, subsidies for adult and gleaned grazing livestock, including dairy and non-dairy livestock, which had grazed for a minimum period of 5 weeks, defined eligible over non-eligible farms for the study. Farm applicants' organization numbers were cross-referenced with farms located in one of the six municipalities in Valdres, identifying a total of 726 possible participants.

Contact information was found for 146 farms through open databases,[12] of which 44 were successfully contacted through a combination of SMS text message, e-mail, or phone call. When contacted for the study, participants were communicated to in Norwegian whenever possible and told the study was about change processes in mountain farming in Valdres. The farmers that responded to the study request were accepted by an invitation in English, with all subsequent correspondence being in English thereafter. Farmers were also invited to recommend other farmers for the second round of recruitment, namely through snow-ball sampling, following the same criterion as above. This method was especially effective for building rapport, as there are sociocultural barriers between researchers and study participants in open study calls without prior contact. Finally, 21 participants were included in the study.

[10] *Fjellbeiteprosjket Endringer i utmarksbeiting og setring - årsaker, virkninger og tiltak* in Norwegian.

[11] *RMP* in Norwegian. Agri-service payments with the following codes were selected: P410, P420, P431a, P431b, P432a, P432b, P440, and animals on outfield pastures.

[12] For example, the *Gulesider* registry in Norway.

One participant had to be excluded from the results, as it was later established that there was a mismatch between the information from the agri-service payment registry and the activity of the farm during the application period. Farm holdings comprising of multiple managers were allowed to participate in the study together. Thus, a total of 28 farm managers in 20 farm holdings formed the social perspectives presented in this Q-Study. The characteristics of the farm households and farm actors are summarized in Table 1, below.

Table 1: Farm household and farm actor characteristics[13]

	Total	Minimum	Maximum	Average
FARM HOUSEHOLD CHARACTERISTICS				
Total farmland area (hectares)				
Total agricultural land	157.2	2.27	15.7	7.86
Cultivated pastures (including rented land)	239.11	2	36.6	12.58
Grazing-only pastures	29.87	0	6	1.91
Production type				
Cow dairy production	8	-	-	-
Goat dairy production	3	-	-	-
Dairy processing	3	-	-	-
Nurse-cow beef	4	-	-	-
Mutton	8	-	-	-
	Total	Minimum	Maximum	Average
OUTFIELD RESOURCES				
Home shieling				
Infield cultivated meadow (ha)	15.72	0.3	6	2.62
Meters above sea level	-	650	1000	848
Distance from farm (km)	-	0.5	9	2.7
Maximum grazing period (weeks)	-	6	14	10
State commons	4	-	-	-
Privately-owned outfields	8	-	-	-
Far shieling				
Infield cultivated meadow (ha)	13.49	0.18	5.4	1.93
Meters above sea level	-	810	1100	914
Distance from farm (km)	-	8	35	18.2
Maximum grazing period (weeks)	-	8	14	11
Number of state commons	6	-	-	-
Number of privately-owned outfields	8	-	-	-

[13] Figures provided in Table 1 are based on approximations provided by research participants in interview data and data collected from https://gardskart.nibio.no/search. The data presented is illustrative but not conclusive.

Maximum number of livestock (adult animals per farm per year)				
Sheep	521	6	120	52
Beef cattle	99	10	60	25
Dairy goats	420	90	230	140
Dairy cows	152	5	40	15
Horses	11	1	5	3
Sum total	2573	-	-	-
FARM ACTOR CHARACTERISTICS				
	Total	Minimum	Maximum	Average
Members active on farm	60	1	6	3
Years managing	-	2	35	15
Farm managers	35	1	2	1.7
Pluriactive managers	27	1	2	1.4

2.2.4 Q applied: the sorting process

Participants were reminded of the objective of the study and different farm managers' social perspectives were discussed openly between farm managers during all stages of each study. This is important because, as has been previously described, farm holdings are dynamic and unfolding, and decision-making processes unfold as they are discussed among farm actors. Caution was taken not to discuss perspectives between farm managers of different farm households, to preserve anonymity among participants. Resilience was not discussed explicitly with farm managers, as per Daugstad's recommendations following her 2019 study,[14] given it could potentially mislead participants to express their own thoughts/opinions less freely. The study began with a semi-structured interview to become familiar with the participants' farm characteristics, their motivations for farming, their experiences, and any other relevant background information.

The participants were then informed of the procedure for the Q-Study. They were told that (1) sorting cards each contained a statement related to mountain farming, (2) they would eventually sort the cards on a sorting grid based on their level of agreement or disagreement, and (3) they would be interviewed throughout the process. Furthermore, they were invited to shift their perspectives during the study, prioritizing their own subjective experiences based on their farming practices, but also extending beyond the farm to other farms or system levels when relevant. Hence, the focal system was defined for participants as mountain farming in Valdres, representing the territorial scale.

To begin the sorting process, participants were asked to read and separate statements into three basic piles, namely "more how I think," "unsure or irrelevant," and "less how I think." Participants were not

[14] Internal communication by phone, January 18th, 2023.

discouraged from sorting statements into further piles, if they felt it was necessary for organizing their thought process. The aim of a successful sorting process is to regard each statement relative to the other, which encourages participants to prioritize their ranking of statements. Participants were invited to ask questions about the statements, comment on the content of the statements, and if needed, seek clarification on the meaning. Clarification was provided based on examples from the literature cited, yet explanations were kept open so as not to mislead participants. Once the first sorting process was finished, participants were invited to discuss what they had read if they wanted.

The sorting process continued on the grid, which was comprised of 13 columns and 7 rows following an inverted normal distribution layout. In Q-Studies, participants are often encouraged to divide statements into piles progressively (Webler et al., 2009), yet this wasn't always the case for this Q-Study due to participant time restrictions and scheduling priorities. Participants were told that the columns represented hierarchy in the ranking of statements, organized from left ("least how I think") to right ("most how I think"). Following this distribution, the fewest number of statements had to be selected according to the highest degree of saliency, with non-salient statements organized in the central columns.

Participants were encouraged to start with the columns of highest saliency and work their way towards the middle, following the recommendations made by Q researchers (Webler et al., 2009). After sorting, they were asked how they felt about their final Q Sort and were allowed an opportunity to rearrange statements accordingly. Finally, in order to build on the internal validity of the social processes represented in the Q-sorts, farmers were asked to identify any relevant themes in their final distributions, particularly in the corners representing highest saliency. All comments made by the participants during the Q-Study were recorded for subsequent data analysis.

2.2.5 Data analysis

Interview data

Participants' comments were recorded according to the statement they were responding to, which allowed me to support evidence for emerging supporting perspectives when analysing Q-data. Further, this supported the analytical lens of a relational approach to studying resilience, as participants were encouraged to discuss the statements wherever relevant and highlight any nuances in their perspectives. Interview data was further coded when linking participants' social perspectives to the indicators of agroecological resilience.

Q-data

Pattens found in final Q-Sorts are regarded as factors and were analysed using inverted factor analysis through extraction and rotation. Factor analysis is commonly used in survey design to extrapolate causal associations among categories of answers, where each individual answer is considered a variable (Webler et al., 2009). The fundamental difference in Q is that the Q-Sorts used in the data analysis are the variables, and the emerging social perspectives are considered factors. The factor analysis used for this Q-Study was Principal Component Analysis (hereon PCA).

Data analysis was completed using PQMethod Software (Schmolck, 2014). This first level of analysis (i.e., extraction) reveals *eigenvalues* for each Q-Sort, or the factor by which the Q-Sort was scaled within the factor matrix. Eigenvalues with a value of less than 1 are considered too minor for further analysis. In the second level of analysis, a varimax rotation was performed on the extracted factors, which is akin to "changing the viewpoint from where results are observed, much like changing the range of a scale or applying a logarithm" (Zabala et al., 2018). Subsequently, a correlation coefficient is calculated, revealing the standard deviation of each Q-Sort from the mean, described as a *factor loading* and represented by *z-scores*. Hence, each factor loading describes the degree to which individual Q-Sorts correspond with emerging social perspectives.

The researcher must decide how many factors to rotate and highlight, and four guiding criterion of selection are applied: simplicity, clarity, distinctiveness, and stability (Webler et al., 2009). They detail how simply social perspectives can be described, if participants load onto one factor or more, how similar correlations between factors are, and how similarly participants cluster into respective loadings. Participants who load highest onto emerging factors are regarded as defining social perspectives, whereas those that don't load onto a factor reveal poor data resolution for analysis.

It also the researcher's responsibility to describe emergent social perspectives based on the *z-scores* of statements from each factor loading and corresponding comments made by participants during the Q-Study. The internal validity for this study is supported by its large sample size (i.e., number of Q statements), corresponding to an extensive literature review, finally corroborated among multiple external experts. Measurement validity of the statements were supported by brief follow-up interviews among participants loading most heavily onto each social perspective in order to support my own interpretation of emerging factors. The final factor analysis was also supported by interviews preceding the Q-Study in order to represent participants' perspectives as best as possible.

The Q-data was interpreted similarly to how factors were selected. Raw z-scores describe the salience of each statement within the social perspective, which are compared between each other. Highest

and lowest points of salience are used to describe areas where farmers' perspectives converged and diverged, which begins to describe their perspectives on change processes in mountain farming in Valdres. Factor Q-Sort values also indicate the column ranking placed on individual statements if the social perspective (i.e., factor) were a participant in a Q-Study. This is especially useful when comparing individual Q-Sorts with social perspectives. However, Webler and colleagues caution overly relying on such comparisons, as individual perspectives will never entirely represent any one social perspective (2009). These interpretations are also tied to participants' statements from interview data.

Normalizing statements

Before linking participants' social perspectives to the framework for indicators of agroecological resilience, a weighted average of corresponding normalised z-scores was calculated for each statement group tied to each indicator. The intended purpose of the normalisation was to accurately quantify the intended language of the statement so it may represent the indicator in question.

A total of 24 statements were normalised by rephrasing the original statement and/or inverting the loading of the z-score, whenever applicable. In the event that factors had both positive and negative loadings, the statement was normalised according to the loading for the factor of greatest salience. This represents the associated standard deviation of indicators of agroecological resilience in each social perspective. As was the case with raw Q-data, interpretations from resilience indicators were supported by interview data.

For example, the statement "farm closures lead to a deterioration in mountain farmers' social networks" was categorized into the indicator *socially self-organized*, which describes the degree to which farmers, consumers, and other farm actors can organize in response to change (Cabell and Oelofse, 2012). Because participants in both factors agreed with the original statement, the statement was negatively phrased to transform factor loadings negatively. This suggests that farm closures have a negative impact on the social self-organization of mountain farms, which was highlighted in the results from interview data. After mean values for each indicator of agroecological resilience were calculated, they were arranged from lowest to highest values to highlight strongest and weakest indicators. Corresponding positive scores were analysed as areas enabling resilience in mountain farm systems, while negative scores were analysed as areas enabling vulnerability.

3 Results

3.1 Factor loadings

Factor extraction

Eight factors were revealed from the PCA with eigenvalues greater than 1, with a cumulative explanatory variance of 76% across participants' Q-Sorts. These factors were automatically flagged at $p<0.05$. Individual varimax rotations were carried out for at least two factors – revealing a total explanatory variance of 43% across participants' Q-Sorts, and up to five factors – revealing a total explanatory variance of 62%. Varimax rotations require at least two factors.

Rotations of three through five factors revealed factor loadings where several participants hadn't loaded onto any factor. This revealed less clustering between participants, albeit enhanced social perspectives among remaining participants. Neither did more than two factors reveal significant differences in participants' social perspectives and would have required an analytical capacity beyond the scope of this thesis. Two factors were selected for the final analysis, which revealed the greatest clustering of Q-Sorts, with all participants loading onto either one factor.

A total of 10 farm households representing 13 farm managers loaded highly onto factor 1, which showed 22% explanatory variance and an eigenvalue equal to 6.747. The remaining 10 households representing 15 farm managers loaded highly onto factor 2, which showed 21% explanatory variance and an eigenvalue equal to 1.884. Six participant Q-Sorts had relatively small differences in their factor loadings (with differences in z-scores ranging between 0.015 and 0.092).

The remaining 14 households corresponded to factor loadings with differences in z-scores ranging between 0.141 and 0.787. The highest overall loading for factor 1 was farm 12 ($\sigma = 0.695$), while the lowest was farm 1 ($\sigma = 0.4033$). The highest overall loading for factor 2 was farm 3 ($\sigma = 0.796$), while the lowest was farm 6 ($\sigma = 0.409$). 24 out of 49 statements were highlighted as significant at $p<0.01$, and an additional 2 statements were significant at $p<0.05$, while 23 statements were non-significant at $p>0.05$. This suggests that there was greater overall disagreement among participants than agreement. Individual factor loadings for participants' Q-Sorts – presented as perspectives in the subsequent results – are presented in Table 2, on the next page. All 49 Q statements and their corresponding z-scores for each factor are presented in Table 3, on the subsequent pages.

Table 2: Factor loadings (z-scores) for all participants and the municipalities where their respective municipalities in Valdres. Corresponding factor loadings are highlighted in bold under each factor.

Q-Sort	Municipality	Total participants	Factor 1	Factor 2
Farm 12	Vang	1	**0.6946**	0.1588
Farm 21	Øystre Slidre	1	**0.6868**	0.2609
Farm 9	Vang	2	**0.6639**	-0.0005
Farm 20	Vang	1	**0.6472**	-0.0168
Farm 15	Vestre Slidre	2	**0.6402**	0.31
Farm 8	Sør-Aurdal	1	**0.5711**	0.2306
Farm 13	Vang	1	**0.561**	0.0342
Farm 11	Vang	1	**0.521**	0.3796
Farm 2	Vang	2	0.4985	**0.5133**
Farm 17	Nord-Aurdal	1	**0.4332**	0.3624
Farm 18	Vestre Slidre	2	0.4165	**0.4967**
Farm 1	Vang	2	**0.4033**	0.3865
Farm 19	Vestre Slidre	1	0.3691	**0.4452**
Farm 6	Vestre Slidre	2	0.3174	**0.4091**
Farm 4	Øystre Slidre	1	0.2765	**0.6487**
Farm 3	Vestre Slidre	1	0.2687	**0.7956**
Farm 14	Nord-Aurdal	2	0.2308	**0.6174**
Farm 10	Vang	1	0.1508	**0.6961**
Farm 7	Sør-Aurdal	2	-0.0464	**0.5774**
Farm 5	Vestre Slidre	1	-0.1171	**0.6696**

Table 3: Factors with corresponding z-scores for individual statements, ordered by descending levels of agreement within factor 1. Significance for statements are shown at P < .01 (*), whereas statements of non-significance are shown at P>.05 (**).

Number	***Statement***	***Factor 1***	***Factor 2***	***Significance level***
19	*The fragmentation of cultural landscapes threatens the economic viability of upland grazing systems.*	2.73	0.73	*
42	*Visitors want a maintained cultural landscape: increased overgrowth will negatively affect tourism revenues in Valdres.*	2.0	-0.41	*
27	*Increasing livestock densities is a vision for sustainably managed outfield areas*	1.63	-0.04	*
15	*If the grazing pressure becomes too low in outlying areas, values associated with grazing, biological diversity and grazing quality will change.*	1.5	1.33	**
5	*Farm closures lead to a deterioration in mountain farmers' social networks.*	1.45	1.43	**
11	*It is important that mountain farms make greater use of local grass resources (e.g., outfields) instead of concentrates.*	1.08	1.77	*
25	*Grazing several livestock species on mountain pastures benefits grassland biodiversity.*	1.01	1.44	**
33	*The land grant stimulates domestic feed production.*	0.93	1.11	**
48	*My farming practices negatively impact other obligations in my life (e.g., family care, off-farm employment).*	0.75	1.73	*
14	*Virtual fencing systems offer promising workload reductions for seasonal pasture and outfield management.*	0.73	0.54	**
12	*Traditional livestock breeds are better "landscape managers" for outfield pastures than their modern counterparts.*	0.66	-0.35	*
22	*More frequent occurrence of extreme weather will lead to greater crop variation.*	0.65	0.29	**

28	*Traditional farming practices like outfield grazing are vital for community well-being.*	0.5	2.2	*
45	*My mountain farming practices are positive for my family's quality of life overall.*	0.49	2.35	*
46	*Local supply chains can only be profitable if consumers are willing to pay for high-quality foods.*	0.44	0.16	**
24	*My farming contributes positively to reducing greenhouse gas emissions.*	0.4	-0.42	*
49	*Funding schemes like Innovation Norway can increase the economic self-sufficiency of mountain farmers.*	0.33	0.06	**
36	*Norwegian "plant-based" and "white-meat" dietary campaigns discourage mountain farming.*	0.3	-1.32	*
40	*Private ownership of the outfield areas is better than state commonality for safeguarding grazing resources.*	0.2	-1.31	*
39	*It is the municipality's responsibility to assess key grazing areas and prioritize farmers before designating land use to others.*	0.15	0.29	**
20	*Heavier tractors and machinery negatively impact soil quality and fodder crop yields.*	0.14	1.1	*
37	*Mountain farming is supported primarily because of the production of public goods such as biodiversity, cultural heritage and cultural land, and to a lesser extent because of the contribution to food security.*	0.14	0.47	**
32	*Increased intensification of agriculture in Norway damages the reputation of mountain farming.*	0.09	-0.57	*
26	*Researchers and experts provide knowledge and advice that is important for mountain farming.*	-0.01	0.25	**
30	*It's fairer for most people to reduce their overspending/ luxury consumption than for me to make changes to my farming operations to save the climate.*	-0.06	-1.58	*
6	*When (milk) production increases per farm, it becomes more difficult to farm seasonal pastures and outfields.*	-0.12	-0.64	

8	*Local farm management decisions are made more complicated by national agricultural policies.*	-0.14	0.02	**
9	*Facebook groups can compensate for poorer local agricultural networks.*	-0.19	-0.4	**
18	*Access to fields with different topography and varying soil conditions can help reduce crop risk/ ensure consistent feed production.*	-0.22	0.09	**
4	*Outfield grazing and summer pasturing is challenging because production drops.*	-0.27	0.26	
16	*The benefits of specializing my production outweigh the costs of diversifying my farming practice.*	-0.28	-0.48	**
3	*Future generations of mountain farmers rely on investments made by today's farmers.*	-0.3	0.28	*
31	*My farming practices negatively impact other obligations in my life (e.g., family care, off-farm employment).*	-0.32	-1.45	*
21	*Greater dependence on leased land creates more challenges for mountain farming.*	-0.51	-0.11	**
1	*My farming is more dependent on cooperation with other farmers and local actors than on external actors.*	-0.52	-0.45	**
47	*Mountain farming needs to adjust to the successors' needs and wishes for a sustainable agriculture.*	-0.6	-0.41	**
35	*Grazing livestock on outfield pastures is profitable even without the grazing subsidy.*	-0.62	-0.21	**
23	*Private ownership of the outfield areas is better than state commonality for safeguarding grazing resources.*	-0.64	-0.05	*
7	*By growing many different fodder crops, my crops become robust against annual climate variations.*	-0.7	0.08	*
38	*Land distribution efforts are important for resolving conflicts and sustaining operations.*	-0.77	-0.67	**

29	*Current farm resources (e.g., infrastructure, workloads) prevent me from grazing livestock on the outfields.*	-0.79	-0.11	*
10	*Improved liming and drainage systems are more effective inputs for grass yields than are locally adapted grass varieties.*	-0.83	-0.18	*
34	*Traditional food production like mountain farming will be less valued by future generations in Norway.*	-0.87	-1.8	*
13	*National cooperatives (e.g., FK, TINE, Nortura) contribute positively to innovations in mountain farming.*	-0.94	-0.57	**
2	*For mountain farming, the advantages of a future warmer climate will be greater than the disadvantages of increased risk of floods and droughts.*	-1.26	-1.27	**
43	*Outdoor leisure activities contribute to functional outfield areas.*	-1.26	0.29	*
17	*Producing vegetables and/or grains is a viable alternative to mountain farming practices.*	-1.49	-1.18	**
44	*Without an accurate calculation of return on equity, it is unclear what benefit there is to modernizing my practices.*	-1.51	-0.18	*
41	*The advantages of cabin development are greater than the disadvantages for mountain farming.*	-3.09	-2.11	*

3.2 Perspective 1: low-input, minimally disturbed, and open landscape farming

3.2.1 Statements of agreement

Participants within perspective 1 (hereon P1) strongly agreed that the fragmentation of cultural landscapes was affecting the economic viability of outfield grazing systems (σ = 2.73). Participants also largely agreed that visitors in Valdres want a maintained cultural landscape, with increased overgrowth of vegetation negatively impacting tourist revenues (σ = 2.0). Participants also strongly agreed that increased livestock densities represented a vision for sustainably managed outfield areas (σ = 1.63).

Other areas of agreement were that associated biodiversity values are impacted if the grazing pressure in the outfields is too low (σ = 1.5), that farm closures are harmful for the local agricultural network (σ = 1.45), that it is important to utilize local resources rather than concentrate feed (σ = 1.08), and that it is important to graze several livestock species to promote outfield biodiversity (σ = 1.01).

Viability of outfield grazing threatened by landscape fragmentation

Participants within P1 described different drivers of landscape fragmentation and consequences for outfield grazing in their interviews, with cabin development being the most frequently mentioned driver. Landscape fragmentation, in this context, does not only refer to the removal of outfield grazing areas, but of the spatial process of dividing these areas into alternate land use types. All participants within P1 recognized the threat of landscape fragmentation for the region of Valdres, with descriptive examples ranging from others' farming practices to their own. Three farm households had direct experiences with development consequences for their farming.

A micro-dairy producer in Øystre Slidre had resorted to fencing in their dairy cows by their shieling because of the rapid cabin development surrounding the shieling, where they would otherwise freely graze. They noted how 12 dairy farms they once shared state common outfields with had since closed operations. However, they clarified they believed their neighbours exited mountain farming not because of the cabin development, but rather because they perceived their non-farming neighbours to have higher quality of life standards than they did as farmers.

Two small-scale dairy producers in Vang sharing private outfields explained how they opened a settlement case to secure their outfield grazing resources against expansive hotel development. The developer in question had land use rights tied to allodial rights[15] from a shieling which was no longer

[15] *Odelslova* in Norwegian: a concession right in Norway which ties family members to land ownership in an effort to prevent landscape fragmentation.

in operation. When asked if either would consider investing in tourism instead of mountain farming, one dairy farm manager responded that "it's hard to say, but if the hotel becomes so big that we are 'squeezed out' of active dairy farming, we cannot let that opportunity pass us by. We will have to participate in the development and focus on selling and renting the property, which is something we don't really want."

The other dairy farm manager described how they had been in contact with the municipality over the issue of conflicting land use rights for several years, suggesting "they should look into the matter and develop a plan of action." However, the farm manager said the municipality hadn't acknowledged this idea until the conflicts had already arisen.

An organic dairy producer in Sør-Aurdal identified landscape fragmentation "as a clear threat," and that it wasn't just farmers that were affected by development in outfields, but also domestic reindeer herders. This perspective was supported by a mutton producer in Vang, who actively participates in gathering and slaughtering domestic reindeer in the area. This farm manager referred to a conversation with a large-scale domestic reindeer herder, and that "the herder also agrees that these cabin developments are some of the biggest challenges yet. We have lots of untouched nature in the mountains, but more and more human activity. It's not just an issue in Vang, but for the whole region."

A small-scale dairy producer in Vang agreed that such developments are an issue for the region at large, but particularly with so-called cabin communities.[16] However, they also offered a converse perspective on development in outfield areas, which acknowledged population declines in the region and its effect on farmers' mental health. They described how "when we have visitors around the summer farm, it creates an active community for all residents, not least the cabin people who will learn something about agriculture." Even still, participants had differing experiences with visitors in outfield areas, which will be detailed further on.

