Path-dependencies in Norwegian dairy and beef farming communities: Implications for climate mitigation

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Abstract

Within Norwegian agriculture, combined dairy and beef production has been identified as a major source of greenhouse gas emissions and thus targeted for significant reductions. The article examines the path dependency of the dairy and beef production system in Norway and focuses on identifying lock-ins. The authors used qualitative methods to gather information from stakeholder meetings in Trøndelag and Rogaland counties. They explored the stakeholders' responses to two different visions of agriculture in the future: the improved utilisation of outfields using Norwegian Red cattle and increasing production per animal by using feed concentrates. Six key areas of lock-in were identified: technology investment, culture, feeding strategy, policy, access to new farmland through moorland conversion, and ownership of the climate issue. The findings suggest that the current pathway in agriculture is strongly locked into production orientation through these lock-ins, making a production reduction option difficult to implement. There was also widespread belief among the stakeholders that the system of combined dairy and beef production was climate-friendly option, suggesting that farmers are not convinced that a change in this direction is required.

The authors conclude that the option of reducing production would be difficult to implement without addressing the multiple lock-in effects.

Fuglestad, E.M., Burton, R. & Rønningen, K. 2020. Path-dependencies in Norwegian dairy and beef farming communities: Implications for climate mitigation. *Norsk Geografisk Tidsskrift–Norwegian Journal of Geography* Vol. 00, 00–00. ISSN 0029-1951

ARTICLE HISTORY

Submitted 21 July 2019

Accepted [to be entered]

EDITORS

Kerstin Potthoff, Catriona Turner

KEYWORDS

climate mitigation, dairy and beef farming, greenhouse gases, Norwegian agriculture, stakeholder perceptions

[Footer:]

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Introduction

There is now almost no disagreement among scientists about the existence of anthropogenic climate change nor the urgency to take action to mitigate its long-term consequences. While mitigation efforts continue to focus on ever-increasing levels of CO_2 released during the burning of fossil fuels, emissions from agriculture are also rising (albeit at a lesser rate) and contributing significantly to global warming (Smith et al. 2014). It has been estimated that non-CO_2 emissions from agriculture in 2010 were 5.2–5.8 $GtCO_2$ equivalents per year (eq/yr) and comprised c.10–12% of global anthropogenic emissions, while fossil fuel use by machinery in agriculture was 0.4–0.6 $GtCO_2$ eq/yr, adding an additional 1–2% to the agricultural emissions (Tubiello et al. 2013). Consequently, the IPCC working group on Agriculture, Forestry and Other Land Use (AFOLU) contended that 'Leveraging the mitigation potential in the sector [agriculture, forestry and other land use] is extremely important in meeting emission reduction targets (robust evidence; high agreement)' (Smith et al. 2014, 816).

In common with other European countries, Norway needs to face the challenge of meeting emission reduction targets. A total of 8.4% (4.5 m tons) of Norway's CO_2 eq emissions come from agriculture, while the release of greenhouse gases from cultivated moor soil and organic soil contribute an additional 1.9 million tons. Approximately 50% of agricultural emissions come from farm animals. In 2018, methane from animal husbandry (digestion), nitrous oxides from manure and artificial fertilisers, as well as other nitrous oxides, contributed 4.5% of Norway's total greenhouse gases (GHGs) (Miljødirektoratet 2020).

Along with other European countries, Norway has signed agreements (e.g. the Paris Agreement) to reduce agricultural production emissions. Key measures for Norwegian agriculture include restrictions on the cultivation of peatland, regulations to improve manure and fertiliser management, and support for manure storage, environmentally friendly manure dispersal, delivery of manure to biogas plants, and improved drainage of agricultural soils (Landbruks- og matdepartementet & Klima- og miljødepartementet 2019). A critical driver of these reductions is the government's June 2019 agreement with the farmers' organisations in which the government accepted responsibility for reducing emissions from the food sector (e.g. food wastage), while stating that 'the agricultural sector must be in charge of on-farm improvements' (Landbruks- og matdepartementet & Klima- og miljødepartementet 2019, 12). This obliges Norwegian farmers to reduce GHG emissions by 5 million tons CO_2eq in the period 2021–2030, at the same time as increasing agriculture's uptake of carbon (Landbruks- og matdepartementet & Klima- og miljødepartementet 2019).