Visitors' valuation of the cultural landscape

Farmers within P1 had varying experiences with visitors' valuation of the cultural landscape, but commented less on the implications for tourist revenues in Valdres. As was previously introduced, Valdres has the highest proportion to total labour of employees engaged in industries like tourism among all regions of Innlandet County. A mutton producer from Nord-Aurdal who had been pluriactive in the tourist industry for several decades suggested residents in Valdres are "quite dependent on

[16] *Hyttefeld* in Norwegian, which differ from individual holiday homes, characterized by large numbers of densely built holiday homes, often with full amenities found in regular housing units.

tourists, but if outfield areas are afforested – as they have become in northern Sweden, for example – visitors don't appreciate it. It ruins their view."

A primary example of positive landscape valuation was given by an organic dairy producer in Sør-Aurdal. "We have many visitors on the shieling and very positive reactions, even if our grazing collective doesn't build any fences around their cottages," they said referring to potential livestock encroachment on visitors' property.

A dairy farmer in Vang said, "if you manage to set limits on the number of visits to the barn, having individual cabins and visitors can actually be of positive value." Building on this example, the hopeful successor of this dairy farm had built a rental cabin next to the shieling to earn extra income from tourist activities and promote their summer farming practices.

Yet participants in this factor openly discussed the difference in visitors' interactions with different livestock breeds, management practices, and herd dynamics. For example, cows from dairy farms which haven't upgraded to automated milking systems (AMS) are in contact with farm workers at least twice a day during milking periods, which is believed to have an influence on their 'friendliness' in the outfields. Another commonly held belief was that nurse-cows and their calves could respond aggressively to unknowing visitors, which could result in conflict in outfield areas. Moreover, livestock could possibly interact with visitors' property in a way that is perceived negatively by visitors.

A situation in-kind was described by a mixed mutton and goat dairy producer in Vang, who said they had received several complaints about their goats damaging visitors' cars, but that "people want to visit that area because it's an open landscape thanks to the goats. At the same time, they don't know they should keep their cars behind a fence, like I do when I'm in the outfields"

Livestock grazing density in outfield areas

Few comments were made by participants in P1 about their perspectives on increased livestock grazing densities being a vision for sustainably managed outfield areas.

Participants' comments reflected outfield grazing management for achieving multifunctional goals, such as biodiversity and climate goals. All participants within P1 described woody shrub or tree encroachment on either their home or far shieling, with most attributing it to lower grazing pressure and the decline in active shielings. A small-scale dairy producer in Vang believed this was due to the loss of several livestock species on the outfields, attributing the encroachment of dwarf birch (Betula *nana ssp. alpina*) on their shieling to the decline in goat grazing activity.

They also emphasized that “at this point, we can use all the grazing animals we can get. If you’re a farmer and you have a grazing animal, bring them onto the outfields.” When commenting on another statement about greenhouse gas emissions reductions, they made a distinction in the various multifunctional goals in outfield grazing, saying “we want to graze as much land and clear as much woody vegetation as possible. Without grazing, we lose this resource and the possibility to farm.”

Another small-scale dairy producer in Vang commented that “you can see clear changes in the vegetation, especially trees popping up in outfield areas that I haven't noticed before. It happens fast, so there is a great need for grazing animals in the area, as there were before. However, as society evolves with fewer and fewer active farms, the trend is that the use of outfield areas is declining.”

A small-scale dairy producer in Vang made a further connection to farm structure and support measures for maintaining livestock densities in outfields, suggesting “high grazing pressure is associated with climate and environmental goals. And in order to keep that going, you have to maintain small farms.” Yet they also reflected that “in order to increase grazing pressure on the outfields, I would need to expand the barn and invest in alternative production, such as nurse-cows, goats, or sheep.”

A mutton producer in Vestre Slidre acknowledged how some farmers were caught in the ‘farmer’s treadmill’,[17] due to agricultural policies encouraging efficiency standards. “Farmers must increase production and grow to a point where it becomes impossible to use their shieling. The farmer we share our outfields with will enlarge their herd next year to 30 cows with an AMS. Despite meaning more work, the value of their outfields is so important for them that they will continue to use them.”

Another example of a farm manager successfully integrating modern investments in traditional farming practices was provided by a mutton producer in Nord-Aurdal. They described how a farmer in the municipality of Gol had installed their AMS in a container and was transporting it to and from the shieling. “If you include those adjustments in your farm plan, it’s possible to use smaller farms in this way,” they said.

In the absence of grazing pressure, some farm managers have attempted to restore former grazing pastures. A mutton producer in Vang who described “all grazing animals as good for the outfields” had received public financial support to restore two hectares of infield meadows by their shieling.[18] The participant used harvesting machinery to uproot encroached dwarf juniper (Juniperus *communis ssp.*

[17] The farmers’ treadmill, also known as the technology treadmill, describes a cycle in which farmers experience rationalization and land consolidation processes based on technological adoptions and productivity cost reductions (Cochrane, 1958).

[18] Also known as ‘*tilskudd til spesielle miljøtiltak i jordbruket (SMIL)*’ in Norwegian.

alpina) and would re-apply for funding to expand the area. Nonetheless, they acknowledged the high labour costs and time commitment needed for landscape restoration, and that they weren't yet sure if they could afford to continue.

3.2.2 Statements of disagreement

Participants within P1 strongly disagreed that the advantages of cabin development outweigh the associated benefits for mountain farming (σ = -3.09). Participants similarly disagreed that (a) there are unclear benefits to modernizing their farming practices without an accurate calculation of the return on investment (σ = -1.51); (b) vegetable and grain production were viable substitutes for outfield grazing (σ = -1.49); and (c) outdoor leisure activities contribute to functioning outfield areas (σ = -1.26).

Cabin development in mountain areas

To reiterate comments by participants in P1, cabin development in mountain areas was largely seen as a threat to mountain farming, particularly for grazing resources. This adds to previous assessments of the impact of holiday home development on removing usable grazing area from livestock. An organic dairy producer in Sør-Aurdal who has been actively farming for 30 years acknowledged that "this is creating a lot of conflict within the municipality… It should've been better regulated from the beginning. There are many cottages in this municipality alone, which has a lasting impact."

There was a commonly held belief among participants that farmers were deprioritized in land use settlements involving cabin developments. A small-scale dairy producer in Vang commented that "when it comes to tourism development, those plans are prioritized over mountain farming. I don't see any benefits from cabin development." Similarly, a micro-dairy producer in Vestre Slidre reflected "when it comes to cabins versus mountain farming, cabins will always win the space."

Many farmers in Norway have partially or completely diversified their entrepreneurial income away from mountain farming and into development projects (Loureiro and Jervell, 2005), although none among participants in P1. A mutton producer in Vestre Slidre noted how the benefits of cabins aren't always accrued by mountain farmers, as "cabin development is good for a very few number of people who aren't dependent on mountain farming… Perhaps they're previous farmers and entrepreneurs who owned land close to cabin areas."

They also discussed the mismatch in political objectives at the local and national level, suggesting that "the focus of the State, like the Ministry of Environment, has become finding ways to mitigate the negative effects of cabin development, while the municipality has tended towards entrepreneurship.

At some point the negative effects outweigh the positive ones." Another mutton producer in Vang simply said, "the more cabins they build the less space will be available for grazing animals."

Such comments reflected a sense of exhaustion among participants who had experienced the negative impacts of cabin developments in their outfield areas. A small-scale dairy producer in Vang commented that "farmers that have survived are less nostalgic and are looking for different ways of earning an income. What are the incentives for farmers to continue? How much money should we throw at people before we lose farmers in Vang," they asked referring to the limitations of agri-service support measures against structural developments.

Among all participants in P1, four were engaged in the direct sale of agricultural products to visitors in the mountains. Yet the dependence of farmers on tourists for the consumption of local food products, particularly those with active dairy production, has been contested as justification for increasing cabin developments. The aforementioned dairy producer in Vang commented that they "can sell cheese to visitors, but if there weren't any cabins then we would figure out somewhere else to sell our cheese. Cabins are all about consumption, which is one of the biggest issues of our time!"

Modernizing mountain farming practices

The benefits of modernizing mountain farming practices and ensuing structural developments in mountain areas were largely criticized among participants in P1. Several participants noted how there were limits to the production capacity of their farms, and that small-scale farms were being pressured by agricultural policy objectives to modernize beyond their intended capacity. This lends evidence to misaligned policy directives towards farm performance and adoption capacities for mountain farms.

One small-scale dairy producer in Vang noted that "the rationale for making investments isn't always economical. Business plans aren't always what drive decisions on the farm – we figure it out as it goes; things don't always add up the way you expect. Farmers are professionals at adapting, and it is impressive how quickly they find solutions to problems."

Particularly when referring to investments for future generations of mountain farmers, participants in P1 shared the belief that such investments could lead to further rationalisation of mountain farms. The aforementioned dairy-producer noted "you cannot always take investments into a long-term perspective. The possibilities to run this farm in the future might not exist."

Another dairy producer in Vang commented that "it's not possible for mountain farms to produce at the same scale as farms in southern Norway; technological upgrades are only possible with certain production levels. Trying to reach that scale can cause ecological consequences, like soil

eutrophication. If we can use local resources with our available grazing animals, we can use existing machinery and infrastructure, and service it ourselves."

In examples described in their interviews, where participants made several structural adjustments on their farms, they emphasized low economic and material inputs, particularly adapted towards local climatic conditions, which they described in their interviews. A mutton producer in Nord-Aurdal has been cultivating fourteen different fields for winter fodder within a short window of opportunity. They explained how they had installed a used hay-drier in their barn to reduce their workload during harvesting periods. It also acted as a buffer in case of wet weather conditions, as cut grass could be stored in-situ and air dried after temporarily drying outside. "Whenever I need to buy things for the farm, I'm always checking the used market[19] first," they said.

A micro-dairy producer in Vestre Slidre believed that the fundamental investments that needed to be made were in labour, such as for maintaining productive grasslands, rather than physical infrastructure like barns. When asked whether funding schemes like Innovation Norway[20] contribute to the economic self-sufficiency of mountain farmers, the farmer responded that "it might make us more self-sufficient, but if you look at the economics of financing farms, it might put you in enormous debt. So, are you more self-sufficient by investing that money?"

Another micro-dairy producer in Øystre Slidre had built a mobile dairy processing unit out of a used trailer to produce butter for sale during the summer. They had also described how they were able to keep investments low when converting a former sheep barn into a free-range cow barn by creating a single large bed. Such innovations highlight how farmers with smaller production units can innovate within lower investment margins.

Outdoor leisure in outfield areas

Participants in P1 reflected on the value of outdoor leisure activity in outfield areas as dependent on the kind of activity that visitors participated in. A mixed mutton and goat dairy producer in Vang commented on the balance between visitor exposure to mountain farming and their interference in farm activities. The farm manager described how they "have problems with goats chewing visitors' cars and tourists bringing goats into the wrong place. It's not all positive, but it's important for people to see how the animals are kept on the mountains. They want to see the goats being milked."

[19]Referring to Finn.no, an online marketplace for second-hand goods in Norway

[20] Innovation Norway is a national development bank which aims to stimulate entrepreneurial activities among different sectors in Norway, including within agriculture.

The limitation created by visitor activity in outfield areas was discussed for its traffic volume. Two small-scale dairy-farmers in Vang sharing outfield areas described how “if everything around leisure activity in the mountains wasn’t so big, it could be good for mountain farming, but there are so many people visiting with their dogs all day long,” and that “slow tourism could work if visitors care to learn about the livestock animals, as long as they don’t interfere with them.”

However, as has been previously mentioned, some participants described how visitor interaction may also depend on farmers’ management practices and their herd dynamics in outfield areas. An organic dairy producer in Sør-Aurdal expressed that “it’s a good thing when more people can use the outfields to experience their natural environment. Even though my cows have their horns, people aren’t easily frightened by them because the herd is relatively small. But if they run into larger breeds in large herds, that can be a scary situation.” A micro-dairy producer in Øystre Slidre mirrored this belief in their comments about virtual fencing systems, saying “especially with larger cattle breeds, people can be quite afraid of them because they can be dangerous.”

Altogether, these statements of greatest significance and comments made by participants in P1 reflect a social perspective informed by values held in low-input farming, minimally disturbed outfield areas, open landscapes maintained through high grazing pressure, caution towards agricultural development trajectories in Norway, and a sense of neglect when land use decisions are made.

3.3 Perspective 2: cultural heritage, social connectedness, and quality-of-life farming

3.3.1 Statements of agreement

Participants within perspective 2 (hereon P2) strongly agreed that their farming practices were positive for their family's life quality overall (σ = 2.35). They similarly agreed that traditional farming practices such as outfield grazing are vital for their community's well-being (σ = 2.2). Participants also agreed that it was important to use local resources such as outfield pastures instead of concentrate feed (σ = 1.77) and that off-farm income is crucial for their overall household income (σ = 1.73). Finally, participants had similar levels of agreement that (a) it is important to graze several livestock species to promote outfield biodiversity (σ = 1.73), (b) farm closures are harmful for the local agricultural network (σ = 1.43), and (c) associated biodiversity values are impacted if the grazing pressure in the outfields is too low (σ = 1.33).

Family life quality and community well-being

Participants within P2 highlighted the importance of their farming practices for their personal, their families, and their communities' well-being. Especially the outfield grazing season, during which participants could spend longer periods of time on their shielings with their families, was valued among all participants within P2.

Many participants recognized that their farming practices were both a lifestyle and an occupation. A small-scale dairy producer in Vang described the outfield grazing period as "the best time of year," a belief that was held by several participants in P2. A former nurse-cow beef producer in Vestre Slidre described mountain farming as something they've always seen as positive for their children's upbringing, adding that "if they grew up here and had somewhere to call home, they could say they were from somewhere and were someone."

A mixed dairy and mutton producer in Øystre Slidre also noted their wishes for their farming practice to positively contribute to their children's upbring, saying "this is a lifestyle and I want my children to grow up with it. They can have a valuable experience even if they won't become farmers." In fact, participants described farm management decisions that had allowed them to spend more time with their families.

A former nurse-cow beef producer in Vestre Slidre believed it had been positive for their family and their children to have grown up on the farm. They commented that "the perseverance of small-scale farmers in Valdres is essential for maintaining our local cultural identity, and outfield grazing is the glue that keeps these relations strong."

A small-scale dairy producer in Vestre Slidre commented that the statements they agreed most with reflected practices towards saving time, in part to have more time with their family. For example, using virtual fencing systems for dairy cows grazing in the outfields allowed them to remain on the farm outside of milking periods for longer. They also emphasized the importance of food self-sufficiency for their household, such as vegetable and grain cultivation.

One mixed mutton and goat dairy producer in Vang had suggested that "farming is very much about making food for my own family before making it for others," which was also reflected in their self-sufficient vegetable production and in their commitment to full-time farming. "Being on the farm means I can be at home and decide how my day goes. If the kids are sick, I can take better care of them than if I were working outside of the farm," they concluded in their interview.

Local forage versus concentrate feed

Participants in P2 largely commented that the need for reducing concentrate feed inputs was tied to environmental goals, farm management practices, and farm self-sufficiency goals.

Farm self-sufficiency was described in terms of optimizing resource use, as one mixed mutton and beef producer in Sør-Aurdal described, "in many ways mountain agriculture has an advantage based on local grass production." They also referred to the importance of local resources and national identity, suggesting "Norwegians like to be effective with the resources they have… if you want to increase production here it has to be based on local resources, not external resources, but that is what the government is encouraging. You're not optimizing production if you have to buy more soy from Brazil and wheat from Ukraine."

Farmers have been compelled to shift farm inputs towards external resources, largely in an effort to increase yield-per-animal rather than expanding their herds. Some mountain farms have even combined farm intensification with outfield grazing practices, as an organic nurse-cow beef producer in Vestre Slidre described: "our neighbours by the shieling use large amounts of concentrate feed during the outfield grazing period, so their cows can't be bothered to graze during the day. It's not a problem for their yields if you feed them large amounts of fodder all year round."

A former nurse-cow beef producer in Vestre Slidre further highlighted the national agricultural policy as a driver of farm intensification. They said "one cannot discuss concentrate feed without having the same discussion about Norway's agricultural channelling policy. When areal planning decisions are made without a sustainability perspective you will have more transport-related emissions from

increased fodder requirements. The Ministry of Agriculture and Food is looking for the cheapest alternative for farmers and consumers alike, but is that sustainable?"

However, other participants in P2 acknowledged how their mountain farming practices can depend on concentrate feed as well. One mixed mutton and dairy producer in Øystre Slidre said they "know that the difference in the milk comes from the quality of the grass, but we also need concentrate feed when we have poor pasture quality; my neighbours use silage to feed their herd over the summer, which I don't think should be used on shielings at all."

Another small-scale dairy producer in Vestre Slidre also noted a decline in their milk yields during the outfield grazing period due to their calorie-poor mountain pastures. Yet the added benefit of outfield resources was still among the farm manager's priorities, noting "it's important that we reduce costs on the farm by using available resources, especially to minimize concentrate feed."

Having a minimum requirement for concentrate feed was common among participants in P2, as one nurse-cow beef producer in Vestre Slidre described, "we're using very little concentrate feed to be able to interact with our cattle and maintain a relationship with them. Our fodder has soy in it, but we still think outfield pastures are the best feed for our cattle."

One goat dairy producer in Vestre Slidre had also linked sustainability goals with resource optimization, in summarizing that "if there was a way to grow cereals here, I would. I think as climate challenges persist, we will need mountain farming to use every available resource. Of course, the area efficiency of growing crops for plant-based diets is better than having cows in cornfields. We should use the best farms where they belong."

Off-farm pluriactivity

With the exception of a mixed mutton and goat dairy producer in Vang, all participants in P2 were part of farm households where at least one farm manager was working outside of the farm. However, household pluriactivity ranged from being a financial requirement due to poor farm income, to a lifestyle choice, as was described by several participants.

For example, a nurse-cow beef producer in Vestre Slidre commented that it had been possible for them to remain pluriactive throughout their farming careers because they maintained a relatively small farm, adding "why become big when you're happy remaining small?"

Another nurse-cow beef producer in Vestre Slidre, now retired, commented that "working outside of the farm was possible because it all fit together. I worked as a financial consultant and my partner as a veterinarian. If you take my own children's example, they are working in very different professions

that would be difficult to combine with farmwork. Perhaps they could find work in different areas in Valdres, but many things must align for the possibility of taking over the farm."

An organic nurse-cow beef producer in Vestre Slidre noted how their decision to be pluriactive outside of the farm had opened up opportunities to participate in other social aspects of their lives. At the same time, they acknowledged that their livelihood configuration couldn't be compared with other farmers, saying "for dairy farmers, it's hardly a possibility to work outside the farm. It's very work intensive. Our solution is a balance both economically and for our personal interests. My partner would prefer to use more of their time working on the farm if it were economically possible, but for now we like it the way it is."

Several participants instead highlighted the financial dependence on off-farm work in their interviews. One mixed dairy and mutton producer in Øystre Slidre working in a school described how their off-farm work negatively impacted their energy levels for farm activities. She described how "farming used to be a necessity and today it is a lifestyle choice… but ideally, the farm work would be the main occupation for me."

Another small-scale dairy producer in Vestre Slidre commented how "working outside of the farm and receiving subsidies for outfield grazing is important for us. Without the subsidies, we couldn't farm the way we do. But we actually don't know if we'll profit from the farm this year due to economic inflation… We may have to quit sooner than expected, since everything has become so expensive."

The likelihood of farm closures and dependence on subsidy schemes was reflected by another participant, a goat dairy producer in Vestre Slidre, who said, "if we want to sustain mountain farming in Norway, the only way is to subsidize more. As it stands, my job as a teacher subsidizes the farm. Last year I earned negative profits from the farmwork."

3.3.2 Areas of disagreement

Participants in P2 strongly disagreed that the advantages of cabin development outweigh the associated benefits for mountain farming (σ = -2.11). They strongly disagreed that traditional food production like mountain farming will be less valued by future generations in Norway (σ = -1.8). Participants similarly disagreed that (a) it is more important for others to reduce their luxury spending to achieve GHG emissions reductions than for farmers to change their practices (σ = -1.58); (b) their farming practices negatively impact other life obligations (σ = -1.45); (c) alternative dietary campaigns discourage mountain farming (σ = -1.32); and (d) private ownership of outfield areas is better than state commons for safeguarding grazing resources (σ = -1.31).

Traditional food production and cultural heritage

Participants in P2 believed that traditional food production, such as outfield grazing, would equally be valued by future generations, and that alternative 'plant-based' or 'white meat' campaigns wouldn't affect mountain farming. However, when ranking the statement on future valuation of traditional food production, five participants in this factor commented that they hoped it would be valued equally. Participants instead discussed their views on consumer food choices in Norway.

One small-scale dairy producer in Vang lamented that "consumers think that we don't have to produce food in Norway, that we can simply buy it in the shop from other countries," but they don't see the bigger picture." Adding that*, "*I would hope the public would see the difference. It's unfair when you see adverts for margarine that markets itself as a product with *no bullshit*."

A nurse-cow beef producer in Vestre Slidre described "a kind of narrow-minded thinking that you see in urban areas, especially. We have a lot of money in Norway, and we can simply buy our food – it doesn't matter where it comes from. Preferences are constantly changing, but we hope future generations will appreciate traditional food production."

Yet not all participants in P2 were so sure about the influence campaigns had over food produced from mountain farming. In response to valuation among future generations, a large-scale dairy producer in Nord-Aurdal said, "I hope so. I can't imagine they wouldn't." The farm manager later described how "TINE[21] had a project to promote dairy produced from the shieling. "It wasn't successful because consumers weren't willing to pay a higher price. Norwegians can pay a lot for devices and cars, but never for food. Food is always First Price[22]," they said.

[21] The largest Norwegian dairy processing cooperative owned by its suppliers.
[22] First Price is a brand of food items in Norway which are sold at relatively lower prices.

A mixed mutton and nurse-cow beef producer in Sør-Aurdal echoed this belief, saying "Norway is a very rich country, but people will always shop for First Price. They would rather spend money on luxury travel." A goat dairy producer in Vestre Slidre also described why they believed consumers wouldn't prioritize paying more for food, saying "it's only 11% of household income that is spent on food in Norway, which is much lower compared to other countries in Europe."

In turn, an organic nurse-cow beef producer in Vestre Slidre described an ethical trade-off behind consumer values, suggesting "they aren't as consequential with their decisions as they might believe. Some values for health-related choices might outweigh those for climate-related choices."

Responsibility towards emissions reductions

Participants in P2 believed that it was equally important for them to pursue GHG emissions reductions in their farming practices as it is for others to reduce emissions from their personal consumption. Several participants acknowledged their roles as both consumers and farmers towards climate goals, as one mixed mutton and dairy producer in Øystre Slidre said, "others need to reduce their footprint as well as I do."

Participants also commented on differences in farm structures and the potential to reduce their farm emissions compared to other farms in Norway or abroad. One small-scale dairy producer from Vestre Slidre said, "we don't have the biggest farm, so we don't feel like we have the biggest climate impact; we all have to pull together for the climate." Yet when considering the need for climate action further, the farm manager continued to explain how "we need more subsidies to invest in newer equipment. We can't invest in climate action if we're going bankrupt. Investing in a direct seeder would help, but it's so expensive and we don't have the income for it because we're a small farm."

Another mixed mutton and beef producer in Sør-Aurdal suggested that "even if we're farmers, of course we also have to reduce our overspending. As farmers, we've signed the Agricultural Climate Agreement, so we have to do what's necessary – we are considering buying an electric tractor, for example." Multifunctional goals among participants' farming practices were mentioned several times throughout their interviews.

A small-scale dairy producer in Vang described how they believed their livestock grazing contributed to increased photosynthesis through higher plant turnover, saying "that is a net positive for carbon sequestration. But others might disagree… Of course, I'm using a tractor to harvest grass. Without an electric tractor being available, that is my only option."