How realistic is it to expect Norway's farmers, who work with often very marginal farms, to achieve the required reductions in GHG emissions? Voluntary action to date appears to have been minimal. In a representative survey of 646 Norwegian farmers Brobakk (2018) found that only 2% claimed to have implemented measures that might mitigate climate change, with most of them simultaneously reducing management costs or generating additional income. According to the IPCC's Fifth Assessment Report Working Group III, one of the problems with mitigation measures is that 'real world' contexts have a tendency to make what seem to be realistic solutions on paper, difficult to implement in practice (Victor et al. 2014, 114). In particular, the report observes that the feasibility of implementing mitigation measures has yet to be fully understood and that it is important to include insights from different social sciences.

This article looks at how the dairy and beef sector in Norway – one of the key sectors targeted for emission reductions (St.meld. nr. 39. (2008–2009); Meld. St. 21 (2011–2012)) – is affected by the 'real world' contexts within which farmers operate. In particular, we explore stakeholder's narratives of carbon 'lock-ins' that might prevent the adoption of mitigation measures. Through stakeholder meetings in two major agricultural regions of Norway, the counties of Trøndelag and Rogaland, conducted as part of a wider study of sector lock-in (described in the Method section), we explored narratives and path dependencies on what contextual factors limit GHG mitigation options in the agriculture sector, and how these lock-ins can be overcome.

Lock-in in agricultural systems

A common perspective in the study of anthropogenic climate change is that human behaviour is part of a well-developed system or 'socio-technical regime' formed by an alignment of factors such as technologies, regulations, institutions, and cultural discourses (Unruh 2000; Geels 2004). Path dependency and lock-in play an important role in these regimes. Path dependency refers to a situation in which the decisions presented to various actors are dependent on prior decisions or experiences in the past. For instance, over time the choice of a particular technology will lead to a situation in which it will become increasingly difficult to follow a different development path. Stassart & Jamar (2008) contend that such dependencies emerge because the more the system develops, the lower the coordination costs and the greater the 'certainty' in the technology, whereas alternative solutions simply appear inefficient or ineffective in comparison (Musshoff & Hirschauer 2008).

Path-dependent systems are maintained by 'lock-ins'. If one part of such a system is moved in a different direction, other parts pull it back towards the original pathway. For example, current attempts to introduce synthetic animal proteins are being hindered by regulatory systems that have been designed for existing livestock production, and do not support the technological requirements of the synthetic protein sector (National Academies of Sciences, Engineering, and Medicine 2017). At the same time, politicians and meat industry representatives are 'haranguing' companies working on making meat-like products from plants about their use of the words ‘meat’ or ‘milk’ in their product labelling (Purdy 2019). With the potential for many such occurrences within each system, lock-ins can ‘reinforce cultural patterns and activities that may be easily seen as suboptimal but are highly resistant to change, even when most participants recognize such a need’ (Allenby 2012, 2).

The use of the lock-in concept has been strongly advocated as a means for understanding the social causes of climate change. In particular, Urry (2010, 1) states:

> in order to overcome the problems of this high carbon world it is necessary to bring about a wholesale shift to an interlocking set of low carbon systems – this involves establishing and examining the sociological characteristics of such a low carbon ‘economy-and-society’.

Numerous lock-ins have been observed in agriculture. For example, Lamine et al. (2012) note that lock-ins affecting sustainable crop production include factors such as the development of collective dynamics and learning processes, agricultural advisory systems, governance of research and extension, retail guidelines, and environmental organisations. In a historical study, McLeman et al. (2007, 12) found that the ‘dust bowl’ drought in Oklahoma in the years 1932–1936 was substantially worsened by pre-drought favourable climatic conditions, which led to the expansion of the cotton industry, which reshaped communities such that cotton production was ‘what Sequoyah County farmers knew and did best’ (McLeman et al. 2007, 389) and consequently rural businesses focused on supporting it. Other lock-in factors in agriculture include the institutional lock-in to a recommended list of seeds to inhibit the adoption of nitrogen-efficient wheat varieties (Mylan et al. 2015) and cultural factors such as livestock shows, the symbolic value of breeds, and local products of cultural importance, which in combination have been found to prevent agro-ecological transitions (Beudou et al. 2017).