In some situations, though, participants commented how people's personal consumption hadn't received as much attention as farming for emissions reductions. The same farm manager said, "I don't

think my farming is the bigger problem, but rather people who have holiday homes halfway across the world. If you want to reduce meat consumption for emissions reductions, many tens of meals with meat would be the equivalent of a single plane flight."

Another large-scale dairy producer in Vang suggested that "we produce food for people… cows are not to blame for climate issues. There are limits to what farmers in Norway can do for the climate. Especially with those who have luxurious lifestyles, like taking weekend trips abroad and flying several times per year, it's slightly provocative to hear them blame cows for climate issues."

Privately owned versus state common outfield areas

The issue of privately owned versus state common outfield areas was discussed among all participants in the study, but to a lesser extent among participants in P2. Four out of nine active shielings managed by participants in P2 were on privately-owned outfields, yet there was no clear relationship between whether participants who owned private outfields believed this was the best land use configuration. Instead, participants described the distinction based on their respective municipalities and experiences.

An organic nurse-cow beef producer in Vestre Slidre said, "cabin development isn't an issue for our shieling because we're on state commons. In Vang, particularly within the municipality, the borders between private and public outfields don't necessarily make a difference." The implication made by this farm manager is that the legal framework which is designed to safeguard outfield resources in public areas may absorb the negative consequences of developments in neighbouring privately owned outfield areas, for reasons outside of the farm manager's control.

An example of this situation was provided by a goat dairy producer in Vestre Slidre, whose outfields were surrounded by cabin communities despite belonging to state commons. They had fenced in their home shieling's infield pastures for summer grazing the kids, while the milk goats were kept on the far shieling to free roam. Although the farm manager couldn't explain this situation, they described how their farm would've been excluded from outfield grazing altogether "if the Danish crown hadn't proclaimed state-owned commons some 300 years ago. Only the farms on the west side of the valley would have had access to the mountain farms."

Another mixed mutton and goat dairy producer in Vang described how, the fact that Vang had almost entirely privately owned outfields, made it difficult for farmers to make decisions together. They said, "there can always be one farmer who decides against things. I've experienced that public commons can be good for cooperation between farmers because more heads think better together."

This was reflected in a nurse-cow beef producer's comments in Vestre Slidre, who said "in some private areas, people decide to build cabin communities, which isn't a good way of using outfield areas. But if you look at how it has been for [outfield areas in] Langsua National Park, it's been managed in a fantastic way. Projects like Stølsvidda[23] are possible when outfields are state-owned, but then the state decides what happens." The last sentence refers to the relative decision-making power national park managers have in land use decisions in outfield areas, according to some farmers. This perspective was held by several participants in P1, which will be addressed in further detail later on.

Altogether, these statements of greatest significance and comments made by participants in P2 reflect a social perspective informed by values held in time spent with family, being engaged in off-farm activities and interests, traditional food production, a robust cultural identity, and a sense of social responsibility in mountain farming.

3.4 Statements of agreement and disagreement between perspectives

3.4.1 Disagreement among participants

A total of 26 out of 49 statements indicated relatively more disagreement than agreement among participants within each factor. Values in differences between factors on individual statements ranged between Δ = 1.01 and Δ = 2.41.

Participants in each factor differed most in that visitors in Valdres want a maintained cultural landscape (Δ = 2.41), with slight disagreement among participants within P2. Participants in P1 agreed more strongly that the fragmentation of cultural landscapes threatens the economic viability of outfield grazing systems, while those in P2 somewhat agreed (Δ = 2.01). Participants within P2 strongly agreed that their mountain farming practices are positive for their family's quality of life overall, while those in P1 only slightly agreed (Δ = 1.86).

Strong differences were found in that increased livestock densities represented a vision of sustainably managed outfield areas (Δ = 1.66), yet participants' comments from interview data couldn't support this distinction. Participants also strongly differed in that Norwegian "plant-based" and "white-meat" dietary campaigns discourage mountain farming (Δ = 1.62).

Similar differences were found in statements that outdoor leisure activities contribute to functioning outfield areas (Δ = 1.55), that it is fairer for others to reduce their luxury spending to achieve GHG

[23] Stølsvidda is protected area and project managed between the municipalities Vestre Slidre and Nord-Aurdal, promoting a large, continuous shieling community between the Valdres and Hemsedal regions in Norway.

emissions reductions than for farmers to change their practices (Δ = 1.52), and that private ownership of outfield areas is better than state commons (Δ = 1.51).

Visitor valuation of the cultural landscape

Several participants in P2 disagreed that visitors in Valdres want a maintained cultural landscape, and especially whether their valuation of open landscapes created through mountain farming, and associated biodiversity values.

A goat dairy producer in Vestre Slidre commented that *"*if you ask a regular person on the street, they won't know what biodiversity is and why it's important." Another mixed mutton and dairy producer in Øystre Slidre suggested that they believed "it's the other way around. Some locals appreciate forests more than open landscapes. And the tourists appreciate the farm animals more than the landscapes they create."

The seeming uncertainty among participants in P2 on visitors' valuations was described as a conflict in societal values by a former nurse-cow beef producer in Vestre Slidre. They said, "I think mountain farming is better for most people, where one can see the animal in the landscape. It is important for society, but the situation has really changed in the last two generations, which have had completely different values."

A participant in P1 believed this incongruity in societal values was, in part, because of the absence of a formal visitor's centre "to build awareness around mountain farming and its effects on biodiversity, landscape, and food production." The small-scale dairy producer in Vang referred to the Norwegian Centre for Mountain Farming,[24] which had recently undergone organizational restructuring, but was expected to re-open sometime during this study.

Viability of outfield grazing threatened by landscape fragmentation

With the exception of one participant in P2, whether participants agreed if landscape fragmentation impacted the viability of outfield grazing was tied to the extent farm managers felt impacted themselves. Many participants in P2 believed that this wasn't necessarily the case for their farming practices, in part because of where their shielings were located.

A mixed mutton and dairy producer in Øystre Slidre said they hadn't been threatened by landscape fragmentation "because our outfields are public commons, we don't experience this issue – we have strong regulations in place to counteract development, but that isn't true in other places." An organic

[24] *Nasjonalt senter for fjellandbruk i Norges* in Norwegian

nurse-cow beef producer in Vestre Slidre described how they were familiar with “sheep farmers taking their flock into public commons even though their grazing rights are in private outfields. They can’t use their own because they’ve developed cabins to be able to persist as farmers.”

However, as had been previously described, state commonality has not necessarily prevented development from happening in outfield areas, nor on protected land. Aforementioned cases of a micro-dairy producer in Øystre Slidre and a goat dairy producer in Vestre Slidre are examples of developments limiting outfield grazing systems. The same farm manager acknowledged that cabin development is an important source of income for the local municipality, but that it remains a challenge for farmers. They said, “some people tell me I should make a visitors’ attraction out of the farm, but I’m not a salesman. I’m just a farmer. I don’t visit other people’s place of work and expect the same. We’re here to produce food, not cosy animals.”

Yet another participant in P2 who was pluriactive in development projects, such as cabins, believed that the discussion surrounding the impacts on mountain farming wasn’t necessarily “driven by common sense.” The mixed mutton and beef producer said, “smaller issues might receive more attention than necessary; some farmers are jealous of others that sell their outfield pastures for development, and it becomes emotional.”

Part of this belief was held in the need to invest in the economic viability of the region of Valdres. Adding to the discussion, the farm manager believed that mountain farming “has to couple with tourism and make the area more attractive, as they do in Austria, Switzerland, and Italy. That would be a meaningful objective and could create a sense of social responsibility in mountain farming.”

Despite ongoing conflicts, a mixed mutton and dairy producer in Øystre Slidre said they believed the region maintained a strong farming network through farmer field schools and ‘barn days,’ where “we have regular contact with other active farmers in the area through social and sponsored activities. Not just in Øystre Slidre but with other farmers in Valdres. We meet two times a year to discuss different farming practices.” Indeed, this might be especially relevant for active farmers in light of Øystre Slidre experiencing an over 40% decline in farm holdings using outfield areas as in 1995, yet an almost 9% increase in the number of livestock in outfield pastures in the same period (Bye and Bjørlo, 2023c).

Family life quality and farmer well-being

Several participants in P1 expressed doubt towards the benefits of their farming practices and overall lifestyle for their family and personal well-being. Among several reasons, the distance from loved

ones, the time spent navigating agricultural bureaucracy, and comparatively less free time than non-farmers were mentioned by participants.

A small-scale dairy producer in Vang acknowledged that farming hadn't been anything more meaningful to them but questioned the value of their sacrifices. "We discuss this every day. The poor income from the farm and amount of administration involved makes our quality of life as farmers worse – the actual farming is something we love. But it completely affects our family life quality because it is both a lifestyle and a job".

The underappreciation felt by some mountain farmers was highlighted by a micro-dairy producer in Øystre Slidre. They believed that current farm closures weren't necessarily driven by cabin development, but rather by the perceived higher life quality standards for non-farmers than for farmers, such as summer holiday time and better work income. "Very often this is hardest for dairy farmers who work full-time, starting and ending their days in the milk barn. I understand their reasons for quitting very well." The same farm manager also commented on the implications of full-time farming, saying "if you don't work outside the farm, you have a lonesome life. That's also the reason for these livestock tragedies you hear about, because the farmers are lonely and don't have contact with others."

A mixed mutton and goat dairy producer in Vang – the largest goat dairy producer included in this study – described how their solution to taking a two-week vacation each year was to hire off-farm labour, saying "I would have more time with them if I had another job. I can see these years of my life as perhaps not the best for being a farmer. My father never went on holiday because he made sacrifices for the farm. I'm making sacrifices with the farm to be able to spend time on holiday."

For other participants in P1, even though they were well integrated into the local community, the greater distance from loved ones negatively impacted their life quality. A mutton producer in Vestre Slidre commented that family visits were infrequent since they started managing six years ago, while a micro-dairy producer in Vestre Slidre said, "we have very little time to visit our family, especially in the summer. Our goal is to make more time during the winter for them, but they have to come here in the summer."

Particularly on issues involving land use conflicts and tourist interference with livestock in outfield areas, participants in P1 perceived this to be a greater threat than those in P2. Further divergence was found in the extent to which participants believed their farming practices were beneficial for their own, their families, or their communities well-being. In several cases this was linked to the combination of farming type and dependence on off-farm work for household income.

Alternative dietary campaigns

Multiple participants within P1, especially those loading highly onto the perspective, believed that mountain farming was impacted by alternative dietary campaigns, particularly for ruminant meat production in the context of climate action. Participants' comments also reflected the scope of influence such dietary campaigns had, which could probably explain why factors diverged.

A small-scale dairy producer in Vang believed alternative dietary campaigns to be fashionable and described how they "try to highlight the negative health impacts of eating red meat. I think it's better for the climate to produce locally fed meat rather than importing meat from abroad."

The perceived misguidance among consumers by dietary campaigns was reflected in a micro-dairy producer's comments in Vestre Slidre, who believed that "the government also plays a part in this when they recommend nutritional health requirements but encourage industrial farming through their climate policy. The numbers are completely different when you compare industrial emissions to those from to this kind of farming."

Yet a small-scale dairy producer in Vang described nuance in consumer's food choices, suggesting that "people who have the knowledge to question meat consumption also see the positive effects of grazing livestock and are more flexible with their dietary choices." Several participants believed this distinction could be made among consumers, particularly with regards to animal welfare. A mixed mutton and goat dairy producer believed it relies on consumers' exposure, saying, "everyone should buy their meat from local farmers and should see the animals for themselves to understand their higher welfare."

This sentiment was reflected in several statements made by participants in P2. One nurse-cow beef producer in Vestre Slidre suggested how "it is very important that people see grazing animals in the outfields, and that the meat comes from animals that roam freely. We cannot grow vegetables in the mountains, so consumers need to see the animals."

This distinction is important because several participants recognized their dual role as food consumers and producers when responding to this statement. An organic nurse-cow producer in Vestre Slidre said, "we would likely disagree with other farmers on several issues, like seeing a strict opposite between meat and vegetable consumption, which aren't as obvious to me." As will be described later on, the extent to which participants perceived external change processes to influence mountain farm systems varied further between both factors.

3.4.2 Agreement among participants

For the areas of agreement, the differences between factor loadings for statements ranged between Δ = 0.01 and Δ = 0.43. Once again, given there were fewer statements with statistically non-significant differences between perspectives, this indicates less overall agreement among participants within each perspective.

Participants in both perspectives almost unanimously disagreed that the advantages of a warming climate will be greater than the disadvantages for mountain farming (Δ = 0.01), and almost unanimously agreed that farm closures are harmful for the local agricultural network (Δ = 0.02).

Participants in both perspectives disagreed that land distribution efforts are important for managing conflicts in outfield areas (Δ = 0.09), while there was strong agreement that biodiversity and grazing quality in the outfield areas are affected if the grazing pressure is too low (Δ = 0.18). They similarly agreed that the land grant stimulates domestic fodder production (Δ = 0.18), and that virtual fencing can reduce farmers' workloads during the outfield grazing season (Δ = 0.19).

In turn, similar levels of consensus between both perspectives were found for statements where participants disagreed that vegetable/grain production is a viable substitute for mountain farming (Δ = 0.31) and that national farming cooperatives contribute to innovations in mountain farming (Δ = 0.37). Finally, participants largely agreed that grazing several livestock species benefits biodiversity in outfield areas (Δ = 0.43). The statements chosen to highlight consensus in farmers' comments reflect participants' greatest overall consensus levels.

Benefits versus risks of climate change for mountain farming

Participants in both perspectives commented on how future climate warming could impact their farming practices. The two most recognized climate threats among participants were drought and extreme precipitation, with shallow topsoil of cultivated grasslands highlighted for its vulnerability. As was introduced in this study, aggravated drought conditions and increased stormwater events are predicted to impact Oppland over the next Century. Six participants specifically referred to the dry summer of 2018 when responding to this statement, as highlighted by a goat dairy producer in Vestre Slidre:

"Extreme weather patterns will affect our yields. I'm quite anxious now because in 2018 we experienced a lot of snow during the winter, like we have this year, and then the drought came. We're also quite exposed to run-off from extreme rainfall. Particularly on this mountain side where the topsoil is so shallow," adding that "in 2018 it was so dry that I had to buy silage bales from Iceland.

But in the outfields, there was plenty of growth because there are heathlands and a rather moist landscape."

A mixed mutton and goat dairy producer in Vang said they were able to buffer the dry summer by irrigating their fields but were vulnerable to intense rainfall. "Last summer the rain washed away our entire yield on two fields, so I see downpours as a bigger risk in weather extremes," they said. Other participants believed that mountain farms would be less exposed to the risks of a warming climate than farms in southern Norway, particularly because of their greater exposure to flood events.

A micro-dairy producer in Vestre Slidre believed "mountain farmers will experience the negative impacts of climate change to a lesser extent than other farmers, but I don't believe the advantages outweigh the risks. In 2018 the farmers here experienced drought when we ran out of water in the streams."

Another small-scale dairy producer in Vang also believed that farms with flatter topographies, such as those in Rogaland County, could experience larger climate impacts. They believed their outfield grazing management promoted flexibility in their farming practices to buffer climate impacts: "We have had extreme drought in 2018 and real problems making hay. In 1988, we had the worst rainfall ever on the farm. There are frequent occurrences of extreme weather here, but outfield grazing is not so vulnerable to them because we are located higher up."

Although on-farm winter fodder production was believed to be at risk in the event of a dry summer, several participants agreed that outfield grazing resources, including infield meadows by shielings, were valuable for buffering the overall impacts. A nurse-cow beef producer in Vestre Slidre commented that "when you have a dry summer the grass production is rather sparse around the farm, but on the mountain farm it is excellent. There's a lot of variation between them."

A small-scale dairy producer in Vang similarly said, "down on the farm during the summer of 2018, the grass looked burnt. But we took the cows up earlier that year and stayed there for longer." It is worth noting, however, that the same farm manager had commented on increased encroachment of dwarf birch (Betula *nana ssp. alpina*), "probably because of the warmer climate," they speculated. This suggests that rapidly changing vegetation patterns mountain areas combined with extreme climate events could have conflicting effects on farm managers' adaptive capacities in outfield areas.

Farm closures

Participants in both perspectives agreed that farm closures are harmful for the local agricultural network in Valdres. It has been shown how Valdres has experienced a decline of approximately 40% of farm holdings between 1999 and 2019. Previous comments by participants in P1 recognized

agricultural policies towards farm rationalisation as a significant change agent in mountain farming. Yet when describing their experiences with farm closures, several participants in P2 also identified farm rationalisation as a common driver. With the exception of a mixed mutton and dairy producer who believed that Øystre Slidre still retains a strong farm network, participants discussed changing farm networks at local and regional scales.

A micro-dairy producer in Øystre Slidre described the biggest problem facing mountain farming as "the kind of government support that encourages farmers to build barns for 50 cows, when they only have pastures for 15 cows. That is worsening the farming network. I expect we won't have any farmers in my village in five years' time." Such comments are especially relevant in the context of increasingly uninhabited agricultural settlements, which in Valdres have deteriorated by nearly 20%.

Structural limitations to livestock production in mountain farming were highlighted by several participants from different viewpoints. A mutton producer in Nord-Aurdal renting several fields confirmed this challenge, saying it had become difficult to use their outfield areas and mountain pastures with fewer farmers. "When I quit, I don't think anyone will want to farm these difficult-to-navigate fields. I'm the only one with small tractors that can navigate them," they said. Indeed, the largest area of rented agricultural land in Valdres is in Nord-Aurdal, possibly making marginal fields less attractive to consolidated mountain farms.

A mutton producer in Vestre Slidre explained how they were intentionally off-loading harvesting activities to a young entrepreneur in order to promote the local agricultural economy. "Part of that decision is a sustainability perspective of wanting to support generations that are active in the area. And the grass that is cut is done on three cultivated fields that would otherwise be out of use," they said.

A small-scale dairy producer in Vang described how they are "extremely dependent on good relationships in Valdres. We meet people with different backgrounds and education levels and that widens our social perspectives." Conversely, their partner manager detailed how some relationships are more valuable than others, particularly when farmers adhere to rigid agronomic practices. They said, "farmers in Norway are more likely to accept what is told to them by advisory services without second thought. Most of these farms are smaller and are run traditionally over generations."

An organic dairy producer in Sør-Aurdal similarly described how rigidity within farm networks can make cooperation between farmers more challenging. They asked, "how can farmers understand cooperation is possible when your father taught you how to do things a certain way that is different from your neighbour?" A mixed mutton and nurse-cow beef producer in Sør-Aurdal linked these

network rigidities to “an ageing population in Valdres with many farmers adhering to farming practices that their fathers taught them.” They added, “that’s not a very progressive farming model. Many farmers are hardworking and solid people, but they probably don’t like changes.”

Biodiversity values and grazing pressure

Although participants in P2 slightly disagreed that increased livestock densities represent a vision of sustainably managed outfield areas, participants in both perspectives agreed that low grazing pressure is associated with declines in biodiversity values and grazing quality.

An organic nurse-cow producer in Vestre Slidre commented on their experience of mountain birch (Betula *pubescens tortuosa*) encroachment, and that “perhaps differences in livestock breeds would be more important if there were very many grazing animals, but there aren’t enough to notice a difference. Outfields are overgrown because there are fewer grazing animals and fewer trees being harvested for shieling activity.” This perspective was also held by a nurse-cow beef producer in Vestre Slidre, who said, “Angus cows are very good grazers, but there simply aren’t enough grazing animals on the outfields at the moment.”

Other participants highlighted biodiversity values on their infield meadows, largely because of how they had structured their farms and managed their productive grasslands. A small-scale dairy producer in Vestre Slidre commented that “our farm is beneficial for our harvesting activities and biodiversity. We have many small fields, we never use pesticides, which means we have more field edges that host insect and bird life.”

Similarly, a mixed mutton and goat dairy producer in Vang explained that farmers should actively use the outfields and take measures to improve biodiversity. In particular, that they are “running a kind of farm that allows us to use the most marginal and steepest land. None of our fields are ploughed or treated with chemical fertilizer. We have fewer yields for that, but I strongly believe we have high quality and diverse feed for our animals.”

A small-scale dairy producer in Vang summarized the challenges of outfield grazing when herd sizes or production levels increase based on fodder quality. “If you have high-producing cows and bring them to the summer farm where the grazing quality is poor, those cows must walk farther and milk production drops.” A micro-dairy producer in Øystre Slidre also noted seasonal variations in fodder quality, as “the quality of the grass in the beginning of the summer is very good but after that it declines fast.”

Four participants noted how they were dependent on outfield pastures for sustaining their livestock herds, pointing to economic drivers for outfield usage rather than biodiversity goals or fodder quality.

An organic dairy producer in Sør-Aurdal confirmed they wouldn't have enough cultivated land around the farm to produce winterfeed as well as graze them on infield pastures over the summer, "but without the grazing subsidy I wouldn't be able to use the outfields. There has to be a catalyst from the government." Even still, the same farm manager concluded that "we should prioritize animal welfare and environmental goals when we encourage outfield grazing."

Outfield resources by the shieling were cultivated for winter fodder production by several participants, particularly by those with too few infield meadows by the farm. A mutton producer in Vestre Slidre commented on the differences in fodder quality in managed infield meadows by the farm compared to those by their shieling. "I notice a vast difference in grass species and grazing quality. There are some acidic and wet areas with very few valuable species by the shieling, which provides volume for silage bales but little nutritional quality."

Vegetable/grain production as an alternative to mountain farming

Most participants were engaged in vegetable production for food self-sufficiency, either on the farm or by the croft. Apart from one micro-dairy producer in Vestre Slidre, however, participants in both perspectives disagreed this was a viable substitute for mountain farming. The dairy producer commented that "perhaps not instead of but in addition to producing grass. There's room for both, but we really need grass for our animals during the winter."

A mixed mutton and dairy goat producer was positive towards several individuals who were attempting vegetable production in the mountains, yet the objective of their farm production was towards selling organic-certified cheese. "I don't have experience selling vegetables, but I have produced them for the family. Milking is my job but not my passion. The day I start making cheese I will turn to organic concentrate fodder to have it certified."

Several participants highlighted the risk involved for securing vegetable viable harvests. A mutton producer from Nord-Aurdal said "we're producing vegetables for ourselves, but of course we're at 800m above sea level. Last summer our harvest wasn't very successful. It is certainly possible, but grass production is the main farming activity in mountain areas. A cold summer ruins a vegetable harvest."

Another mixed mutton and dairy producer in Øystre Slidre described how they were contacted by a project coordinated by Innovation Norway to trial vegetable production but declined due to the perceived risk of weather extremes. They said, "I know too little about it and the economic margins are thin. The climate would also be a problem. When it downpours the soil runs off, which makes it difficult to produce vegetables here."

An organic nurse-cow beef producer in Vestre Slidre believed the investment costs for vegetable production, particularly those in new farm equipment, outweigh the economic returns, saying “I wish I could agree more with this, but for most farmers it is simply too labour intensive.”

Several other participants noted the land use trade-off implied by keeping livestock and producing vegetables. One mixed mutton and goat dairy producer in Vang was aware of several commercial vegetable producers in the area, but concluded that “in order to live off of the farm too, so that’s why we sell our milk.” This was reiterated by another goat dairy producer in Vestre Slidre, who described mountain farming as “dependent on calorie-conversion by ruminants. Vegetable and cereal production should be prioritized in areas suited for it. We can’t do that up here. If there was a way to grow cereals here, I would.”

Altogether, these statements of greatest overall significance reflect commonly held perspectives among participants in both perspectives. In particular, participants perceived themselves to be vulnerable to future climate changes, although not to the same degree as other farming systems in Norway. They also expressed vulnerability to a diminishing farming network, which affected participants on an immediate level, like social cohesion and a sense of loneliness. Vulnerability was also expressed structural level, as mountain farms were believed to be encouraged to consolidate, rationalise, and expand production capacities. Moreover, biodiversity values associated with outfield grazing and the belief that livestock production was the best land use configuration for farming in mountain areas were important areas of consensus among participants in both perspectives.

3.5 Linking social perspectives to resilience indicators

Mean values for each indicator of agroecological resilience, based on normalised z-scores within each perspective, are presented in Figure 7, below. Overall, the perspectives held by participants in P1 demonstrated areas of greater vulnerability towards changes in mountain farming (Σ = -5.71), while the perspectives held by participants in P2 described somewhat greater resilience towards changes in mountain farming (Σ = 0.66).

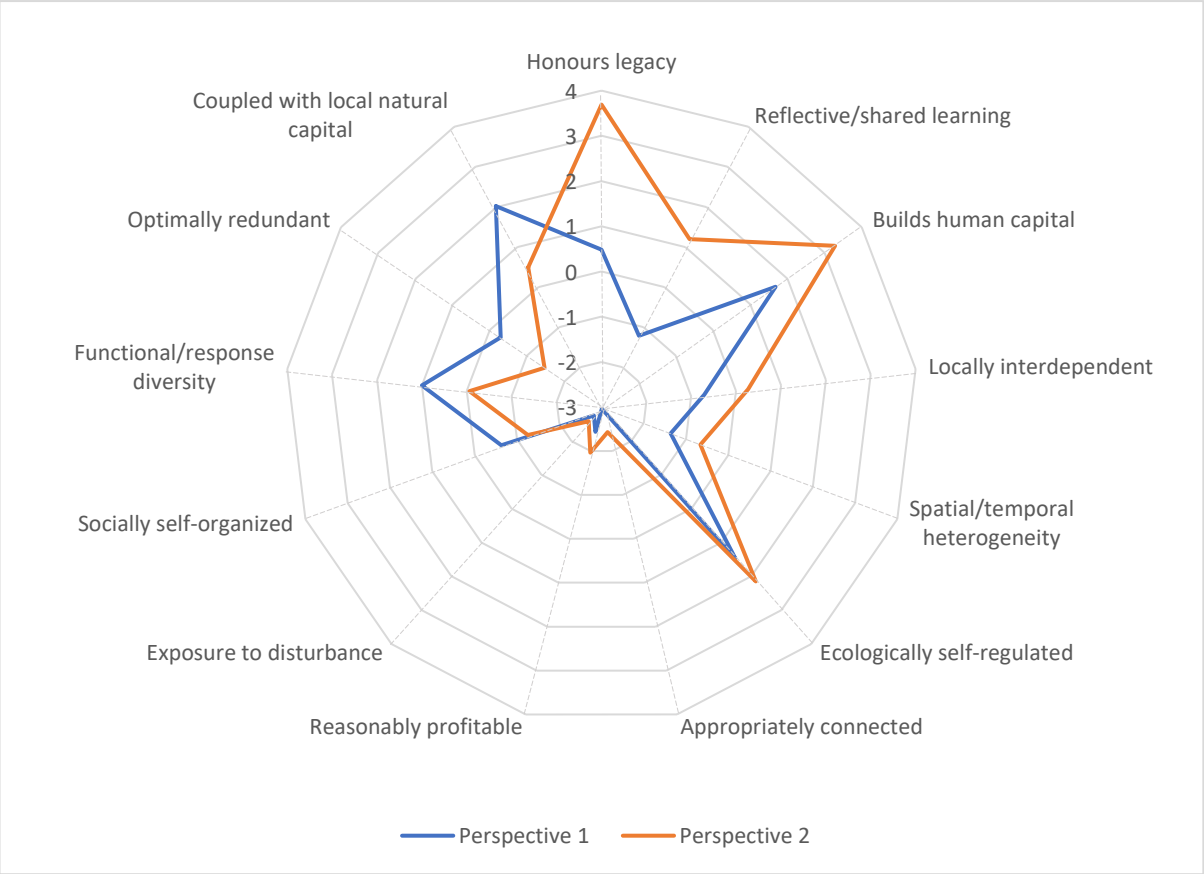

Figure 7: Normalied z-scores for statements categorized by 13 indicators of agroecological resilience, ranging from -3 in the centre of the spiderweb to +4 at the periphery. Z-scores correspond with areas enabling either vulnerability or resilience based on the two distinguishing perspectives.

3.5.1 Areas enabling resilience among participants

Coupling with natural capital and honouring legacy

The indicator responsibly coupled with local natural capital scored highest for P1 ($\bar{x}$ = 2.02), indicating the greatest perceived area for enabling resilience in mountain farming. Farm systems that are responsibly coupled with local natural capital are said to use local resources within the biophysical

means of the system, which relies more on functioning ecosystem services such as nutrient, waste, and water cycling (*ibid*). Statements in this indicator described increasing livestock densities for sustainably managed outfield areas, maintaining outfield usage based on current farm resources, and contributing positively to greenhouse gas emissions reductions.

This indicator was driven by the statement on increasing livestock densities and maintaining outfield usage. Valdres has lost over one-fifth of all outfield grazing livestock between 1995 and 2020 (Bye and Bjørlo, 2023c). Placing more value on increasing livestock densities describes how participants desire mountain farm systems to reorganize in such a way that outfield grazing resources can be more readily exploited.

When commenting on their outfield grazing practices, participants in P1 described having to adjust to seasonal variations, structural limitations to outfield grazing, and varying outfield resource availabilities. A small-scale dairy producer in Vang explained "how important it is to be agile when on the summer farm. If we extend the grazing period for too long, the grazing quality is poor, the milk quality declines, and it is very difficult to bring back up."

The desire for increasing grazing pressure in outfield areas and the changes necessary to achieve this vision were not always clear among participants. For example, when asked about the viability of modernizing their farming practices, a small-scale dairy producer in Vang said, "I don't want to have more animals – it just piles onto the workload: more veterinary visits, more winter fodder, more manure to deal with. It's nice to stay small. My goal is to fill my milk quota, which remains small." This suggests that the desire for increased grazing pressure isn't for individual farms to increase their herd sizes.

An internal discussion emerged between two farm managers in dairy production when commenting on the viability of farm structural changes. One manager noted how barn upgrades are not compatible with shieling practices, because larger herds are increasingly difficult to manage on the outfields, and because the necessary investments in the shieling aren't viable with poor farm income. They emphasized several times over that "high grazing pressure is absolutely essential."

The other manager believed that it was equally important to consider investments for mountain farms to persevere and inspire other parts of society in Valdres. "The municipality of Vang has been very supportive in providing investment funds to mountain farming, especially for young farmers and innovative projects. But, of course, there is a lot of responsibility involved in accepting these loans. There aren't four cows per farm as there was 50 years ago, but we must also be willing to invest in our farms and grow them as any other business would," they said.

For P2, the highest mean value corresponded to the indicator honours legacy ($\bar{x}$ = 3.69), which describes farm systems that exhibit strong biological and cultural memory. Cabell and Oelofse liken honouring legacy to path-dependency (2012), for example by embedding contemporary knowledge in traditional farming practices. Statements in this indicator included whether traditional food production will be valued by future generations, the impact of Norwegian agricultural intensification on the reputation of mountain farming, and the impact of alternative dietary campaigns on mountain farming.

This indicator was driven by traditional food being equally valued by future generations in Norway. Therefore, based on Norwegian public valuation, participants may consider it unlikely that mountain farm systems need to pursue development trajectories that reorganize themselves into novel states. Cultural identity was highlighted as a core feature within participants' comments on food production in Norway. Even though participants believed mountain farming could be valued for food production, they openly discussed some uncertainties in their answers tied to larger societal changes.

A former nurse-cow beef producer in Vestre Slidre reflected how campaigns aimed at promoting rural development might not align with upholding local cultural identity. They said, "there have been different recruitment campaigns on how we can develop the local population. But I doubt many villages have had a desire to do so. There was a Dutch family who moved into the area and established cheese production, which is very nice for the area. But is it truly local? It's a dilemma, really." They had also commented on the value of projects like the Valdres Nature and Culture Park[25] as positive for local food production. They spoke in great detail and admiration of their mother, who had produced traditional low-fat cheese varieties, such as *bufar* and *knøøst*, throughout her lifetime.

When asked whether they believed traditional food production was integral to their cultural identity, a mixed mutton and dairy producer in Øystre Slidre said, "it's not the main aspect of my identity, but I think it reflects stronger in contrast to the rest of society. Regular contact with animals and my interest in local biodiversity is most important for my identity." Concerning local food production, the same farm manager described how they were uncertain about entering independent production schemes. They said they "would love to be independent, but investments in food production are heavily regulated. If we did, we could cooperate with other farmers or hotels and other tourist industries to create our own products."

Similarly, a mixed mutton and nurse-cow beef producer in Sør-Aurdal described a situation where "many of us would like to try other kinds of production, but we're dependent on the state for our

[25] *Valdres Natur og Kulturparken* in Norwegian

farming. As long as the states supports us, they decide main modes of production and most farmers will adapt to those decisions." When considering the possibilities of diversifying their farming practices, they said "if we sold our meat based on grass-fed production, we would have to be very good at marketing it. And we don't have a strong marketing base in this region."

A large-scale dairy producer in Nord-Aurdal who had installed an AMS believed they successfully embedded traditional food production in a modernized farming structure, by "adapting to the world as it is today, not as it was in 1850." They added that this was important to invest in the barn to make the decision on inheriting the farm easier for their sons.

These examples illustrate how farmers that have modernized their practices may retain their cultural identity in traditional food production. The same farm manager also recognized the structural limitations of other mountain farms to modernize their practices combined with the pressure public perception might place on mountain farmers. "People want free-run cows, but not all remaining farmers can modernize their practices. If a cow is only able to go outside for two and a half months, is it really free run? We can't expect the same life quality standards for cows as for humans," they noted.

Investing in an AMS has been found to create cultural lock-ins among dairy producers (Rønningen et al., 2021), which the farm manager acknowledged when talking about outfield grazing workloads. "It's important for us to have regular contact with the cows and maintain a relationship that also helps when we bring them in for milking in the summer. But at the moment, it's far more work to milk them in the shieling. We spend over three hours milking every morning and evening during the summer," they said.

Building human capital

The next highest indicator for participants in P1 was builds human capital ($\bar{x}$ = 1.68), which describes how farm systems make use of available resources through social networks, particularly those involving multiple actor groups, based on available technology, norms, and infrastructure. Statements in this indicator included the valuation of the cultural landscape by visitors, the impact of farming practices on other life obligations, the effect of farming practices on life quality, adjusting farming practices to the needs of future farmers, and the contribution of outdoor leisure to functional outfield areas.

This indicator was driven by the positive valuation of the cultural landscape among visitors, suggesting that public valuation can support mountain farm systems throughout their adaptive cycle. However, participants in P1 largely described activities in outfield areas as hindering to their farming practices.

The positive valuation among visitors was not necessarily perceived as a constructive element in mountain farming by participants.

This situation was best described by a mutton producer in Vestre Slidre, saying developments in outfield areas created a kind of paradox. “Norwegians are tending to appreciate being in the wild more by being in cabins. They want open views and a nice landscape but don’t want grazing animals,” they said. A mixed mutton and goat dairy producer in Vang who experienced minor conflicts with visitors in the outfields drew on the same paradox, saying “hotels still use active summer farms in their commercials because that’s what people want to see.”

A small-scale dairy producer in Vang also said, “when TINE makes an advert they use the image of mountain farming, but the average cow is locked in a barn eating silage. Mountain farming is the image that people would like to have – similarly, small farms are struggling with keeping up animal welfare standards. So, the problem comes from when people don’t understand the life of a cow well enough and base their thoughts on their human needs.”

Although participants believed visitors desired open cultural landscapes, a small-scale dairy producer in Vang described how part of “being a farmer is remaining adaptable and robust against changes; it’s more important to appreciate your own work than seek it from others.” This suggests that human capital is partly constructed by participants’ self-appreciation in their role as cultural landscape managers. Another small-scale dairy producer in Vang emphasized this by saying “if you're young and want to be a farmer, you have to really want it.”

Builds human capital was also the second highest scoring indicator among participants in P2 ($\bar{x} = 3.28$). Contrary to participants in P1, the indicator was driven by the statement that mountain farming has a positive effect on mountain farmers’ family life quality overall. Cabell and Oelofse suggest that building human capital can “provide meeting places for socializing, encourage multi-generational interaction, give opportunities for participants to develop, and build trust” (2012). Participants largely associated these benefits with their time spent on the shieling during the summer months, particularly for family time, caring for animals, and outdoor leisure.

Even with these positive associations, participants acknowledged that some mountain farming activities have experienced conflicts with other activities in the outfields. A nurse-cow beef producer in Vestre Slidre described how their family “lives in the mountains because we like this way of living, like cycling through the mountains in the summer. We also have more visitors but the tourists staying in cabins don’t always know how to interact with the cows. Now there is also more awareness around how to responsibly enjoy the mountains, with information signs, for example.”

A mixed mutton and goat dairy producer in Vang explained how they had hoped entering mountain farming could give them peace and quiet on the shieling, but in fact experienced more activity than expected. “On both mountain farms there’s a lot of car traffic passing by. I think it’s positive that people use the outfields and I’m even thinking about selling cheese locally to visitors, but I don’t like it when people are disturbing the animals,” they said, adding, “we used to have another summer farm which is what I dreamed of: you go there and say goodbye to the world.”

Ecological self-regulation

The third highest indicator for participants in P1 was ecologically self-regulated ($\bar{x}$ = 1.47). This describes components of the farm system that exhibit stabilizing mechanisms, which in turn reduce the need for external inputs. Statements in this indicator included whether summer farming is viable with increased farm production, the importance of using local fodder resources instead of concentrate feed, and if summer farming creates challenges with maintaining overall farm yields.

This indicator was driven by the importance of using local fodder resources instead of concentrate feed, which describes how resources are exploited within the ecological means of the production system. Regulating ecosystem services are of particular interest, which in the context of outfield grazing would secure productive outfield pastures for the following grazing season through grazing activities. It is worth noting that with the exception of two participants in P1, all farm managers described a situation where they were partially dependent on purchasing round bales for supplementary winter fodder. Most participants in P1 described how their desire was to remain small, yet that they sometimes struggled to make use of locally available resources because of political pressures towards increasing production.

A small-scale dairy producer in Vang described how they believed local politicians “aren’t interested in what we’re doing. They have a limited amount of time, money, and resources which doesn’t prioritize outfield grazing.” This was reiterated by a micro-dairy producer in Øystre Slidre, who believed “people want mountain farming, but they don’t support it. The politics around agriculture is towards bigger farms. As soon as you build a bigger farm you can’t use the shieling.”

An organic dairy producer in Sør-Aurdal believed whether or not farmers use outfield grazing areas is primarily economically driven, saying “when it comes to additional work being done on the farm, like outfield grazing, farmers have to decide between labour intensity and added benefit. When I couldn’t find help for the shieling last year, I kept the cows down on the farm because it would’ve been too much work for me alone.”

Ecologically self-regulated was also the third highest scoring indicator among participants in P2 ($\bar{x}$ = 2.15), which was also driven by the importance of using local fodder resources instead of concentrate feed. Participants in P2 described the economic rationale for using outfield resources in order to maintain their farming practices. A mixed mutton and dairy producer in Øystre Slidre said, "I have to have my livestock on the outfields or else I would have to buy winterfeed from elsewhere to sustain them throughout the year."

An organic nurse-cow beef producer in Vestre Slidre also said, "if we didn't use our outfield pastures, we would have to buy additional winterfeed and use fenced in pastures." The importance of making greater use of outfield grazing resources is highlighted not only as an alternative to concentrate feed, but as a necessity for the current farm configuration to persist. It should be noted that participants within P2 were mostly winterfeed self-sufficient, with some farm managers occasionally buying additional round bales for horses, calves, and sheep. Consequently, outfield and infield pasture management is highly valued among participants in order to conserve grazing and pasture resources for the future, albeit within the means of existing farm structures.

3.5.2 Areas enabling vulnerability among participants

Optimal redundancy

The indicator optimally redundant scored lower for P2 ($\bar{x}$ = -1.47) than for P1 ($\bar{x}$ = -0.29). Cabell and Oelofse explain how optimal redundancy, otherwise known as the relative utility of system components, can be positive or negative for farm systems. Yet having system components perform similar functions can act as a buffer against shocks (2012). This indicator was driven by the statement that private ownership of the outfield areas is better than state commonality for safeguarding grazing resources, which also describes participants' connectivity to institutions in cycles higher up in the regional panarchy.

As was previously discussed, there was no clear relationship between whether participants who owned private outfields believed this was the best land use configuration. Instead, participants in P2 more often expressed state commonality as a buffer against development projects in outfield areas. One mixed mutton and dairy producer in Øystre Slidre believed that "we don't experience the issue of landscape fragmentation because we have strong regulations in place to counteract development, but that isn't true in other places."

From P1, an organic dairy producer in Sør-Aurdal believed "I think it can work both ways. When outfields are privately owned, there are always personal interests involved, like landowners prioritizing hunting activities. With public common outfields, claims towards those holdings from

distant relatives can be made overnight," they said referring to grazing rights being conditional on the use of shielings in connection to agricultural properties, for which farm ownership is determining.

Yet strongly held beliefs among participants in P1 explained why some participants believed public common outfields were poorer land use configurations for outfield grazing. A proposed wildlife corridor between Jotunheimen and Langsua National Park has been of recent importance to several farmers. A small-scale dairy producer in Vang described how "the economic challenges of farming can be mitigated by private ownership. The neighbouring municipality is part of the Langsua National Park, which creates a lot of administration and bureaucracy, which I believe negatively impacts summer farming."

This concern was echoed by another small-scale dairy producer in Vang, who described how they hadn't been consulted when a road was built on state commons bordering their outfield areas in Øystre Slidre. They said, "I think it is better my outfields are privately owned, because we were able to petition against the road being built towards our outfields. The municipality built the road without any forewarning for farmers on public commons. National Park managers have a lot of power."

Internal communication with a Langsua National Park manager detailed how officials have tried to engage farmers in a participatory approach to lessen workloads when cooperating on management plans.[26] According to this official, "such activities are cooperated on with farmers every year to discuss what the challenges are that can be solved together. My experience is that concerned farmers do not want others involved in their own management. It creates a sense of insecurity about what will happen in the future."

Private ownership of outlying areas creates opportunities for farm managers to maintain an 'escape plan' by navigating a period of transformation into an alternative livelihood situation. In such a situation, farm managers could enter a new adaptive cycle by participating in development projects instead. Yet the vulnerabilities perceived by participants in P1 towards increased regulation in outfield areas were less salient than those perceived by participants in P2 towards increased development pressures. Both vulnerabilities point to increasing difficulty in conserving outfield resources through the adaptive cycle.

Spatial and temporal heterogeneity

For participants in P1, the indicator spatial and temporal heterogeneity scored lower ($\bar{x}$ = -1.36) than for P2 ($\bar{x}$ = -0.66). This indicator was driven by the statement that the fragmentation of cultural

[26] Anonymous, phone communication on March 7th, 2023.

landscapes threatens the economic viability of upland grazing systems, which has previously been described in detail.

For P1, this indicator was further driven by participants' agreement that (a) private land ownership is equally effective than tenancy agreements in fulfilling local forage production, and that (b) greater dependence on leased land creates opportunities for mountain farming. Yet using participants' interviews to explain factor loadings was limited for the topic of tenancy in agriculture, as the relationship between land ownership and tenancy agreements was not always clearly expressed.

Conserving infield meadows through tenancy agreements allows for greater farm production, which also allows farm managers to accumulate grazing resources (e.g., by delaying or advancing harvests). Yet the inefficiencies in conserving the productivity of various fields could equally expose vulnerabilities should the farm system experience any (unforeseen) disturbance. Overall, participants recognized how agricultural areas were increasingly cultivated through tenancy agreements in Valdres, although many participants in P2 believed that privately owned fields were better managed and maintained.

A mixed mutton and nurse-cow beef producer in Sør-Aurdal described an economic outlook on tenancy, saying "you invest more in your own land than your rented land, of course." Agronomic investments for effective forage production and preserving productive grasslands were mentioned at length. The same farm manager described how "liming is essential in Sør-Aurdal but might not be as relevant in neighbouring municipalities where they have better soil, which ties together with using local resources – we can make grass bioavailable to our livestock by liming." Another mixed mutton and dairy producer in Øystre Slidre considered "land to be better used than if you would rent it." Infield meadow productivity was also considered the main investment, as they had "tried to vary inputs in different fields to maximize fodder production for my cows. Liming has many benefits, especially in mineral-poor soils like ours."

Further distinction among participants in P2 was found in comments made by two farm managers engaged in organically managed grasslands. An organic nurse-cow beef producer in Vestre Slidre said, "the amount of rented land has increased with the decline in overall farmers. There are less than half the amount of active farmers in our area alone. The rest of us are renting the fields, but the production still remains local." A mixed mutton and goat dairy producer in Vang described how they didn't think "it's so important whether farmers own land or not. We have a positive experience renting land because people are very kind and we don't pay very much, so why should we own the land?"

Another perspective on the economics of land tenancy provided by a participant in P1. The mutton producer in Nord-Aurdal said “as long as you can keep leasing contracts for a minimum of 10 years, you don’t have to buy the land, but you still use it as your own. With the greater availability of land, the fields are becoming much cheaper than they were 10 years ago.”

Among other participants in P1, however, tenancy belonged to a sense of responsibility towards maintaining land on farms that have since ceased production. A small-scale dairy producer in Vang described how “if you have long-term contracts, rented land can be useful. I’m only renting lands to keep the infield meadows productive, and the owners want them to be used.” Conversely, the same farm manager stressed how private land ownership was imperative to grassland management, saying “you feel a responsibility towards owning something that you know you have to defend.” They added that “there are enormous transport and fence maintenance costs involved in renting land, which makes it difficult for other farmers to use the outfields.”

Reasonably profitable

The indicator reasonably profitable scored very low among participants in P1 ($\bar{x}$ = -2.44) and P2 ($\bar{x}$ = -1.96). Reasonably profitable farm systems ensure a sustainable livelihood without overreliance on external sources of funding, government support mechanisms, or economic pluriactivity. Statements in this indicator included the willingness of consumers to pay premium prices for high-quality foods, the significance of off-farm work for household income, the importance of subsidy payments for outfield grazing, and the relevance of return-on-equity calculations for deciding whether to modernize farming practices.

For P1, this indicator was driven by the relevance of return-on-equity calculations for deciding whether to modernize farming practices. Financial investments could potentially determine the ability of the farm system to conserve resources for future exploitation. Disagreement with this statement indicated that there were structural and financial limitations to farm upgrades participants could make. Yet particularly for dairy producers in P1, some participants described they were locked-in to one kind of livestock production.

A small-scale dairy producer in Vang said, “I went into dairy production because it was the most effective way to use existing infrastructure, so it made sense for me to specialize in dairy production.” An organic dairy producer in Sør-Aurdal described the challenge of inheriting their farm “because my father hadn’t invested in the farm at all.” Despite making cost-effective upgrades to the barn in 2018, they expressed regret in having expanded their tie-stall barn to accommodate more dairy cows. Consequently, it increased their overall workload and their shieling needed similar upgrades which

were no longer economically feasible. Although this farm manager is exempt from the coming tie-stall ban, they described uncertainty towards any future changes in agricultural regulations that could create further lock-in.

A goat dairy producer described how their decision to build an additional building segment to the barn was to increase milk production. When asked about the relevance of making investments for future farming generations, they responded "if we can't make those investments today, we should be able to make them in the future," suggesting farm profitability ought to drive the farm's innovative capacity. Even still, they commented on how increased production levels created lock-ins towards higher farm yields, saying "I would like to use less concentrate feed and more grass fodder. But if I use less, I wouldn't get the same milk yields or quality that TINE requires," adding that "without additional help I wouldn't be able to manage the farm."