Furthermore, dairy farms can be locked into development pathways. For example, De Herde et al. (2019) suggest a strong sense of security linked to mainstream dairy contracts, self-identification as milk producers, and common visions of what is 'good farming' practice, psychologically locked farmers into large-scale intensive farming, while a payment system that provided a bonus for higher levels of production, problems of collection on small-scale farms, agricultural advisors' focus on equipment investment, and the loan policies of banks all acted as structural lock-ins. Lock-ins in the agricultural sector were thus seen as creating a dependency pathway towards ever increasing and more intensive production (De Herde et al. 2019).

Studies of path dependencies that limit climate mitigation in agriculture are scarce. In one such example, Stuart & Schewe (2016) observed in the USA how corporate control by corn seed companies encouraged farmers to maximise yields, and that while farmers admitted to over-applying fertiliser, they were unlikely to engage in mitigation because they were dependent on the seed companies. Importantly, the Stuart & Schewe contend that this lock-in is such that education on climate change (one of the Norwegian Government's approaches to promote mitigation (Norwegian Ministry of Climate and Environment 2019)) is ineffective. The above-mentioned examples of lock-in in agriculture illustrate is the great variety of factors that can constrain the development of agricultural systems. To change the pathway of dairy and beef farming in Norway requires an understanding of what factors are locking farmers into the current system, such that policies that address what limits the adoption of mitigative measures can be developed.

Norway's challenges: the context for climate mitigation

The climate and environmental context

The Norwegian framework for GHG cuts has been established through a series of reports and White Papers. In the case of the government, this process began with the White Paper *Norsk klimapolitikk* (St.meld. nr. 34 (2006–2007)), which was followed by a parliamentary climate agreement in 2008, ratified in 2012 (Meld. St. 21 (2011–2012)). The agricultural sector presented its own White Paper on climate in 2009, which proposed a 1.1 million CO_2eq reduction by 2030 (Prop. 39 L (2018–2019)). In 2015 an expert group established by the Ministry of Food and Agriculture delivered a report on GHG emissions in Norwegian agriculture claiming that the sector could reduce its emissions by 20% by 2030 (Klimautvalget 2016). However, the 2012 climate agreement (i.e. Meld. St. 21 (2011–2012) already stated that emissions would be cut by 40–45% by 2030 (Brobakk 2018), leaving the ambitions of the agricultural sector well below those of the government. One of the reasons why substantial reductions of GHG emissions might be difficult for the agricultural sector to achieve is that, encouraged by government policy, farmers are continually expanding their farms in terms of both area and numbers of animals (Vik et al. 2019).

A specific challenge is the growing proportion of rented land in Norway (Forbord et al. 2014; Stokka et al. 2018). While, on the one hand, less productive land is going out of use and is being replaced by spontaneous forest regrowth, on the other hand there is a need for increasing the quantity of farmland per farm. In 2016, c.45% of farmland in Norway was rented (Statistisk sentralbyrå 2018), mainly from neighbouring farmers who had closed down their operations (Statistisk sentralbyrå 2020). This often meant that farmers needed to drive long distances, which in turn added to farm costs, labour costs, working time, and climate emissions. While the climate impact may be limited, the effects are still largely negative for farming in general (Forbord et al. 2014; Kårstad et al. 2015) and the implementation of measures to mitigate climate change (Burton & Farstad 2020).

Another common way of increasing farm size in Norway in the 20th century was the conversion of moorland to pasture (Fig. 1). The reclamation of moorland on a large scale was begun by the Association for the Country's Inner Colonisation and Retrenchment of Out-migration (Selskap for landets indre kolonisasjon og emigrasjonens innskrenkning),[1] which was formed in 1908 with the objective of making land available to young people and thus prevent further out-migration to America (Store norske leksikon 2018). In recent years, the amount of moorland permitted to be brought into cultivation annually has increased steadily from 1258 ha in 1997 to 2270 ha in 2017 (Prop. 39 L (2018–2019)). Approximately 7% of the current total cultivated land in Norway was formerly moorland (Prop. 39 L (2018–2019)). Following increases in the amount of land being reclaimed and the recognition that this was contributing significantly to Norway's agricultural GHG emissions, Parliament banned new cultivation of moorland in 2019 (Prop. 39 L (2018–2019)).