Ten farm managers in P1 were actively engaged in off-farm work, with five participants describing the desire to be engaged in farming full-time. A small-scale dairy producer in Vang said, "working off the farm is completely necessary at the moment, but we're working towards being on the farm – it's ridiculous we need to invest money we make off the farm to keep it running – why should it be that way?"

For participants in P2, this indicator was driven by the necessity of off-farm work for their household income, which has been discussed earlier in the results. Ten farm managers in P2 were actively engaged in off-farm work, with just two participants describing the desire to be engaged in farming full-time. As described by an organic nurse-cow beef producer in Vestre Slidre, "neither my partner nor I planned our education aiming to become farmers, so it's something we've chosen to do because it's part of the way we want to live our lives. But as it stands, we only earn a fourth of our total income from the farm."

They then added that they value off-farm activities and work, "even if farming would generate the same amount of money. We want to do what we're doing in addition to the farming." The supposed balances between on-farm and off-farm work, as has been shown, were not always perceived as beneficial among participants in both perspectives.

Exposure to disturbance and appropriately connected

The indicator carefully exposed to disturbance scored lowest for participants in P2 ($\bar{x}$ = -2.58), indicating their strongest perceived area of vulnerability in mountain farming. This describes events that would not otherwise push the farm system beyond a critical threshold. Statements in this indicator included the impact of heavier farm machinery on soil quality and crop yields, the robustness

of diverse crop mixtures against climate variations, the impact of weather extremes on crop yields, and the relative (dis)advantages of future climate change.

This indicator was driven by the advantages of future climate change being greater than the relative disadvantages, followed by the impact of heavier farm machinery on soil quality and crop yields. Disturbances driven by climate change have the potential to transform the farm system through a critical release of resources. However, as Darnhofer and colleagues describe, a release phase is also when "new connections are established and resources used and linked in novel ways" in the farm system's adaptive cycle (2016).

Participants in P2 did not mention their perceived vulnerabilities to climate change in detail. One mixed mutton and beef producer in Sør-Aurdal commented how "drier and colder Spring seasons with earlier snowmelt, and warmer Fall seasons are more common. In 2018 we had a very dry summer and our south-facing slopes dried out completely. But we haven't changed our agronomic practices since because we don't usually have problems with weather conditions in this area."

Rather, participants described their reliance on entrepreneurs for grass harvesting activities, the difficulty in managing harvest times with exposure to weather extremes, and rising operating costs. As one nurse-cow beef producer described, "I hire an entrepreneur to make silage bales in my outlying fields, but I have to plough more often on those fields because their tractor is heavy, perhaps every four years – whereas I usually plough every five to six years."

A mixed mutton and goat dairy producer in Vang described the challenges of prioritizing biodiversity goals and managing organic infield meadows. "We rent 20 hectares to realize our kind of production. We could probably produce equally as much on 7 hectares if we didn't prioritize biodiversity." When describing their reflections on developments for the farm, they said they "would like to build a hay-drier which would help when the weather is unpredictable," yet emphasized how such longer-term investments would require time to plan for which they otherwise didn't have.

For participants in P1, the indicator appropriately connected scored lowest ($\bar{x}$ = -2.96), indicating their strongest perceived area of vulnerability in mountain farming. Appropriately connected farm systems describe both the quantity and quality of relationships between human and non-human elements of the system (Cabell and Oelofse, 2012). Statements in this indicator included funding schemes' impact on the economic self-sufficiency of mountain farmers, whether social media platforms compensate for deteriorating agricultural networks, and the relative (dis)advantages of cabin development for mountain farming.

This indicator was driven by the perceived negative impacts of cabin development on mountain farming. Cabin developments appeared to impair the quality of relationships between farmers, livestock, and non-farmers. If developments in outfield areas hinder the agroecosystem's ability to conserve outfield grazing resources, the system could enter a new adaptive cycle with fewer connectedness and resource potential.

Consequently, mountain farmers' inability to exploit outfield grazing resources for sustaining ruminant livestock production could push the farm system into a shorter and faster adaptive cycle, based more on external fodder inputs and intensified infield resource exploitation. As was highlighted by a small-scale dairy producer in Vang, who described tourist development as the most significant threat to their outfield grazing practices, "if the basis for being on the shieling is lost, there will also be questions about the entire operation with milk production, as we are dependent on outfield grazing."

Four participants in P1 had received funding from Innovation Norway for barn, shieling, or croft upgrades, and participants somewhat agreed this public funding source could contribute to economic self-sufficiency overall. Many participants, however, were reluctant to use Innovation Norway as a financing scheme because they were uncertain whether the farm could produce enough profit to cover the investment costs.

A mutton producer in Vestre Slidre described how "the only way to keep sheep year-round is to use the outfields. But what we can notice from previous political decisions that were funded through Innovation Norway was an overall increase in the size of sheep farms, which meant those farms were having to import fodder resources from elsewhere. They weren't always able to bring them onto the outfields."

The second lowest indicator for participants in P1 was careful exposure to disturbance ($\bar{x}$ = -2.75), which was also driven by the relative (dis)advantages of future climate change. Beyond discussing the impacts of a changing climate, participants commented further on the utility of locally adapted grass varieties, fodder crop diversity, and points of vulnerability in their agronomic practices in greater detail, such as the impact of heavier farm machinery on soils and crops. The negative impacts of heavier machinery was a guiding reason for some participants to keep their investments low, as a mutton producer in Vestre Slidre said, "investing in a new tractor was the limit for me. The lighter tractor makes it easier to drive in the Spring and Fall when the ground is relatively wet."

A mutton producer in Nord-Aurdal confirmed this, suggesting they "have smaller machinery which can be used for fields that would otherwise be neglected by farmers with large tractors. You can see where the large tractors have driven by looking at how the grass grows." The same farm manager described

how they were mostly using different grass varieties to restore fallow grasslands, such as Italian ryegrass (Lolium *multiflorum var. italicum*) for loosening compacted soil. They also recalled how the Norwegian Agricultural Advisory Body[27] informed them of field tests for locally adapted grass varieties on the Løken Gård research station in Øystre Slidre. However, the participant hadn't followed up since last hearing that the tests had failed due to a late frost event.

A small-scale dairy producer in Vang believed that "as long as we're consistently liming, we will have good grass yields," but similarly explained how they're using "different grass varieties to restore fallow fields and renting to keep grasslands productive. The landowners want them to be used since they haven't been productive for several decades."

Yet another small-scale dairy producer in Vang described the risks of losing biological diversity on infield meadows through excess liming and fertilization. Instead, they sought to promote infield biodiversity by grazing key areas around the farm. "With too little grazing or periodic cutting, we've noticed that the number of dragonheads (Dracocephalum *ruyschiana*) is going down and is increasingly vulnerable in this area," they said. They had also commented on poor advice provided by the County Governor's Office,[28] which had suggested liming over areas of matgrass (Nardus *stricta*) to promote calorie-rich pastures. The farm manager believed this would have destroyed biodiverse plant assemblages, which matgrass is an indicator of.

A mutton producer in Vestre Slidre described the importance of varying seed mixtures and sowing rates for different fodder quality requirements. "This farm has very little need for drainage and the soil is relatively alkaline, which means local grass varieties are important. People with dairy cows are dependent on higher quality fodder and will plough grass fields more frequently. I like to think that fodder production for sheep in the mountain areas can be achieved with sowing periods every 10 years," they said.

A small-scale dairy producer in Vang commented on how "people have invested in large 200 horse-power tractors in Valdres, but the topsoil is the same depth as it was 100 years ago. So how can they be good for it?" They admitted they were not necessarily knowledgeable about agronomic inputs for grassland cultivation, as they relied on a relative for this advice, but "avoided ploughing whenever possible, perhaps every five years or so."

A combination of internal forces tied to agronomic practices such as renting land, maintaining cultivated infield meadows, and maintaining lighter machinery could lessen the exposure of mountain

[27] *Norsk Landbruksrådgiving* (NLR) in Norwegian.
[28] *Statsforvalteren* in Norwegian.

farming to soil and fodder crop disturbances among participants in P1. Mountain farms were perceived as vulnerable, however, to exogenous forces of a changing climate, in particular to variations in grassland production for winter fodder.

The second lowest scoring indicator among participants in P2 was appropriately connected ($\bar{x}$ = -2.43), which was driven by the impacts of cabin development on mountain farming. Several participants insisted on distinguishing between individual private cabins and cabin communities when responding to this statement. A large-scale dairy producer in Nord-Aurdal said, "cabin development's effect on summer pasture farming isn't positive when they build cabin communities, because lots of people come. Few cabins on the mountains are positive for people and create a lively environment, which isn't an issue for the summer farm."

Another small-scale dairy producer in Vestre Slidre described a personal conflict where cabin owners wanted to build an antenna "after making a lot of noise about not being able to access the internet. Now we have a big antenna outside of our shieling because of the pressure from the cabin association. The municipality wants to retain cabins in the area because they receive lots of money from them. Our argument was that the buildings in public commons, including our shieling, are several hundreds of years old [referring to cultural landscape aesthetics]. We tried to organize against it, but the association got its way in the end."

This example describes the powerlessness farmers sometimes feel in land use decision-making processes, impairing the quality of their connections to other actors in outfield areas. A mixed mutton and goat dairy producer in Vang described the struggle in using outfield areas and feeling sadness when seeing farmers step out of mountain farming. "Sometimes you even have farmers who have built cabins on the outfields, which is even more strange because they're your own people and they're like tourists on the mountains. It makes for a very difficult conflict," they said.

As was previously mentioned, a mixed mutton and nurse-cow beef producer in Sør-Aurdal who was pluriactive in cabin development admitted how they "have experienced problems between the few sheep farmers and cabins in our outfield areas [in the neighbouring municipality of Øystre Slidre]." The area in question – in which 40% of all holiday homes in Innlandet are located (Arnesen et al., 2021) – was notoriously mentioned by many participants as a worst-case scenario for cabin development's impact on outfield grazing.

Despite their perceived positive influence on the community, participants in P2 may also be challenged to exploit outfield grazing resources and conserve them for future grazing seasons if regional change processes favour developments which impair the connectivity of mountain farm systems.

3.5.3 Further distinguishing areas of resilience and vulnerability among participants

Reflective and shared learning

The areas of greatest salience between indicators of agroecological resilience further provided evidence for contrasts among farmers' social perspectives. The indicator reflective and shared learning differed highly between both perspectives ($\Delta = 2.42$). P1 scored negatively ($\bar{x} = -1.22$), while for P2 it scored positively ($\bar{x} = 1.20$), indicating a gap perceived areas of vulnerability and resilience. Reflective and shared learning describes systems that promote desirable future states through knowledge exchange between individual and institutional actors.

For participants in P2, this indicator was driven by the statement that traditional farming practices like outfield grazing are vital for community well-being, suggesting that communities which positively value mountain farming could self-reorganize towards a desired future state.

Conversely, for participants in P1, this indicator was driven by disagreement with statements that (a) national agricultural cooperatives[29] contribute positively to innovations in mountain farming, and (b) land distribution efforts are important for resolving conflicts and sustaining grazing operations. This describes reorganization processes within the regional panarchy that inhibit a mutual understanding of mountain farming, particularly at the territorial scale in Valdres. Participants provided multiple examples which point to these formal institutions hindering the adaptive capacity of farmers to sustain their outfield grazing practices.

Some few participants in P2 described how Norwegian agricultural cooperatives positively contributed to mountain farming through advisory services and their contractual obligation to collect agricultural products directly from the farms and shielings.[30] As a goat dairy producer in Vestre Slidre agreed with "the fact that TINE bothers to drive that far to collect milk, even if the costs are quite high. They also helped adjust our seed rates and harvest time for forage production, which has improved it greatly."

Nonetheless, the belief held among most participants in P1 was that such cooperatives were in fact encouraging rationalization processes in Norwegian agriculture. A small-scale dairy producer in Vang described how "the local TINE group is extremely conservative, especially when it comes to climate measures. The advisory service suggested I should double the amount of concentrate feed I give to my cows, which I thought was absurd."

[29] For example, Felleskjøpet (Norwegian agricultural products retailer, including concentrate feed and seeds), Nortura (the largest Norwegian meat and egg processing cooperative owned by its suppliers), and TINE.
[30] *Hentebrikt* in Norwegian

An organic dairy producer in Sør-Aurdal described their disappointment in national cooperatives, saying “when TINE and Nortura advertise traditional breeds of grazing animals along the fjord, do consumers know how much milk produced in Norway actually comes from our mountain farms? They’re lying to their customers.”

A micro-dairy producer in Vestre Slidre believed that TINE was encouraging rationalization by lobbying for a higher minimum milk requirement to 45 litres per day in order for milk to be collected from the shieling. “This quota affects us very much – the higher the quota, the more farmers can expect to rent more land. We would like to reduce our dairy cows to include other livestock in their stead. But they want us to increase milk production to be eligible for subsidies,” they said.

The economic rationale for cooperatives to set minimum production quotas is tied to the collection, transportation, and processing costs for smaller versus larger farms. A mutton producer in Nord-Aurdal described how they were concerned for their livestock’s welfare when Nortura had discussed closing the nearest slaughterhouse in the neighbouring municipality. “I wouldn’t want my sheep to be on a truck for four hours to reach the nearest alternative. I’ve heard of livestock being transported for 8 hours at a time, which is completely absurd”, they said.

When asked about land distribution efforts, participants in P1 commented on their experiences with land use conflicts being settled in land consolidation courts. An organic dairy producer in Sør-Aurdal said, “I have a problem with land consolidation courts in Norway. My experience has been that they act more like ‘bargainers’ and operate on little evidence. I felt I had no right to dispute the claim made by the court. It’s also very expensive to make a claim, so many farmers don’t even bother.”

A small-scale dairy producer in Vang believed that “the land consolidation courts always prioritize cabin owners over farmers. They don’t fulfil their purpose in Valdres. They were very friendly with the hotel owner planning to develop on our outfield area.” Another small-scale dairy producer in Vang described the structural inefficiencies created since farm holding and farm pastures had last been consolidated. They said, “it would be more rational if we owned fields adjacent to the farm. Instead, we have fields in a long strip at low and high elevations. The consolidation courts haven’t replanned these agricultural settlements for decades.”

Honouring legacy

The highest differing indicator between both perspectives was honours legacy ($\Delta = 3.21$), which had scored much higher for P2 than for P1. The difference was driven by the statement that traditional food production will be equally valued by future generations in Norway, which has been previously discussed in detail. Further distinguishing levels of agreement, however, could be found for the

statement that alternative dietary campaigns discourage mountain farming practices. Indeed, several participants in P1 believed that their livestock husbandry was portrayed as harming the climate, as an unhealthy dietary choice, or as encouraging poor animal welfare standards.

As a mutton producer in Vestre Slidre suggested, “many people make food choices to stand against industrial food production, but I fear this creates misunderstanding. We need to change to regional thinking and ask ourselves: what is sustainable in Norway when it comes to food production? Ruminant meat production based on grass feed is more sustainable than pigs and poultry on imported fodder from abroad.”

These comments suggest how participants believed their legacy as mountain farmers was challenged by livestock food production decoupled from grazing resources. Particularly when commenting on their motives from a sustainability perspective, participants in P1 believed that alternative dietary campaigns could create a false understanding among consumers about whether their livestock husbandry, and the grazing resources tied to their practices, were worth preserving for the future. As will be discussed later on, this perspective is relevant to ongoing rationalisation processes occurring in Norwegian agriculture.

In further support of the distinction in path dependencies between farmers, participants within P2 disagreed that the intensification of agriculture in Norway affects the reputation of mountain farming, while participants in P1 slightly agreed. This distinction is perhaps best summarized in comments made by a micro-dairy producer in Vang, who said, “the impact isn’t necessarily on the reputation but on the possibilities of practicing mountain farming. People see the image of cows grazing in the mountains, but the reality is very different from that. We have an ongoing issue with public awareness.”

4 Discussion

Using a relational approach to analysing farmers’ perspectives on changes in mountain farming, this study sought to contribute to transforming farm system research in sustainability science. Critical reflection has been at the core of developing and implementing this Q-Study. The Q concourse was informed by scientific literature and was developed with an indicator framework for agroecological resilience. Statements on change processes in mountain farm systems were created to highlight contemporary challenges faced by mountain farmers.

Following the Q-Study process, farmers systematically ranked and sorted statements reflecting changes in mountain farming systems. Intentional prioritization of statements revealed two emerging social perspectives on key issues in mountain farm systems. This Q-study encouraged rich responses from participants, which supported the self-referential character of Q for engaging participants in various conflicts surrounding a single issue (Zabala et al., 2018). Capturing different social perspectives among mountain farmers helped identify linkages between sustainability policies and local-level solutions in the face of multiple complexities.

Among 20 participants representing five out of six municipalities in Valdres, two emergent social perspectives were revealed. The relational dynamics described in my results are supported primarily by interview data, and discussed in part with farm household and/or actor characteristics. Each social perspective highlighted different sets of relations and systemic changes at multiple spatial and temporal scales.

4.1 Methodological limitations

Multiple areas of limitation were identified throughout the development of this study. First, my selection and interpretation of the scientific literature formed the basis of the concourse employed. Previous Q-Studies have, however, suggested using multiple sources of information when forming the concourse, including interviews among participant-like groups. Time constraints limited the qualitative interviews and participant engagement for the Q-Study. Scientific literature was prioritized in order to more objectively interpret the narratives that are used to describe changes faced by farms and farming communities. However, an ideal systematic literature review would have prioritized findings presented in the results section of the literature only, allowing for direct interpretation by the Q-researcher.

Second, there is debate within Q-literature over the validity of translating Q statements (Webler et al., 2009). They were translated for this study so farmers could interpret them with ease, particularly because the sample size was rather large. Ideal translators are those “with the culture and hence knowledge of how the topic is talked about in that language” (Webler et al., 2009), which was true for my co-supervisor.

A more significant language barrier was my relatively poor understanding of Norwegian, the main language among all participants. English was spoken at varying levels among all participants, and enough time was taken to clarify any misunderstandings. Notably for the interview preceding the Q-Study, however, participants couldn’t always express themselves with ease. Whenever Norwegian words were used, translations were searched so participants views could be understood.

Third, the sorting process varied according to each farm household. Although it was encouraged that only farm managers participate in the study, the indirect participation of other farm members during some of the Q-Sorts possibly skewed the sorting process. On the other hand, greater reflection among participants may have contributed to the robustness to their final Q-Sorts. It was noted by all participants that had they repeated the Q-Study at some point in the past or future, that their final Q-Sorts would have been largely different. This is worth noting, in particular in light of aforementioned spatial and temporal idiosyncrasies found in previous resilience studies.

Furthermore, half of all participants described the point of zero-saliency in their Q-Sorts (i.e., indicating indifference or uncertainty towards statements) as further right than the middle point. A skewed zero-saliency point implies that positively sorted statements were underrepresented, while negatively sorted statements were overrepresented in their Q-Sorts. The immediate implication is that emergent social perspectives were not accurately defined, and novel perspectives may have emerged using a non-normal distribution layout.

Finally, rotating two factors resulted in all participants loading onto at least one factor. This in turn represented a balance and selective trade-off between the total explanatory variance and the degree to which factors converged or diverged, further described in the results section, below. Considering negative factor loadings may be just as important as positive ones when rotating factors (Webler et al., 2009), salience between rotated factors also informed the final factor selection.

4.2 Social perspectives among mountain farmers in Valdres

The first social perspective (P1), comprising 10 farm households with 13 farm managers, described how mountain farmers valued low-input, minimally disturbed and open landscape farming. This interpretation was supported by (a) participants' agreement with contributions to sustainably managed open landscapes and the positive valuations among visitors thereof. It was also supported by (b) participants' disagreement with the supposed benefits of structural changes and developments on mountain farms and outfield areas.

The second social perspective (P2), comprising 10 households with 15 farm managers, described how farmers valued cultural heritage, social connectedness, and their quality of life in their farm management. Support for this interpretation was found in (a) participants' agreement with their farming being tied to their family's and community's well-being, their economic pluriactivity, and the importance of using local resources like outfield pastures. It was also supported by (b) participants' disagreement with the supposed benefits of development in outfield areas, the responsibility towards

climate action falling on others, and the diminishing valuation of traditional food production among future generations.

The most salient areas among participants described their relative (dis)agreement with visitors' valuation of the open cultural landscape, the extent to which cultural landscape fragmentation impacts mountain farming, and whether their farming is tied to their families' and their community's well-being. Areas where participants converged most described their relative (dis)agreement with the supposed benefits of a warming climate, the impact of farm closures on local networks, the contributions of land consolidation courts, and the impacts of diminishing grazing pressure on biodiversity levels.

One area unexplored in this Q-Study was participants' valuation of animal welfare standards in mountain farming, whose importance was emphasized by multiple participants throughout. This may have further distinguished social perspectives or revealed a novel perspective altogether.

When drawing on perspectives as a tool for describing change processes at the territorial scale, findings from previous research can support the perspectives described here. Among 27 livestock farmers in the Aurland municipality (Møre and Romsdal County), a quantitative study tied farmers' perceptions of the functions of agriculture to their farming goals, revealing three composite factors (Bernués et al., 2016).

One factor described by the authors revealed how farmers' positive perceptions of upholding cultural heritage and rural development could be tied to their goals of improving their family's life quality, relations with neighbours, and environmental friendliness (*ibid*). This perception can be best linked to P2 in my study results, particularly how mountain farming shaped part of their connectedness to society.

The next factor described by Bernués and colleagues revealed how farmers' positive perceptions of cultural landscape management, vegetation and biodiversity maintenance were negatively associated with the goals of farm rationalization and economic growth (2016). This perception could be tied to P1 in my study results, best described by a sense of marginalization among farmers from society.

However, my study made no distinction between perceived goals and functions of mountain farming, nor have I provided statistical proof when linking participants' social perspectives to indicators of agroecological resilience. This limitation to quantitatively assessing participants' Q-Sorts could have been overcome with a complementary questionnaire for participants and running a second PCA.

Neither were participants asked to describe their valuation process as part of this Q-Study. In a most recent Q-Study, Torralba and colleagues coded answers from 45 participants using a plural valuation

framework, describing three social perspectives. Two social perspectives on landscape sustainability – namely the preservation of (a) natural values and (b) socio-cultural values – support my findings of how farmers held divergent views in landscape-level change processes (2023). Yet by further analysis in their study described several kinds of values held by participants that were tied to different landscape types.

According to the authors, this reveals "synergistic effects" between participant valuation and landscape type (Torralba et al., 2023). Synergistic effects are determined by the direction of influence between the system actor and the system state, depending on the actors' positionality within the SES. Indeed, as has been previously described, a majority of participants noted there had been woody shrub/tree encroachment onto either their home or far shielings.

For participants in P2, many said these changes didn't directly impact their mountain farming practices. Further analysis would have been valuable to determine whether shieling characteristics, like location, elevation, or proximity to town centres, explained for the changes perceived by participants in detail. Rather, the combined impacts of fewer outfield grazing animals and cultural landscape fragmentation could have influenced the level of salience within P1, considering participants had experienced these effects more directly. Likewise, for those farmers whose personal well-being was negatively impacted by their farming practice, this could have affected their perspectives on socio-cultural values in the study.

According to the participant who defined P2 in my study, "the themes that I agree most with are social aspects because we want to do what we're doing in addition to the farming. We aren't economically reliant on the farm." Narratives describing synergistic or marginalization effects among Norwegian farmers have been uncovered by Vik and colleagues (2010). Drawing on the views of small-scale farmers in the Geiranger community in Western Norway, both agricultural rationalisation processes and tourist development trajectories had created a sense of disempowerment (*ibid*).

In a separate paper that tried to unravel the so-called "agrarian paradox" of perceived higher life quality standards by farmers but grievances over low incomes, Rye asked whether money actually matters in Norwegian farmers' evaluation of their life quality (2000). Using extensive mixed methods, Rye concluded that farmers' unhappiness was more related to their marginalisation in Norwegian society rather than their actual spending power.

This could help explain why farmers in P1 placed more significance on the negative impacts of landscape fragmentation and cabin development. Cabin development was also perceived negatively by participants in P2, which represents a driver of change affecting more than economic life-quality

standards. As has been found for other parts of Norway, researchers suggest that it may be too late for some mountain farming systems to persist, as "the declining number of farming families managing the landscape is affecting their ability to apply traditional management approaches" (Wehn et al., 2018).

Returning to parallels drawn with Torralba and colleagues' research, the blurriness of my results with regard to farm managers' positionality within the SES could have been overcome by asking *how farmers' social perspectives are linked to different kinds of landscape valuations* and which landscape change processes they identified most with. The method of choice to analyse these linkages would be a Kruskal–Wallis test, which Torralba and colleagues employed following their Q-Study (2023).

This method could have also revealed geographical distinctiveness in each social perspective within the region of Valdres. In fact, Kvakkestad and colleagues also used a Kruksal-Wallis/Wilcoxon test to ascertain geographical distinctiveness in their Q-Study of farmers' perspectives on agri-service payments. Perspectives on 'fair income from food production' and 'production of cultural landscapes' revealed how farmers in different municipalities held divergent views on payment formats for their agricultural activities (2015).

Further analysis to determine whether intraregional differences are found in Valdres between the six municipalities would have been particularly relevant for participants in P1, as the majority of farm managers living in Vang loaded onto this factor. However, this Q-Study had limited participant data for analysing such variations, as no participants were included from the municipality of Etnedal, and very few from the municipalities of Nord-Aurdal, Øystre Slidre, and Sør-Aurdal.

Analysis for geographic distinctiveness would have been especially relevant for Etnedal, which represents the municipality in Valdres with the greatest overall population ageing, declines in livestock husbandry, and losses of farm holdings using outfield areas (Bye and Bjørlo, 2023b, Bye and Bjørlo, 2023c, Bergseteren and Haug, 2023). Incomplete regional representation could point to selection bias through combined purposive and snowball sampling for participant recruitment, as participants likely recommended farming acquaintances they were in most proximate contact with.

There are also limitations that point to my data interpretation and representation, which proved difficult to overcome. Q has been criticized for its use of factor analysis among a relatively small number of participants. Factor analysis is typically chosen for large sample sets in order to obtain a representative statistical power for analysing data. There have been recommendations made by multiple authors to modify the statistical analysis used in Q (Kampen and Tamas, 2014, Akhtar-Danesh, 2017). However, proponents of Q maintain the validity of using factor analysis based on the

methodology's philosophical roots, in which social perspectives are seen as subjective and emerge from relatively small participant groups (Ramlo, 2022).

Weaknesses in interpreting subjectivity were found in the seeming contradictions between participants' Q-Sorts and their comments on statements. For example, the evidence from factor analysis suggests participants in P2 perceived traditional food production to be equally valued by future generations, yet many participants said they *hoped* this would be true. Their comments further revealed a distrust in Norwegian consumers' readiness to spend more income on food produced in Norway. Nuanced responses like these can of course lead to various interpretations, which could have been addressed by improving the Q sample.

Reducing the number of statements and phrasing statements more concisely might have helped in this regard. As a mutton producer in Vestre Slidre noted, "I interpret some statements quite ambivalently… For example, with traditional versus modern livestock breeds: I believe modern breeds will travel shorter distances and maintain the open landscape within a central area, which is a validated guess at best." Rightfully so, the impacts of different livestock breeds on landscape change processes varied within each context and held true for different farmers' perspectives in this study.

Several statements were noted throughout the study process for their weak interpretability. Perhaps of greatest concern was the statement "visitors want a maintained cultural landscape: increased overgrowth will negatively affect tourism revenues in Valdres." Participants could have interpreted it for (a) visitors' valuation, or (b) overgrowth's negative effect on tourism revenues. Based on participants' comments, the former interpretation was chosen.

Three statements that participants dwelled on in particular were (i) land distribution efforts are important for resolving conflicts and sustaining farming operations; (ii) improved liming and drainage systems are more effective inputs for grass yields than are locally adapted grass varieties; and (iii) my farming is more dependent on cooperation with other farmers and local actors than on external actors.

Several participants were unclear on the directionality and definition of these statements. For example, when asked what defines local versus external actors, participants were told that local actors corresponded to the immediate farming community (e.g., neighbours, family members), while external actors belonged to networks outside of the community (e.g., agricultural advisors, work volunteers). Yet for some participants, entrepreneurs hired for round bale pressing that lived in neighbouring communities were still considered local. Statements where participants were

encouraged to shift their perspective on scales within the focal system were evidently confounding, adding to the latent subjectivity of the Q-Study.

There is a trade-off to consider, however, with the flexibility afforded to participants and the richness of their social perspectives. This could be overcome in my research design by making statements more concise. Piloting the Q-Study in Valdres would also have made my Q concourse more robust and contextually relevant. When asked about the Q-Study process, a majority of participants summarized the experience as difficult but rewarding, as they hadn't yet been asked to confront farm system complexity in this way.

However, the participation of farmers was limited to their answers in the Q-Study. More time for the study would have allowed for deeper critical reflection among participants, and greater familiarity with participants' native language would have undoubtedly provided richer results. These improvements could either strengthen or weaken the plausibility of my results.

4.3 Resilience towards changes in mountain farming in Valdres

Resilience was defined as mountain farming's capacity to respond to disturbances through dynamics that minimize its vulnerability and promote desirable change processes. Within the Q concourse, the change processes most relevant to participants were reflected in the areas of greatest salience within factors. These were processes describing landscape vegetation changes, landscape structural changes, increased human activity in outfield areas, farm rationalization pressures, climate changes, and wider societal changes.

Resilience in mountain farming was attributed based on mean values for statement groups in each indicator of resilience. The social perspectives could be described in further detail by highest and lowest scoring indicators, together with participants' comments. A notable difference was drawn between different areas of complementarity within the resilience framework. As was expected, the framework could describe different sets of cultural, environmental, material, social, and technological relations among mountain farmers in Valdres.

For P1, the greatest areas enabling resilience were coupled with local natural capital, ecological self-regulation, and building human capital. These indicators suggest that key phases for enabling resilience within mountain farming are from reorganization to conservation, as well as throughout its adaptive cycle. A particular focus on mountain farming sustainability was considered with regards to increasing livestock densities, attributing farming practices to climate mitigation efforts, and maintaining farm productivity with existing farm resources.

Greater vulnerability and a weakened adaptive capacity among participants in P1 were tied to careful exposure to disturbance, appropriate connectivity, reasonable profitability, and spatial and temporal heterogeneity. These vulnerabilities translated into the phases exploitation to release, primarily driven by changes in outfield and farming structures, the climate, mountain farm profitability and public valuation thereof.

They represent chronic disturbances occurring over larger temporal scales, to which participants felt vulnerable to different extents. Combined cabin development and landscape fragmentation were clearly undermining the potential for participants to exploit outfield grazing resources, especially large-scale development projects.

Conversely for P2, the strongest areas enabling resilience among participants were honouring legacy, building human capital, and ecological self-regulation. These indicators suggest that key phases for enabling resilience within mountain farming are from release to conservation, as well as throughout its adaptive cycle. In other words, greater overall resilience points to a strengthened adaptive capacity among participants in P2 throughout the entirety of the adaptive cycle. Perspectives on local resource usage, family and community relationships, and public valuation of traditional food production were all associated with mountain farming sustainability.

However, vulnerability towards change processes were tied to the indicators optimal redundancy, careful exposure to disturbance, reasonably profitable, and appropriate connectivity. Vulnerabilities in the phases exploitation to release, in the face of chronic disturbances either over shorter or longer temporal scales, were revealed. These were similarly driven by changes in outfield and farming structures, land use configurations, the climate, and mountain farm profitability.

Previous research has used large-scale and multi-contextual assessments linking European farmers' perspectives to different capacities for resilience. In their 13-part questionnaire, Spiegel and colleagues revealed almost one thousand European farmers' capacities for robustness, adaptability, and transformability (2021). They found that different classes of farmers, especially younger, more optimistic, and well-connected farmers demonstrated greater resilience capacities. Others support the finding that age influences farmers' goals, particularly when it comes to their family life quality (Bernués et al., 2016).

A second PCA may have revealed such linkages in farmer characteristics, although temporal idiosyncrasies in measuring perspectives may only be addressed using long-term studies, perhaps over generations of farmers. Spiegel and colleagues claim uncertainty in their results as to what drives farmers to engage in different resilience capacities (2021). In this respect, a combined Q-Study and

indicator-based assessment has provided insights as to how and why farmers value alternative approaches to mountain farming. As far as was reviewed for this study, no research has thus far attempted to link farmers' perspectives to indicators of agroecological resilience. The contextual detail provided in participants' statements support the linkages made between Q-Sorts and resilience indicators.

Some parallels could be drawn, however, to other research using the adaptive cycle as a heuristic model for studying changes in agroecosystems. For Dutch Northern Frisian dairy farmers, researchers found that rather than an alternate system state for farmers taking measures to rebalance soil organic matter contents, "an alternative set of relationships" defined their analysis of sustainable dairy agroecosystems (van Apeldoorn et al., 2011). Alternative sets of relationships could be distinguished between both factors' greatest areas of resilience and vulnerability in my study, particularly those described by indicators promoting socio-cultural, ecological, and structural change processes.

This distinction has been supported in a review by Knickel and colleagues, which examined 14 case studies for systemic change in resilience of agricultural and rural systems (2018). The authors draw evidence from several European countries for determinants of farmers' quality of life beyond income, such as well-being and environmental integrity. For example, the authors described challenges among farmers in Sweden to restructure or grow their farms that is compatible with environmentally sustainable practices, pointing to trade-offs in adaptive capacities driven by agricultural policy frameworks (*ibid*). Using behaviour-based indicators of resilience proved useful in resurfacing wider changes in Norwegian agriculture. In both perspectives, and particularly for P1, multiple participants commented on the seeming contradictions between Norwegian agricultural and climate goals.

Participants believed agricultural policy developments in Norway were encouraging modernized farming practices outside of the means of existing farm structures and resource availabilities, which has previously been argued by multiple researchers (Vik et al., 2019, Rønningen et al., 2021, Hansen et al., 2022). The creative capacity of farmers to enable transformation in mountain farming in Valdres may therefore be examined in greater detail within a larger Q Study.

Even still, three exceptions could be found among my participants who continuously used outfield grazing areas combined with modernized farming structures, such as an AMS or intensive feeding systems. If farm managers widely agree that grazing values are negatively impacted if grazing pressure is too low, this could imply that the general resilience of regional outfield grazing systems in Valdres is compromised by structural improvements in individual, fewer, and more locally specific outfield areas. Transformative shifts have been documented for farmers in Oppdal County converting from

dairy to mutton production, even though evidence for the impacts of such transformations on mountain farming persistence weren't explicitly stated (Daugstad, 2019).

This study does indeed lend evidence for national performance-based policies further marginalizing persisting mountain farms in Norway, at the expense of national food self-sufficiency goals. Previous resilience studies have shown that Norwegian farmers express more vulnerability towards developments in agricultural policies than they do towards climate change impacts (Eriksen and Selboe, 2012, Svedal Jørgensrud, 2014, Beitnes et al., 2022).

Early research has forewarned against development trajectories in Norway's agricultural policy. Since the 1970s, national objectives have prioritized technology as the main "adjustment variable" in farm structures and productivities, yet simultaneously sought to reduce the negative externalities of such structural adjustments (Borgan, 1978). Current policy developments continue to struggle with such paradoxes. The latest agricultural policy agreement has heralded the supposed effects of tourism development for value-creation in local agriculture and promoting farm succession by younger generations, while simultaneously acknowledging the increasing costs involved in maintaining outfield infrastructure (Regjeringen, 2023).

Even still, the examples provided by Knickel and colleagues, together with findings argued in this study, should not be taken for granted. Others have shown how national support measures have positively enabled the resilience of farmers and farm networks in Norway. In one study looking at international responses to the COVID-19 pandemic, the authors found that a majority of interviewed farmers perceived positive impacts of the pandemic on local demand for Norwegian food products (Måren et al., 2022). Moreover, the authors explain how "even small semi-subsistence farmers did not fare badly because of government subsidies and other sources of income."

The recentness of the COVID-19 pandemic at the time of this study may have influenced participants' perspectives in my Q-Study, which wasn't considered for the Q concourse. For example, participants in P2 scored highly for honouring legacy, suggesting how pandemic responses moved the agricultural system into a new adaptive cycle.

National support measures may have taken advantage of a phase of high connectivity (e.g., through well-organized agricultural support measures towards disturbances) to reorganize into a phase of conservation (e.g., by barring international trade) to support local food production. These latent disturbances could have influenced my participants' perspectives on the positive public valuation of traditional food production in Norway, even after the pandemic. Previous examples of optimism biases have been uncovered in resilience research using farmers' perspectives (Perrin et al., 2020).

In order to have analysed resilience and vulnerability in its detail, it would have been necessary to consider all indicators and their supporting statements as relevant to describing their complementarity or contrast with social perspectives. The highest and lowest-scoring indicators were chosen to analyse aforementioned results, which reduced the quality of participants' responses from the study process.

As has been rightfully criticized, however, the use of an indicator-based resilience assessment framework proved demanding for thorough conceptualization and summarizing (Spiegel et al., 2021). Moving forward, it would be valuable to combine Q Studies with quantitative approaches for assessing farmers' perceptions of resilience (*ibid*). Indicator-based assessments can complement findings for more context specificity, particularly for the household level, but in some instances at the territorial level as well.

To improve upon the Q Study itself, further research should involve multiple persons in the interpretation of the scientific literature for the Q concourse development. Scientific literature – which included interview data among farmers – was prioritized in order to more objectively interpret the narratives that are used to describe change processes in mountain farming. However, an ideal literature review would have prioritized findings presented in the results section of the literature only, allowing for systematic triangulation by multiple Q-researchers.

5 Conclusion

The degree to which farmers in Valdres perceived factors influencing changes in mountain farming were dimensionalised using Q-Methodology, a mixed methods approach to analysing operant subjectivity. Twenty farmers participated in this study as actors in multifunctional agriculture, whose paradigms were highlighted for their transformative potential in achieving sustainability in Norwegian agriculture. These farmers were recognized as agents of change processes within a wider social-ecological system, defined at the territorial level of mountain farming in Valdres.

My first research question asked how farmers' perspectives on factors influencing changes in mountain farming converge and diverge. An array of values held by farmers included integral outfield grazing areas, small-scale farming structures, traditional food production, family and community well-being, biodiversity values, and local resource utilization. The results demonstrated two emergent social perspectives among farmers, with a total explanatory variance of 43% in the correlation matrix.

Farmers who valued low-input, minimally disturbed, and open landscape farming were described within perspective 1. Landscape fragmentation, greater risk of climate change impacts, cabin development, and increasing farm closures were major drivers of changes in mountain farming, exposing vulnerabilities to the viability of their outfield grazing practices. Alternatively, farmers who valued cultural heritage, social connectedness, and quality-of-life farming defined perspective 2. Greater reliance on off-farm pluriactivity, increasing farm closures, greater risk of climate change impacts, and cabin development were major drivers of changes in mountain farming.

The greatest divergence between perspectives revealed whether participants believed visitors in Valdres desire open cultural landscapes, with increased overgrowth in outfield areas negatively affecting tourism revenues. Although both perspectives found that grazing values are affected by grazing pressure, perspectives differed for whether increased livestock densities represent a vision of sustainably managed outfield areas. My second research question addressed whether farmers' social perspectives can be linked to indicators of agroecological resilience to describe change processes, with the intention of discerning wider land use changes in Valdres.

For participants in perspective 1, open cultural landscapes maintained by increased livestock densities were perceived to be a vision of sustainably managed outfield areas, which could serve as points of resilience in reorganizing, exploiting, and conserving future resources for outfield grazing management. Yet participants commented on how intensification processes in Norwegian agriculture were impairing traditional food production in Valdres.

More specifically, national policies encouraging production efficiencies, emissions reductions, higher animal welfare standards, and alternative dietary campaigns were driving negative transformations in mountain farming for participants in perspective 1. These correspond to vulnerabilities at all phases throughout the adaptive cycle, possibly encouraging sudden farm transformation or farm closure under multiple pressures. However, relatively less vulnerability was interpreted for participants' outfield grazing practices than those in the first social perspective.

The positive outlooks participants in perspective 2 held towards their practices for social well-being, public valuation of traditional food production, and their commitment to climate mitigation efforts demonstrated their greater overall resilience. Such linkages were established based on participants' ability to uphold mountain farming practices throughout the adaptive cycle, particularly for releasing and reorganizing farm resources. Even so, the reliance on local entrepreneurs and national subsidies for forage production, the impacts of heavier agricultural machinery on grass forage productivity, and ensuing climate change impacts could impair farmers' ability to mobilize infield and outfield resources.

In effect, these pressures point to vulnerabilities found at all phases throughout their adaptive cycle, which could eventually compromise future mountain farm resilience.

Future Q Studies ought to include participants at multiple levels within the regional panarchy to successfully establish whether linkages from farm system adaptive cycles correspond to those found at higher levels. Based on participants' responses, actors such as municipal officials, state officials, land court consolidation members, cabin owners, and regional developers could coordinate sustainability efforts with the interest of safeguarding future outfield grazing resources for local food production to persist.

A relational approach has continued to prove useful in capturing values held by farmers and hence pathways for resilience in Norwegian mountain farming. As was previously summarised, the general resilience of regional outfield grazing systems in Valdres may be compromised by structural improvements in individual, fewer, and more locally specific outfield areas. The long-term consequences of these development trajectories point to spatial and temporal idiosyncrasies in resilience capacities for the regional panarchy.

6 Appendix

6.1 Literature review

Number	English statement	Norwegian statement	Reference	Title	Comments	Indicator of agroecological resilience	Phase in adaptive cycle
1	*My farming is more dependent on cooperation with other farmers and local actors than on external actors*	*Gårdsdrifta mi er mer avhengig av samarbeid med andre bønder og lokale aktører enn med eksterne aktører*	(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*There was an overall trend towards more formalized collaborations in Rauma (e.g., hiring entrepreneurs). Formalized external networks, like those offered by agricultural extension advisers, were also important to many farmers.*	Socially self-organized	Reorganization
			(Eriksen and Selboe, 2012)	The social organisation of adaptation to climate variability and global change: The case of a mountain farming community in Norway	*During wet summer, farmers less dependent on off-farm employment relied more on household labour (i.e., cohabitants), while farmers with greater reliance on off-farm employment were more likely to rent equipment or hire entrepreneurs.*		
			(Gezelius, 2014)	Exchange and Social Structure in Norwegian Agricultural Communities: How Farmers Acquire Labour and Capital	*The social structure of Norwegian farming communities, including large-scale farms, emphasizes the importance of local rather than external social networks for farm viability.*		
3	*Future generations of mountain farmers rely on investments made by today's farmers*	*Fremtidige generasjoner av fjellbønder er avhengige av investeringer gjort av dagens bønder*	(Brandth and Overrein, 2013)	Resourcing Children in a Changing Rural Context: Fathering and Farm Succession in Two Generations of Farmers	*Older generations valued practical skills and manual work for their children's upbringing, hoping these investments would result in farm takeover. Contemporary generations included in the study acknowledged that their children's interests are shifting.*	Socially self-organized	Reorganization
			(Burton and Farstad, 2019)	Cultural Lock-in and Mitigating Greenhouse Gas Emissions: The Case of Dairy/Beef Farmers in Norway	*Some famers found Automatic Milking Systems, together with establishing joint-farming enterprises, to be a necessary investment to ensure the succession of their farms.*		

			(Vik et al., 2019)	The political robot - The structural consequences of automated milking systems (AMS) in Norway	*Only three out of 26 farmers considered the attractiveness of investing in AMS for future generation succession.*		
			(Wiborg and Bjørkhaug, 2011)	Challenges for future farming in Norway: The role of place for farm succession	*In Norway, the economic costs and poor return on investments have been found as major reasons for potential new farmers not to take over the farm.*		
5	*Farm closures lead to a deterioration in mountain farmers' social networks*	*Nedlegging av gårdsbruk fører til at det sosiale nettverk til fjellbøndene blir dårligere.*	(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*Identified various structural changes which have led to the deterioration of mountain social networks and in turn created more individualized farm operations, negatively impacting farmers' experiences.*	Socially self-organized	Reorganization
			(Eriksen and Selboe, 2012)	The social organisation of adaptation to climate variability and global change: The case of a mountain farming community in Norway	*Identified key changes in social relations connected to structural economic changes in the region, like poor farm incomes and greater land tenancy. Altogether, farmers relied less on farmer-to-farmer collaborations.*		
			(Flaten, 2017)	Factors affecting exit intentions in Norwegian sheep farms	*Found an overall but inconclusive an overall positive effect on farmers intentions towards continuing their farming practices when they were part of longer-lasting social networks.*		

4	*Outfield grazing and summer pasturing is challenging because production drops*	*Stølsdrift kan føre til lavere (mjølke)avdrått*	(Bunger and Haarsaker, 2020)	Færre og større melkebruk - hva skjer med seterdrifta?	*"Seterdrift med de utgiftene det medfører, er ikke lønnsomt selv med et doblet setertilskudd. Den største utgiften er diesel til aggregat samt en sterkt redusert mengde mjølk ettersom dyrene beveger seg mer."*	Ecologically self-regulated	Exploitation to conservation
			(Eiter et al., 2022)	Mat og opplevingar i fjellet: Berekraftig bruk av lokale ressursar	*Cites study by Alder et al. (2018), which suggests that the production of milk in the absence of concentrate feed based only on grazing resources will be at least 22% lower than the production potential.*		
11	*It is important that mountain farms make greater use of local grass resources (e.g., outfields) instead of concentrates*	*Det er viktig at fjellandbruket i større grad bruker lokale grasressurser (f.eks. utmarka) i stedet for kraftfôr*	(Eiter et al., 2022)	Mat og opplevingar i fjellet: Berekraftig bruk av lokale ressursar	*Cites multiple studies which argue for increased use of local grazing resources from a sustainability perspective, for which mountains are best adapted.*	Ecologically self-regulated	Exploitation to conservation
			(Beitnes et al., 2022)	Climate change adaptation processes seen through a resilience lens: Norwegian farmers' handling of the dry summer of 2018	*Concentrate fodder resources played an important role in ensuring sufficient feed was available during the summer of 2018. Yet farmers remarked how outfield grazing resources were used over a longer period than usual, allowing farmers to compensate for diminished total grass production.*		
			(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*The wet summer of 2011 caused an increase in concentrate feed prices, which combined with poor grass quality created economic losses for dairy farmers. Sheep farmers differed in their opinions on the impacts of the wet summer for overall yields.*		