Many of the regulations that in the past have limited major structural change (e.g. milk quotas, and the structural profile of the subsidy system) have been liberalised in recent years, enabling dairy farms to continue to expand in size (Brobakk 2018). A major driver of the need for more farmland in recent years has been the automated milking robot. Milking robots have been widely adopted in Norway since 2000, and it has been predicted that 50% of cows will be milked by robots within a few years (xxx). The increase in the number of milking robots has been a major driver of recent increases in farm size in order to establish herds that are large enough to make the milking robot economically viable. Underlying these investments have been increasing lifestyle expectations of Norwegian dairy farmers combined with changing gender roles, with men expected to spend increasing amounts of time with their family rather than in the cowshed (Vik et al. 2019; Burton & Farstad 2020).

[1] Following a merger in 1976, the association became Det norske jord- og myrselskap (lit. The Norwegian Soil and Moor Association).

Lastly, it is important to remember the environmental and cultural context within which Norwegian agriculture takes place. Norwegian food and animal produce has been strongly associated with small-scale, high-quality, environmentally friendly and animal friendly production that, in addition to supplying food, is critical for maintaining biodiversity and cultural heritage, although the latter focus has weakened in recent years (Rønningen 2020). Grazing in remote areas is responsible for many of the open cultural landscapes of Norway, with the smaller farms – often operating in areas where the availability of farmland is exceptionally limited – playing an important role in keeping the landscape open. These farming systems are also important for biodiversity. About one-third of Red List[2] species in Norway are linked to low-intensity agriculture, with forest regrowth providing a threat to many of these species (Daugstad et al. 2006; Aune et al. 2018; Wehn et al. 2018; Hatten et al. 2018).

The agricultural policy context

The challenges for dairy and beef farming in Norway occur within the context of a highly politicised food sector. Although Norway has very little useable agricultural land in Norway as a whole and compared with other countries, agriculture has played a major role in Norway historically and has been partly protected from international markets through subsidies and import tariffs (Almås 2004; Bjørkhaug & Rønningen 2014). Within the dairy and beef sector the Norwegian Red, which is a breed of cattle that can be used for both milk and beef production, has become the backbone of Norwegian agriculture in many areas. Additionally, agricultural policies have been driven in part by a strong desire for food self-sufficiency.[3] To achieve such self-sufficiency, the government has followed a strategy of canalisation, with

[2] The Norwegian Red List is an overview of species at risk of extinction nationally (Henriksen & Hilmo 2015).
[3] In 2019, the level of self-sufficiency was 45%, excluding fish (44%) and when adjusting for imported feed (36%) (Kildahl 2020)

dairy and meat production promoted in the upper valleys, hill, mountain, coastal areas, and Northern Norway, leaving central, arable areas to concentrate on cereals, thus securing a system of relative, comparative advantage to promote agricultural viability nationwide (Almås 2004; Bjørkhaug & Rønningen 2014). It is important to note that Norwegian agriculture has well-established agricultural institutions, not least the *jordbruksforhandlinger* (lit. agricultural negotiations) between the government and farmers union during their meeting each spring to discuss the level of the subsidies and the future of the agricultural policy (Almås 2004).

Currently, Norway is taking two main directions in its efforts to improve the level of self-sufficiency in agriculture. First, there has been a strong discussion between the government and farmers organizations about the need to improve the utilisation of Norway's outfield (i.e. mountain pasture) grazing and grass resources in general. An increasing number of voices have advocated an agricultural policy that is less focused on volume of production and more on the use of Norwegian grass resources (Løkkland-Stai & Lie 2012; Helle 2015). In the wake of these advocacies several reports have been written on the issue of increased use of Norwegian resources in agricultural production (Fjellhammer et al. 2015; Flø & Vik 2017; Thuen & Tufte 2019). One of the main conclusions from these reports is that there is potential for increased use of the use of pastures and outfields as a means of enhancing production, while at the same time maintaining open cultural landscapes.

Furthermore, Grønlund & Harstad (2014) argue that production per animal should be increased, so that farmers have fewer dairy cattle that give more meat or milk, thereby effectively adopting an intensification strategy that would require increased imports of animal feed such as soy. This would also see the size of farms increase to become more sustainable economic units (i.e. with the same number of dairy cattle but fewer farmers, larger units, higher per-animal production). This strategy would fit well with the current government's production-focused agricultural policy (Brobakk 2018, 3) – a policy based on deregulation and increased market orientation in an effort to reduce reliance on agricultural subsidies and limit overproduction (Forbord et al. 2014).