6	*When milk production increases per farm, it becomes more difficult to farm seasonal pastures and outfields*	*Store (mjølke)avdrått gjør det vanskeligere å drive med setring og utmarksbeiting*	(Almås and Brobakk, 2012)	Norwegian Dairy Industry: A Case of Super-Regulated Co-Operativism	*Examines structural trends in Norwegian dairy farms since the mid-20th Century. Tendencies towards joint-farm enterprises and increased production, as well as feed efficiency goals, have challenged farmers' access to domestically grown fodder.*	Ecologically self-regulated	Exploitation to conservation
			(Flaten et al., 2012)	The profitability of early grass silage harvesting on dairy goat farms in mountainous areas of Norway	*Modelled different silage harvesting scenarios in combination with production intensity to evaluate optimal feeding regimes for dairy goats. Found "optimal inputs of fertilisers and concentrates decrease as more land becomes available."*		
			(Asheim et al., 2014)	The Profitability of Seasonal Mountain Dairy farming in Norway	*Modelled different farm structures to examine the profitability of outfield grazing. Found that even under the business-as-usual scenario, small farms with 10-20 cows profit when delivering milk under the quota system and receiving special grazing subsidies.*		
49	*Funding schemes like Innovation Norway can increase the economic self-sufficiency of mountain farmers*	*Støtteordninger som Innovasjon Norge kan øke selvforsyningen til fjellbønder*	(Bjørkhaug and Rønningen, 2014)	Crisis? What Crisis? Marginal Farming, Rural Communities and Climate Robustness: The Case of Northern Norway	*Found that farm actors in northern Norway believed higher production costs, like technological investments, required greater access to public loans (e.g., from Innovation Norway).*	Appropriately connected	Exploitation to conservation
			(Stræte et al., 2022)	Critical support for different stages of innovation in agriculture: What, when, how?	*Concluded that Innovation Norway was a valuable funding scheme for the invention of novel agricultural products but have thus far had limited impacts on the agricultural community.*		

			(Rønningen et al., 2021)	Path dependencies in Norwegian dairy and beef farming communities: Implications for climate mitigation	*"Farmer stakeholders pointed out that investment loans and support from banks and Innovation Norway often set growth targets, such as increasing the numbers of dairy cattle or hectares farmed as a precondition for receiving grants."*		
41	*The advantages of cabin development are greater than the disadvantages for mountain farming*	*Fordelene med hytteutbygging er større enn ulempene for fjellandbruket*	(Daugstad, 2019)	Resilience in Mountain Farming in Norway	*Found that farmers would engage in plot-selling strategy for cabin development as either economic resilience for continuing farming practices, while others believed this strategy to accelerate farm closures in the area.*	Appropriately connected	Exploitation to conservation
			(Lerfald et al., 2022)	Hytteforbudets betydning – en bortfallsanalyse	*In analysing the economic impact of the cabin ban during the COVID-19 lock-down period, the authors conclude that although localized consumption of holiday-home dwellers fell in rural areas during this period, "the development of holiday home areas in itself provides limited benefits economic effects unless these areas are connected to a functioning and more holistic tourism destination"*		
9	*Facebook groups can compensate for poorer local agricultural networks*	*Facebook-grupper kann kompensere for dårligere lokale landbruksnettverk*	(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*"Farmer blogs and Facebook groups represent new social arenas where the members can discuss politics and share experiences and feelings associated with being a farmer."*	Appropriately connected	Exploitation to conservation

			(Vedeld et al., 2020)	Reaching out? Governing weather and climate services (WCS) for farmers	*Describes how national advisory services and farmers' feedback are largely provided over Facebook services, acting as a collaborative learning platform.*		
			(Beitnes et al., 2022)	Climate change adaptation processes seen through a resilience lens: Norwegian farmers' handling of the dry summer of 2018	*Advisory services and farmers commented on the struggle of farmers with limited informal networks when buying compensatory winter fodder, compared to those with better access to formal networks like Facebook groups.*		
15	*If the grazing pressure becomes too low in outlying areas, values associated with grazing, biological diversity and grazing quality will change.*	*Dersom beitetrykket blir for lavt vil verdier knyttet til beite og biologisk mangfold endre seg*	(Steinshamn et al., 2018)	Effects of heifers and sheep grazing on herbage production on a previously abandoned grassland	*Plant communities were unaffected by different grazing systems over three-year research period, with species already adapted to grazing observed on abandoned grasslands.*	Functional and response diversity	Throughout
			(Wehn et al., 2018)	Adaptive biodiversity management of semi-natural hay meadows: The case of West-Norway	*Demonstrated a deterioration in traditional ecological knowledge for grassland management among 20 participants, suggesting long term implications for species composition due to standardised management techniques.*		
			(Ross et al., 2016)	Sheep grazing in the North Atlantic region: A long-term perspective on environmental sustainability	*Reviewed past and present grazing regimes to look at sheep grazing sustainability. For Southern Norway, authors concluded that the upper density limit for "low-productive mountain areas is at most 88 ewes and lambs per square kilometre," emphasizing site-specificity for such estimates.*		

			(Austrheim et al., 1999)	Land-use impact on plant communities in semi-natural sub-alpine grasslands of Budalen, central Norway	*Vegetation surveys in 41 sites revealed moderate grazing pressure was insufficient for suppressing woody species encroachment onto semi-natural hay meadows, adding selective tree cutting and mowing to be necessary measures for long-term biodiversity management.*		
25	*Grazing several livestock species on mountain pastures benefits grassland biodiversity*	*At flere husdyrraser beiter sammen i utmarka er bra for biologisk mangfold*	(Austrheim et al., 1999)	Land-use impact on plant communities in semi-natural sub-alpine grasslands of Budalen, central Norway	*Found that significant differences in nutrient levels of different grassland sites were likely due to former manure spreading practices during traditional management methods, increasing organic matter content, which is consistent with findings around Norwegian summer farms.*	Functional and response diversity	Throughout
			(Bele et al., 2018)	Localized Agri-Food Systems and Biodiversity	*"Since livestock prefer certain species and vegetation types over others, mosaics of more or less grazed areas may be created on both small and large scales. These and other processes contribute to the development and maintenance of species-rich semi-natural grasslands".*		
			(Wezel et al., 2021)	Good Pastures, Good Meadows: Mountain Farmers' Assessment, Perceptions on Ecosystem Services, and Proposals for Biodiversity Management	*Farmers were more likely to mention ecosystem services related to meadow management rather than pasture management.* *"The most relevant practices that changed were related to grassland management, fertilization, mowing, and extensification. Several farmers mentioned less fertilization or a change in fertilizer. On the one hand, some farmers had reduced stocking*		

					densities; on the other hand, grazing had been intensified on some farms."		
10	*Improved liming and drainage systems are more effective inputs for grass yields than are locally adapted grass varieties*	*Forbedret kalking og grøfting er mer effektivt for gode grasavlinger enn lokalt tilpasset grassorter og -arter*	(Neset et al., 2019)	Maladaptation in Nordic agriculture	*Reviewed that, among multiple maladptation strategies, structural liming could lead to soil compaction when tractors drive on wet fields, that drainage systems can increase nutrient leakage and decrease biodiversity.*	Functional and response diversity	Throughout
			(Dombu et al., 2021)	Norsk matsikkerhet og forsyningsrisiko	*Lists drainage, increasing humus content, avoiding soil compaction, and stimulating biodiversity as measures to effectively maintain the production potential of soils.*		
			(Þorvaldsson et al., 2015)	Climatic adaptation of species and varieties of grass and clover in the West Nordic countries and Sweden	*A three-year study revealed well-adapted and highly productive grass forage varieties were preferable in Northern climates, with timothy having the widest adaptation of all measured species.*		
12	*Traditional livestock breeds are better "landscape managers" for outfield pastures than their modern counterparts*	*Tradisjonelle husdyrraser er bedre "landskapsforvaltere" av utmarka enn moderne raser*	(Bele et al., 2015)	Resource use by old and modern dairy cattle breeds on semi-natural mountain pastures, Central Norway	*Groups of older breed dairy cattle more frequently grazed woody vegetation, while modern breed grazed over a more extensive area, indicating better adaptation of old breeds for semi-natural pastures than modern ones.*	Functional and response diversity	Throughout

			(Bhatti et al., 2020)	Management Strategies to Improve the Economics of Sheep Farms in Norwegian Coastal and Fjord Areas-The Effect of Animal Size and Capacities for Rangeland Utilisation	*"On free-range summer pastures, the old sheep breeds, compared with modern ones, stay together in larger flocks, cover longer distances on the range, are more robust towards environmental variation, and choose a diet containing more woody plant species."*		
			(Saether et al., 2006)	Plant and vegetation preferences for a high and a moderate yielding Norwegian dairy cattle breed grazing semi-natural mountain pastures	*Compared old versus modern dairy cattle breeds on two different study sites, revealing that older breeds grazed more in nutrient-poorer pastures in one study site. Equal grazing patters were found in other study site.*		
14	*Virtual fencing systems offer promising workload reductions for seasonal pasture and outfield management*	*No fence' kan redusere arbeidsmengden ved utmarksbeiting og setring*	(Aquilani et al., 2022)	Review: Precision Livestock Farming technologies in pasture-based livestock systems	*Reviewed that remote sensing technologies, including virtual fencing systems, could reduce labour requirements and promote rotational grazing management systems.*	Optimally redundant	Conservation to release
			(Pettersen, 2022)	Automatisering av jordbruket: en casestudie av teknologi-implementering med eksempler fra jordbruket på Vestlandet	*Found that among 8 farmer participants, the impact of virtual fencing technology is conditioned by the context of each farm's organizational structure. One farmer commented: "the old-fashioned fence system that requires a lot of work and capital, which means that many grazing areas are never used."*		

40	*Private ownership of the outfield areas is better than state commonality for safeguarding grazing resources*	*Privat eierskap til utmarka er bedre enn statsallmenning for ivareta beiteressursene*	(Heiberg et al., 2005)	Turisme i verneområder. Forprosjekt	*Notes the complexity involved in value creation in protected areas in Norway, adding that there are especially conflicts between local and national administrations on rights of use for commercial resource exploitation.*	Optimally redundant	Conservation to release
			(Flø and Vik, 2017)	Scenarioer for norsk landbruksproduksjon	*"Dersom mann har en landbruks-eiendom og ikke benytter ressursene på denne, må man skatte for dette. Grunntanken bak dette grepet er at naturressursene grunnleggende sett er et fellesgode. dersom man beholder eiendomsretten til eiendommen, men ikke lar samfunnet ta del i grunnrenten fra eiendommen må man skatte av dette – som av andre kapitalgoder."*		
			(Vik et al., 2010)	Synergy or marginalisation? Narratives of farming and tourism in Geiranger, western Norway	*Identified two narratives from farmer and non-farmer groups tied to Landscape Protected Area. Found that farmers who felt marginalized by tourism development "highlighted characteristics such as external ownership and lack of local control. Hence, large-scale agents were accused of being 'free riders', not contributing to the common good, and selling cultural landscapes without offering economic returns to the farmers who maintain these landscapes."*		

			(Eiter and Potthoff, 2007)	Following up the European Landscape Convention with a comparative historical analysis of forces of landscape change in the Sjodalen and Stølsheimen mountain areas, Norway	*Notes examples of different rights of land use between Sjodalen state commons outfield areas compared to those in Stølsheimen, in which all outfield properties fall under rural commons. These differences have wider impllications for vegetation, tourism activities, and seasonal farming activities.*		
16	*The benefits of specializing my production outweigh the costs of diversifying my farming practice*	*Fordelene ved å spesialisere produksjonen min er større enn fordelene ved å drive med en variert produksjon*	(Rønning and Kolvereid, 2006)	Income diversification in Norwegian farm households - Reassessing pluriactivity	*Found that diversified farming or farm-related income did not have significant impacts on household income, suggesting no added benefit from diversified farm activities.*	Optimally redundant	Conservation to release
			(Vik and McElwee, 2011)	Diversification and the Entrepreneurial Motivations of Farmers in Norway	*Uncovered social motivations for farm diversification were as important as economic motivations, including connections to local networks, providing social goods, and exercising creativity.*		
			(Asheim et al., 2014)	The Profitability of Seasonal Mountain Dairy farming in Norway	*Analysed for three different seasonal dairy farming configurations for profitability. A diversified dairy business was found to be profitable with fewer visitors to the shieling, but off-shieling sales would require strong marketing efforts.*		
17	*Producing vegetables and/or grains is a viable alternative to mountain farming practices*	*Å produsere grønnsaker og/eller korn i stedet for gras kan være et godt alterativ for fjellandbruket*	(Hjelmseth, 2009)	Agroecology and sustainable development of food from mountain areas: 2 case studies about Norwegian mountain almond potatoes	*In examining factors influencing potato production in Norwegian mountain areas, challenges with quality marketing, knowledge and skill generation, and climatic instability. Motivations for potato production were found beyond economic*	Optimally redundant	Conservation to release

					interests, strongly linked to mountain identity.		
			(Milford et al., 2021)	Markedshager i Norge - Utfordringer og muligheter med småskala grønnsaksproduksjon for direktesalg	*There were varying degrees of challenges for market gardeners in mountain areas, particularly finding local demand for products and securing returns on investment, agronomic limitations, and barriers to certified organic production.*		
			(Svanes et al., 2022)	Environmental impacts of field peas and faba beans grown in Norway and derived products, compared to other food protein sources	*Identified the potential to increase the amount of legumes grown for human consumption in Norway. Particularly for faba beans, the area of cultivation has doubled, but "are restricted to cereal producing regions with suitable topographies and longer growing seasons"*		
19	*The fragmentation of cultural landscapes threatens the economic viability of upland grazing systems*	*Utbygging i utmarka (f.eks. hytter) truer mulighetene for utmarksbeiting*	(Forbord et al., 2014)	Drivers of change in Norwegian agricultural land control and the emergence of rental farming	*Studied patterns in farmland control which were attributes to three overarching factors, of which farmland fragmentation was identified as a challenge both for individual farmers and their communities.*	Spatial and temporal heterogeneity	Growth/exploitation to conservation
			(Eiter and Potthoff, 2016)	Landscape changes in Norwegian mountains: Increased and decreased accessibility, and their driving forces	*Extensively reviewed literature to uncover driving forces of landscape change tied to either structures or processes. For example, processes like road construction and abandonment of mountian farming were considered main driving forces of change in the Stølsheimen Protected Landscape.*		

			(Olsson et al., 2000)	Landscape change patterns in mountains, land use and environmental diversity, Mid-Norway 1960-1993	*Described the fragmentation of semi-natural grasslands as a major conservation problem. Identified the decline in summer farm activity and the increase in tourist development in the Sjodal area as the largest drivers of landscape change.*		
21	*Greater dependence on leased land creates more challenges for mountain farming*	*Større avhengighet av leiejord skaper flere utfordringer for fjellandbruket*	(Dramstad and Sang, 2010)	Tenancy in Norwegian agriculture	*"Further, evidence does appear to be mounting internationally that tenancy leads to partial abandonment and/or decline in investment, which is cause for concern, particularly given the trends in areas with high ecological and touristic value dependent on agricultural management."*	Spatial and temporal heterogeneity	Growth/exploitation to conservation
			(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*"Some farmers commented that areas that are difficult to access with large and heavy equipment go out of production, and that entrepreneurs would not take the time or risk to cut field edges and sloped fields (if wet). These findings correspond with Bergset et al. (2014), who estimated that approximately 30 per cent of the rented farmland is subject to bush encroachment in Northern Norway."*		
			(Forbord et al., 2014)	Drivers of change in Norwegian agricultural land control and the emergence of rental farming	*Used multiple sources of evidence in mixed methods approach to analyse drivers of agricultural land control. Found that in less intensive farming regions, positive economic-social relationships between renters and owners could create mutually beneficial outcomes.*		

23	*Private land ownership is more effective than tenancy agreements in fulfilling local forage production*	*At gårdbrukerne eier jorda selv er mer effektivt enn leiejord for å sikre lokal fôrproduksjon*	(Dramstad and Sang, 2010)	Tenancy in Norwegian agriculture	*"Although there are contradictory results reported, a number of studies do indicate that tenanted land is indeed managed differently from owned land, which has particularly been the focus [of the Norwegian Government] with regard to management for conservation purposes."*	Spatial and temporal heterogeneity	Growth/exploitation to conservation
			(Skog and Bjørkhaug, 2020)	Farmland under urbanization pressure: conversion motivation among Norwegian landowners	*Sought to investigate farmers' motivations behind land conversion, which found two significant variables tied to production opportunities. The investments needed on the farm combined with poor household income meant farmers were more likely to covert their land.*		
18	*Access to fields with different topography and varying soil conditions can help reduce crop risk/ ensure consistent feed production*	*Tilgang til jorder med ulik topografi og varierende jordforhold kan bidra til å redusere avlingsrisikoen/ sikre jevn fôrproduksjon*	(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*Author notes how although small farms in western Norway aren't adapted to modern tractor equipment, some participants expressed greater flexibility in having access to different fields - particularly against wetter harvesting conditions.*	Spatial and temporal heterogeneity	Growth/exploitation to conservation
			(Daugstad et al., 2014)	Landscapes of transhumance in Norway and Spain: Farmers' practices, perceptions, and value orientations	*"Some farmers described changing land use by referring to the introduction of tractors for mowing and hay transport. This affected the division between hay fields and pasture lands; areas that could be managed and accessed by tractor were where hay production took place, while the remaining areas were used for pasture, which mainly meant less intensive use than mowing. Hence, the farmers saw an emerging regrowth of bushes on these areas."*		

			(Myklestad, 2004)	Soil, site, and management components of variation in species composition of agricultural grasslands in western Norway	*Specifically tested soil chemistry for grassland species composition against different fertilizer inputs in Western Norway, finding highly varying carbon-to-nitrogen ratios in the absence of fertilization and hence greater species richness. Yet sites with higher levels of soil nitrogen were found in low-productive grassland sites.*		
20	*Heavier tractors and machinery negatively impact soil quality and fodder crop yields*	*Tyngre traktorer og redskap svekker jordkvaliteten og fôravlingene*	(Schutte et al., 2014)	An investigation to enhance understanding of the stimulation of weed seedling emergence by soil disturbance	*Found that superficial soil disturbance in southern Norway promoted emergence of weed seed banks through the magnitude rather than the frequency of germination. Argued that soil compaction after disturbance is more severe in wetter soil conditions.*	Exposure to disturbance	Release
			(Rust et al., 2022)	Perceived Causes and Solutions to Soil Degradation in the UK and Norway	*Respondents of all three social perspectives identified in this study did not believe changing the timing of tillage would improve soil quality, but that less soil compaction and more crop variation could improve soil quality.*		
			(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*"Compaction and driving damages from harvesting under wet conditions affect soil structure and growing conditions negatively and reduce yield quantity and quality. Consequently, farmers had to plan the harvest in terms of feed quality; while at the same time considering the long-term effects that driving has on soil fertility and yields."*		

7	*By growing many different fodder crops, my crops become robust against annual climate variations*	*Ved å dyrke mange ulike fôrvekster blir avlingene mine robuste mot årlige klima variasjoner*	(Neset et al., 2019)	Maladaptation in Nordic agriculture	*Although this study took the example of crop-producing regions in Nordic agriculture, the authors identified diversification and crop diversity as systemic adaptation that would change the farm system overall.*	Exposure to disturbance	Release
			(Vogel et al., 2012)	Grassland Resistance and Resilience after Drought Depends on Management Intensity and Species Richness	*Found mixed results among the relationship between grassland diversity and resilience following disturbance. Intensively managed grasslands benefitted most from grassland diversity in response to drought conditions.*		
			(Þorvaldsson et al., 2015)	Climatic adaptation of species and varieties of grass and clover in the West Nordic countries and Sweden	*Important forage species and varieties with adaptation varieties against varying climatic conditions were evaluated in Nordic countries. They point to the importance of maintaining different varieties at different latitudes, even winter hardy varieties under an unpredictable future climate.*		
2	*For mountain farming, the advantages of a future warmer climate will be greater than the disadvantages of increased risk of floods and droughts*	*For fjellandbruket vil fordelene med et framtidig varmere klima være større enn ulempene med økt risiko for flom og tørke*	(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*Found evidence that some farmers in Western Norway believe higher future temperatures and a longer growing season might benefit fodder production, yet interviewees also reported challenges with increased precipitation and pest-induced diseases.*	Exposure to disturbance	Release

			(Daugstad, 2019)	Resilience in Mountain Farming in Norway	*"For most farmers, the climate change contributing to bush encroachment results is a negative landscape change. However, one of the farmers was quite explicit in pinpointing a positive outcome of changes in climate: the temperature has generally increased. We get higher yields from the fields than 30 years ago. We still harvest mostly two times during summer, but we get a higher yield each time."*		
			(Beitnes et al., 2022)	Climate change adaptation processes seen through a resilience lens: Norwegian farmers' handling of the dry summer of 2018	*Farmers responses underlined how rationalisation processes in Norwegian agriculture were perceived as a greater threat than the impacts of climate change. Yet farmers were doubtful that the state would support them in the same way in the event of future climate events. Financial decisions were made among respondents about future climate adaptation, yet practices remained unchanged.*		
22	*More frequent occurrence of extreme weather will lead to greater crop variation*	*Hyppigere forekoms av ekstremvære vil føre til større variasjon i avlingene*	(Uleberg et al., 2014)	Impact of climate change on agriculture in Northern Norway and potential strategies for adaptation	*Used climate projections to predict future climate impacts on grass fodder production in Northern Norway. Found that "Introducing new species, like perennial ryegrass, may increase fodder quality, while animals simultaneously might enjoy prolonged grazing periods on fresh grassland."*	Exposure to disturbance	Release

			(Özkan Gülzari et al., 2017)	Combining models to estimate the impacts of future climate scenarios on feed supply, greenhouse gas emissions and economic performance on dairy farms in Norway	*Combined models to project the impacts of future climate warming on four regions in Norway. Found that domestic grain production is set to improve in high latitude regions. Yet in regions expected to become warmer and drier, both grain and grass production will be impaired.*		
			(Neset et al., 2019)	Maladaptation in Nordic agriculture	*"Changing crops may have a number of unintended, although not always unexpected, outcomes. Increased maize production might for instance demand a higher input of fertilizers and increase the risk of pest and weed infestations. A Swedish farmer said, "You reap the grain and transport it to a barn and blow hot air on it. It takes a lot of energy to make the drying machine work. So, from one year to another, I can spend twice as much on energy and fuel for drying my grains."*		
24	*My farming contributes positively to reducing greenhouse gas emissions*	*Gårdsdrifta mi bidrar positivt til å redusere klimagassutslipp*	(Blandford et al., 2014)	The trade-off between food production and greenhouse gas mitigation in Norwegian agriculture	*Found five greenhouse gas emissions mitigation options using representative dairy farms in Norway. Conclude that food production based on ruminants involves higher emissions profiles per unit of production, as well as land (e.g., outfields) otherwise suited for sequestration activities (e.g., reforestation).*	Coupling with local natural capital	Reorganization to exploitation
			(Barraclough et al., 2022)	Mapping stakeholder networks for the co-production of multiple	*"Interestingly however, farmers did not often see themselves as coproducers of other ecosystem services like climate change*		

				ecosystem services: A novel mixed-methods approach	*mitigation or protection from extreme weather events, a surprising result given the importance of agricultural practices for climate change mitigation, and the impacts that climate change may have on farmers' livelihoods."*		
			(Bernués et al., 2022)	Targeting best agricultural practices to enhance ecosystem services in European mountains	*Agroecosystem practices were analysed in Nordic and Mediterranean contexts. Found that reducing the use of machinery could contribute to emissions reductions, while a majority of practices were positively associated with carbon sequestration.*		
27	*Increasing livestock densities is a vision for sustainably managed outfield areas*	*Økt beitetrykk er viktig for bærekraftig forvaltning av utmarka*	(Setten and Austrheim, 2017)	Bærekraftig beiting i fjellet: Hvilke prinsipper legger sentrale interessegrupper til grunn for å balansere mellom ressursbruk og ressursgrunnlag?	*Based on workshops held with agricultural stakeholders, researchers found six target areas that would impact the grazing pressure in mountain areas in Norway - a moderate to high grazing pressure was desired by participants.*	Coupling with local natural capital	Reorganization to exploitation
			(Strand et al., 2021)	Verdiskaping i utmark. Status og muligheter	*Comprehensive areal mapping across Norway revealed that grazing resources are underutilized, with strong regional differences in grazing pressure. 40% of grazing resources in Oppland County are underexploited.*		
			(Austrheim et al., 2016)	Synergies and trade-offs between ecosystem services in an alpine ecosystem grazed by sheep – An experimental approach	*Sought to identify optimal stocking densitites for biodiversity promotion within ecosystem services framework. Increased sheep grazing densities were negatively correlated "with plant cover and plant productivity as*		

					compared to both maintained densities and decreased grazing".		
29	*Current farm resources (e.g., infrastructure, workloads) prevent me from grazing livestock on the outfields*	*Nåværende ressurser på gården (f.eks. bygninger, arbeidskraft) gjør det vanskelig for meg å ha flere beitedyr på utmarka*	(Beitnes et al., 2022)	Climate change adaptation processes seen through a resilience lens: Norwegian farmers' handling of the dry summer of 2018	*Identified key areas which supported farmers' ability to cope with the dry summer of 2018, including outfield pastures. Yet farmers also believed relatively few (small-to-medium scale) farmers could persist should climate events become more regular, due to limited transformative potential. One farmer said: "one has the possibility to produce, based on the available resources. Thus, maybe one cannot compare that situation with today's."*	Coupling with local natural capital	Reorganization to exploitation
			(Daugstad, 2019)	Resilience in Mountain Farming in Norway	*Found that farmers' ability to cope with landscape change was reflected in their trade-off between infield and outfield resource usage. Outfields were deprioritized, and low-intensive land use practices fell out (despite limitations to intensification in mountain areas).*		
13	*National cooperatives (e.g. FK, TINE, Nortura) contribute positively to innovations in mountain farming*	*Nasjonale samvirkeselskape (f.eks. FK, TINE, Nortura) bidrar positivt til innovasjoner innen fjellandbruk*	(Hansen et al., 2022)	Loose housing-nothing to lose? Exploring the on-farm profitability and agricultural policy consequences associated with a tie stall ban on dairy farms	*Research led by researchers from TINE that analysed the effect of the tie-stall ban on dairy farm profitability, with a focus on Vestland due to their relatively smaller farm sizes. Found that farms with herd sizes less than 30 would not profit from barn upgrades unless public support was increased.*	Reflective and shared learning	Reorganization

			(Unnerud, 2015)	Hvordan påvirker styret i samvirkeorganisasjoner tjeneste- og produktutvikling i landbruksbasert næringsmiddelindustri? - En kvalitativ casestudie.	*Found that boards of agricultural cooperatives are actively seeking innovations for supply chains and products. For example, TINE counselors have become increasingly specialised and are no longer jointly financed but paid for consultation hours by farmers.*		
			(Klerkx et al., 2017)	Achieving best-fit configurations through advisory subsystems in AKIS: case studies of advisory service provisioning for diverse types of farmers in Norway	*Advisory services of four major agricultural cooperatives in Norway, the relationships they built, and the services provided to Norwegian farmers were examined. Found difficulties among advisors to implement new knowledge and technology, while competing to provide advisory services to farmers.*		
38	*Land distribution efforts are important for resolving conflicts and sustaining operations*	*Jordskifte er viktig for å løse konflikter og sørge for rasjonelle driftsenheter*	(Sky and Elvestad, 2021)	Land consolidation cases relating to grazing arrangements	*In-depth analysis of 20 cases in land consolidation court revealed how the time-consuming nature of revealing ownership rights may take a very long time to process if dealing with many topics at once. Therefore, there is a balance between going into the details of each conflict while maintaining a relatively simple legal framework for assessing cases.*	Reflective and shared learning	Reorganization
			(Hausner et al., 2015)	Effects of land tenure and protected areas on ecosystem services and land use preferences in Norway	*Sought to analyse the relationship between ecosystem services and land tenure in Norway, which revealed how cultural ecosystem services were most readily identified among land users but were unrelated to land tenure or protected areas. The authors suggest that "overlapping tenures in place before the*		

					designation of protected areas are important for understanding conservation effectiveness and the potential for land use conflict."		
26	*Researchers and experts provide knowledge and advice that is important for mountain farming*	*Forskere og eksperter gir kunnskap og råd som er viktig for fjellandbruket*	(Fagerheim et al., 2014)	Anbefalinger til ny forvaltningspraksis for sauebeite i fjellet. Sluttrapport fra en serie fokusgruppemøter 2012-2014.	*Plenary groups were formed between agricultural stakeholders to envision, target, and plan for future outfield areas. For landscape understanding, researchers and administrators were called upon for developing agricultural frameworks with objectives that are governed by individuals' understanding of the landscape (e.g., ecosystem services framework).*	Reflective and shared learning	Reorganization
			(Darnhofer et al., 2017)	Preserving permanent mountain grasslands in Western Europe: Why are promising approaches not implemented more widely?	*"When asked whether those stakeholder groups they thought should be involved in designing measures, a Norwegian researcher commented: researchers generally score low on influence, as do environmental organizations and cultural heritage organizations. To ensure sustainable development in rural mountain areas all three should have a stronger influence"*		

28	*Traditional farming practices like outfield grazing are vital for community well-being*	*Tradisjonell jordbruksdrift, som stølsdrift og utmarksbeiting, er avgjørende for livskvaliteten til bøndene og deres lokalsamfunn*	(Bernués et al., 2016)	Seeing Northern European Fjord and Mountain Agriculture Through Farmers' Eyes: A Critical Step in Promoting Sustainability	*Found that the goals of younger farmers who clustered in economic and innovation objectives were the inverse of those who sought to improve the quality of life of their families, supporting 'traditionalist' versus 'modernist' dichotomies in farmers' perceptions. Older generations valued neighbour relations and family well-being more.*	Reflective and shared learning	Reorganization
			(Frøyen, 2021)	Summer Mountain Farming in Norway: Attendance Factors Among 'Seter' farmers	*Identified several factors that promoted the persistence of summer farmers in Norway, including the culture of collaborative food production for creating a sense of community and togetherness.*		
30	*It's fairer for most people to reduce their overspending/ luxury consumption than for me to make changes to my farming operations to save the climate*	*Det er mer rettferdig at folk flest reduserer overforbruket sitt enn at jeg skal gjøre endringer i gårdsdrifta mi for å redde klimaet*	(Dubois et al., 2019)	It starts at home? Climate policies targeting household consumption and behavioural decisions are key to low-carbon futures	*Looked at household preferences for reducing emissions in major European cities. Found that Norwegian households use more inland flights, which forgoing was less preferred to reduce emissions than having access to dietary alternatives to meat and dairy products.*	Globally autonomous and locally interdependent	Exploitation to conservation

			(Flaten et al., 2019)	Links between profitability, nitrogen surplus, greenhouse gas emissions, and energy intensity on organic and conventional dairy farms	*"We found that all the global environmental indicators, and to a lesser extent nitrogen surplus per hectare, tended to have a positive relationship with profitability. This relationship implies that by improving profitability, farmers will also improve their environmental performance and vice versa. As one example, the main factor that improved profitability and reduced GHG emissions, in particular for organic farms, was greater concentrate feeding per cow."*		
			(Aasen et al., 2022)	The limited influence of climate norms on leisure air travel	*Using a social-psychological framework, the authors determined that the effect of their personal norms versus social norms were marginal on their actual leisure air travel behaviour. However, some norms were beginning to surface in Norway.*		
33	*The land grant stimulates domestic feed production*	*Arealtilskuddet stimulerer til norsk fôrproduksjon*	(Mittenzwei and Britz, 2018)	Analysing Farm-specific Payments for Norway using the Agrispace Model	*Used an economic model to simulate the effects of different subsidy policies; acreage and landscape payments were identified as promoting agricultural activity throughout the country in the short run. Assumed that if digressive support measures for dairy farms in Norway were removed, small dairy farms will be outcompeted by larger ones.*	Globally autonomous and locally interdependent	Exploitation to conservation

			(Asheim et al., 2020)	Policy measures to preserve Norwegian coastal and fjord landscapes in small-scale farming systems	*"The current Agriculture and Cultural Landscape (ACL) subsidy payment places a higher value on arable land compared to the more biodiverse farm pastures, resulting in weaker incentives for keeping farm pasture in production. Raising the rate for farm pasture relative to that of arable land in the ACL scheme would result in stronger incentives for keeping such farm pasture in production, and likely increase biodiversity and landscape values."*		
37	*Mountain farming is supported primarily because of the production of public goods such as biodiversity, cultural heritage and cultural land, and to a lesser extent because of the contribution to food security*	*Fjellandbruket støttes av storsamfunnet først og fremst på grunn av produksjon av fellesgoder som biologisk mangfold, kulturarv og kulturlandskap og i mindre grad på grunn av matsikkerhet*	(Daugstad, 2019)	Resilience in Mountain Farming in Norway	*Direct quote: "just to mow and leave the grass to rot does not make sense." Author continues to describe how the farmer "derived great joy from seeing how well-kept the cultural landscape was due to sheep grazing. Other farmers indicated that staying in farming had to do with producing food for people and not producing landscapes or amenity values."*	Globally autonomous and locally interdependent	Exploitation to conservation
			(Blumentrath et al., 2014)	Agri-environmental policies and their effectiveness in Norway, Austria, Bavaria, France, Switzerland and Wales: Review and recommendations	*In reviewing the effectiveness of different agri-environmental policies in Europe, the authors describe how Norwegian landscape maintenance support schemes have had mixed effects. Agricultural activity support schemes have been successful in maintaining the present level of agricultural production across the country, though environmental criteria are not supported here.*		

			(Bernués et al., 2022)	Targeting best agricultural practices to enhance ecosystem services in European mountains	*By simulating different agricultural payment scenarios for stakeholder groups, the authors found that the willingness to pay for the production of products linked to the territory was slightly greater than the conservation of the cultural landscape in Norway.*		
8	*Local farm management decisions are made more complicated by national agricultural policies*	*Det blir vanskligere for de lokale gårdsdriften å ta avgjørelser grunnet den nasjonale landbrukspolitikken*	(Darnhofer et al., 2017)	Preserving permanent mountain grasslands in Western Europe: Why are promising approaches not implemented more widely?	*Measured the perceived benefit of how policies maintain mountain pastures in Europe. Found that among all experts, almost 40% agreed that farmers require more flexibility in making decisions, while all agreed it was necessary for specific situations.*	Globally autonomous and locally interdependent	Exploitation to conservation
			(Blumentrath et al., 2014)	Agri-environmental policies and their effectiveness in Norway, Austria, Bavaria, France, Switzerland and Wales: Review and recommendations	*Noted how payments per area scheme involve greater administrative costs and complicated evaluation processes, yet they assume that the positive effect of such schemes towards promoting biodiveristy and sustainable land use can be established.*		
39	*It is the municipality's responsibility to assess key grazing areas and prioritize farmers before designating land use to others*	*Kommunene bør i større grad ta ansvar for å kartlegge sentrale beiteområder og sikre at setring og utmarksbeiting blir prioritet i disse områdene*	(Skog and Bjørkhaug, 2020)	Farmland under urbanization pressure: conversion motivation among Norwegian landowners	*"Norwegian land use policies are mainly implemented by municipalities, who are responsible for decision-making regarding farmland conversions. Regional and national government bodies can object if local decisions conflict with vital interests."*	Globally autonomous and locally interdependent	Exploitation to conservation

			(Sky and Elvestad, 2021)	Land consolidation cases relating to grazing arrangements	*Contend that vegetation surveys require expert assistance, which are said to be both time consuming and expensive. Yet if "if the land consolidation court believes that a vegetation map is required, it must appoint the relevant experts, the cost of which is passed on to the parties to the case."*		
34	*Traditional food production like mountain farming will be less valued by future generations in Norway*	*Tradisjonell matproduksjon som fjellandbruk vil bli mindre verdsatt av fremtidige generasjoner i Norge*	(Austgulen et al., 2018)	Consumer Readiness to Reduce Meat Consumption for the Purpose of Environmental Sustainability: Insights from Norway	*Based on survey data from Norwegian consumers, researchers found that reducing food waste and increasing the amount of locally produced/ consumed food; likewise, meat consumption was tied to traditional and social values which makes it easier for consumers to adapt their beliefs to their consumption patterns.*	Honours legacy	Release to reorganization
			(Eiter et al., 2022)	Mat og opplevingar i fjellet: Berekraftig bruk av lokale ressursar i landbruk og reiseliv	*In arguing for increased utilization of mountain-based fodder resources, this report outlines the opportunity for Norwegian-produced food to represent experiential values for which visitors could have a greater 'willingness-to-pay' for traditional foods.*		
32	*Increased intensification of agriculture in Norway damages the reputation of mountain farming*	*Utviklinga mot større og mer intensivt drevne gårdsbruk i Norge skader omdømmet til fjellandbruket*	(Austgulen, 2013)	Environmentally Sustainable Meat Consumption: An Analysis of the Norwegian Public Debate	*In-depth content analysis revealed that "two clashing discourses on what is actually environmentally sustainable meat consumption (and production) are evident in the debate. One that is focussing on the environmentally malign aspects of consumption and production of (especially) red meat and another that*	Honours legacy	Release to reorganization

					is focussing on the environmentally benign aspects of production and consumption of red meat."		
			(Vittersø and Tangeland, 2015)	The role of consumers in transitions towards sustainable food consumption. The case of organic food in Norway.	*Describes how the Ministry of Agriculture introduced a food campaign in the late 1990s to promote the quality of locally produced food. It sought to reinforce quality, safety, and health standards of Norwegian products. This was associated with an "almost active resistance against organic food" in Norway, which the authors couldn't explain for.*		
36	*Norwegian "plant-based" and "white-meat" dietary campaigns discourage mountain farming*	*Norske "plantebaserte" og "hvitt-kjøtt" kostholdskampanjer innebærer at fjellbruket svekkes*	(Austgulen, 2013)	Environmentally Sustainable Meat Consumption: An Analysis of the Norwegian Public Debate	*Highlighted "the nature of environmentally sustainable meat consumption does not only illustrate the lack of consensus on what causes the problem but also suggest that the solutions proposed are diverging." The debate follows the idea that grain-based fodder ought to be prioritized for monograstric livestock for reducing emissions.*	Honours legacy	Release to reorganization

			(BRYHNIA et al., 2002)	Consumer perceptions of pork in Denmark, Norway and Sweden	*"Meat is generally more expensive in Norway than in Denmark and Sweden, but pork is less expensive than beef and lamb.* *In Norway, pork is sold at reduced prices, thus many consumers buy pork in large quantities and freeze the meat for later consumption."*		
			(Austgulen et al., 2018)	Consumer Readiness to Reduce Meat Consumption for the Purpose of Environmental Sustainability: Insights from Norway	*Found that Norwegian consumers were not prepared to transition to plant-based diets, in part due to a lack of awareness and because consumers did not readily associate reductions in meat consumption with environmental friendliness.*		
31	*My farming practices negatively impact other obligations in my life (e.g., family care, off-farm employment).*	*Mitt driftsopplegg påvirker andre forpliktelser i livet mitt negativt (f.eks. tid til familie, arbeid utenfor gården)*	(Svedal Jørgensrud, 2014)	Farm household vulnerability and adaptive capacity to the double exposure of climate change and structural change: A case study of a farming community in Western Norway	*Quote from a farmer on psychological well-being and farming culture: "The kids are in school, and my wife is working. When they are participating in activities, I have to do the farm chores. I have dinner ready for when they come home, but then my wife is tired, and she doesn't feel like talking. They just finish the dinner quickly to go off to some activity. It is lonely being a farmer."*	Builds human capital	Throughout

			(Rønning and Kolvereid, 2006)	Income diversification in Norwegian farm households - Reassessing pluriactivity	*"Although only two of the diversification strategies turned out to have a positive effect on income it should be noted that none of the strategies were negatively related to household income. The results indicate that pluriactivity should be understood as an intended strategy adopted by many farm households in order to fulfil the multiple objectives within the household."*		
			(Skog and Bjørkhaug, 2020)	Farmland under urbanization pressure: conversion motivation among Norwegian landowners	*The motivation for converting farmland to other uses such as development was tied to lower household incomes and the perceived expenses of investing in the farm. The influence from social structures such as family is argued as relevant for making investment decisions.*		
42	*Visitors want a maintained cultural landscape: increased overgrowth will negatively affect tourism revenues in Valdres*	*Besøkende ønsker et vedlikeholdt kulturlandskap: økt gjengroing vil påvirke inntektene fra turisme negativt i Valdres*	(Vinge and Flø, 2015)	Landscapes Lost? Tourist Understandings of Changing Norwegian Rural Landscapes	*"The rural landscape is appreciated for its visual and recreational qualities. The concept of variation stands out as the element the tourists valued most about the Norwegian rural landscape." In particular, "the landscapes that were experienced as threatened were regarded as more beautiful than the landscapes that were thought of as abundant."*	Builds human capital	Throughout
			(Soliva et al., 2008)	Envisioning upland futures: Stakeholder responses to scenarios for Europe's Mountain landscapes	*Found that Norwegian stakeholders linked land abandonment with cultural heritage loss, and that spontaneous reforestation of the landscape could incur problems for tourism in these areas.*		

			(Bernues et al., 2016)	Agricultural practices, ecosystem services and sustainability in High Nature Value farmland: Unraveling the perceptions of farmers and nonfarmers	*From the perspectives of several farmers, interviews revealed how they believed visitors appreciated open cultural landscapes but didn't necessarily understand what created them. The maintenance of open areas allowed for farmers and visitors to enjoy different activities in the landscape.*		
43	*Outdoor leisure activities contribute to functional outfield areas*	*Friluftsliv i utmarka er bra for utmarksbasert fjellandbruk*	(Daugstad, 2019)	Resilience in Mountain Farming in Norway	*"The co-existence of farming and tourism has been beneficial for Oppdal for generations. Farmers have combined jobs in farming with tourism-related jobs, such as working as caretakers of ski lifts, in construction, and as janitors. However, according to some farmers, such practices could be a way out of farming".*	Builds human capital	Throughout
			(Eiter et al., 2022)	Mat og opplevingar i fjellet: Berekraftig bruk av lokale ressursar	*Highlights the Norwegian Tourist Association in their role for promoting outfield areas, particularly in the interest of nature conservation and outdoor activities. Emphasis is placed on increasing the number of outdoor activities rather than increasing international tourism to increase traffic in outfield areas.*		
45	*My mountain farming practices are positive for my family's quality of life overall*	*Mitt driftsopplegg er positiv for familiens livskvalitet generelt*	(Bernués et al., 2016)	Seeing Northern European Fjord and Mountain Agriculture Through Farmers' Eyes: A Critical Step in Promoting Sustainability	*Identified several farmers' goals in Norwegian agriculture beyond market objectives, such as improving the quality of life of their families and building on social networks such as positive neighbourly relations.*	Builds human capital	Throughout

			(Eriksen and Selboe, 2012)	The social organisation of adaptation to climate variability and global change: The case of a mountain farming community in Norway	*"One farmer explained that although this way of life involved lower income and less vacation, it provided freedom and flexibility in daily life and agricultural production and involved collaboration and social contact with other local farmers. He also argued that it increased both the quality of his agricultural production and the quality of life for his family."*		
47	*Mountain farming needs to adjust to the successors' needs and wishes for a sustainable agriculture*	*Fjellbønder må tilpasse seg behovene til de som skal ta over for fremtiden*	(Bjørkhaug and Blekesaune, 2007)	Masculinisation or Professionalisation of Norwegian Farm Work: A Gender-Neutral Division of Work on Norwegian Family Farms?	*"In the current situation, Norwegian agriculture needs to adjust to the incoming recruits or successors' needs and wishes for a sustainable agriculture. These adjustments are most needed on a cultural and social level so that newcomers can sustain a satisfying life situation."*	Builds human capital	Throughout
			(Brandth and Overrein, 2013)	Resourcing Children in a Changing Rural Context: Fathering and Farm Succession in Two Generations of Farmers	*Studied two generations of farming families in Norway to determine whether fathering practices held any influence over farm succession. There were generational differences in parenting cultures regarding how to best raise children for future skills and competences.*		
44	*Without an accurate calculation of return on equity, it is unclear what benefit there is to modernizing my practices*	*Uten en nøyaktig beregning av avkastning på egenkapitalen, er det uklart hvor mye en tjener på å modernisere gårdsdrifta*	(Hansen et al., 2022)	Loose housing-nothing to lose? Exploring the on-farm profitability and agricultural policy consequences associated with a tie stall ban on dairy farms	*Economic analysis of tie-stall bans readily demonstrated that investments in new barns are not favourable for most Norwegian farmers; particularly for farmers with less than 30 cows, in turn, barn upgrades weren't profitable unless grant schemes were significantly increased to this end.*	Reasonably profitable	Conservation

			(Hansen et al., 2019)	Profitability on dairy farms with automatic milking systems compared to farms with conventional milking systems	*Automatic versus conventional milking systems on Norwegian dairy farms were profitable for cow herd sizes between 35-40, while small farms who invested in automatic systems were less profitable than if retaining conventional systems.*		
46	*Local supply chains can only be profitable if consumers are willing to pay for high-quality foods.*	*Lokal omsetting kan bare være lønnsom hvis forbrukerne er villige til å betale for mat av høy kvalitet*	(Åsebø et al., 2007)	Farmer and consumer attitudes at farmers markets in Norway	*Demographic variables revealed that younger consumers were more readily willing to pay for higher quality food, with value placed on local and/or organically produced food than older customers, whose valued social relations of direct food consumption more.*	Reasonably profitable	Conservation
			(Austgulen et al., 2018)	Consumer Readiness to Reduce Meat Consumption for the Purpose of Environmental Sustainability: Insights from Norway	*Consumer support for increased prices on meat for environmental reasons was tied to demographic variables like gender, education, and income, while more than 60% of respondents disagree with these price measures.*		
			(Asheim et al., 2014)	The Profitability of Seasonal Mountain Dairy farming in Norway	*Using different modelling scenarios, researchers determined the profitability of developing a mountain farm dairy business depending on (a) the ability of the farm to extend the dairy production by substituting pasture with haylage and (b) the ability for farmers to market their cheeses for off-season sale.*		

48	*Working outside of farming and/or non-farm activities is crucial to my/our household income*	*Arbeid utenfor gårdsdrifta og/eller ikke-gårdstilknyttet virksomhet er avgjørende for økonomien min/vår*	(Rønning and Kolvereid, 2006)	Income diversification in Norwegian farm households - Reassessing pluriactivity	*Norwegian farm households with active farms were contacted by questionnaire to determine the impact of pluriactivity on income. Researchers found that "on farms that operate relatively labour-intensive livestock farming the household income is lower compared to other farms."*	Reasonably profitable	Conservation
			(Daugstad, 2019)	Resilience in Mountain Farming in Norway	*"All farm households relied on additional income; either one of the couple at the farm had a full-time or part-time job elsewhere or, in some cases, both had additional income." There was scepticism over selling land and participating in cabin development as a form of income diversification.*		
35	*Grazing livestock on outfield pastures is profitable even without the grazing subsidy*	*Å ha beitedyr på utmarksbeite er lønnsomt selv uten beitetilskuddet*	(Bhatti et al., 2020)	Management Strategies to Improve the Economics of Sheep Farms in Norwegian Coastal and Fjord Areas-The Effect of Animal Size and Capacities for Rangeland Utilisation	*"One reason for the overall improved profitability for old-race sheep was that the Norwegian subsidy payments per animal favour lighter sheep. Moreover, subsidises meant to promote grazing are based on the number of grazing animals."*	Reasonably profitable	Conservation
			(Beitnes et al., 2022)	Climate change adaptation processes seen through a resilience lens: Norwegian farmers' handling of the dry summer of 2018	*During the dry summer of 2018, farmers received lump-sum subsidy payments for their grazing animals; yet the author argues that some farmers, in particular those with dairy livestock, may not consider using outfield areas despite payments.*		

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Norges miljø- og biovitenskapelige universitet
Noregs miljø- og biovitskapelege universitet
Norwegian University of Life Sciences

Postboks 5003
NO-1432 Ås
Norway