While the debates are not directly concerned with the reduction of GHGs, the proposed strategies would have clear implications for emission levels in Norway. For example, Lønning (2017) suggest that a transition to smaller scale 'regenerative agriculture' in Norway would address emissions by binding CO_2 to particles in the soil. Additionally, sustained grazing of the outfields would prevent forest regrowth. In southern countries this practice might add to global warming but in northern countries open grazing land at higher altitudes reflects solar energy during the winter months, leading to a greater cooling effect than that of maintaining the land in forest (de Wit et al. 2014). However, intensification has also been suggested as having benefits for the climate. In particular, Rotz et al. (2010) indicate that the level of emissions per kilogram of protein produced from dairy farms can be halved, depending on the level of milk production in combination with the appropriate feeding and manure treatment systems, whereas Swain et al. (2018, 1207) state 'Modern, intensive livestock systems, especially for beef, offer substantially lower land requirements and greenhouse gas emissions per kilogram of meat than traditional, extensive ones.'

In this article our primary objective is to explore whether lock-ins and path dependency within the dairy and beef sector are guiding the direction of Norway's response to climate mitigation in agriculture. In particular, we explore whether stakeholders are leaning towards a scenario of intensification of land use or more extensive 'regenerative agriculture' or a combination of the two. We draw on narratives on lock-in from stakeholder meetings to construct an overall picture of path dependency and lock-in across the dairy and beef sector.

Method

The study on which this article is based was part of a broader project – NEWPATH (2014–2019) – that was investigating factors determining climate mitigation in the Norwegian dairy and beef sector. Within the project, which revolved around an agent-based model, three studies were undertaken to develop an in-depth understanding of different aspects of lock-in. Study 1 involved qualitative interviews with 29 farmers to explore social and structural aspects of lock-in within the farming sector, particularly focusing on how social and cultural factors led farmers and farming families towards particular ways of production (Burton & Farstad 2020). Study 2 focused on the agri-food network – the value chain – at the national level and involved semi-structured interviews with 13 key stakeholders from supply and processing industries, the grocery retail sector, agricultural advisory services, and farmer organisations (Farstad et al. 2020). Lastly, Study 3 looked at a broader group of key stakeholders in the agricultural sector to explore wider lock-ins across the industry, again within the framework of lock-in to development pathways for the dairy and beef system. This article is based on Study 3 but the findings are supported by the projects other two studies.

Two major food producing regions of Norway were selected for the study, the former county of Nord-Trøndelag in Central Norway (part of Trøndelag following a county merger in January 2018) and the county of Rogaland in the south-west (Fig. 2). The two regions were chosen because they are both long-established and important dairy regions where mitigation measures could have significant impacts. While these two regions are not representative of all agriculture, they may provide valuable insights into the dynamics of lock-ins. Trøndelag is one of the main agricultural areas in Norway and has the largest number of milking cows (mainly Norwegian Red breed) of all counties: 20% of the national herd. By contrast, Rogaland includes the most intensively farmed area in the country, Jæren. In 2016, Rogaland had the highest number of cattle, poultry, pigs and sheep of any Norwegian county (i.e. before the two counties in Trøndelag were merged), with dairy as the dominant sector. Both

Trøndelag and Rogaland contain areas of extensively used moorland and low lying mountain, although these land types are more common in Rogaland (Store norske leksikon 2019; 2020).

For NEWPATH Study 3, a one-day meeting was held with stakeholders in each of the regions. The meetings were held at two agricultural schools to provide neutral ground and to encourage students to attend. Each group consisted of 11–15 stakeholders; a larger group of students had attended the meeting in Rogaland and contributed significantly to discussions on meat consumption and everyday practices linked to food, farming interests and transport. The participating stakeholders were associated with dairy and beef farming and including conventional and organic dairy and beef farmers (from both large and small farms), as well as representatives of the Norwegian Farmers Union, a dairy cooperative, a meat cooperative, a farmer cooperative, feed concentrate producers, the agricultural advisory service, agricultural school teachers, and agricultural students (age range 16–19 years); the latter represented the views of future farmers.

As a discussion point to initiate conversation, we presented broad scenarios based on the two main agricultural development strategies for Norway: the intensification of production and the increased use of extensive grazing and outfield resources (as described in the section '*The agricultural policy context*'). In the case of less intensive production, the scenario involved increasing combined dairy and beef production through the Norwegian Red breed, while intensified production involved a switch to higher yielding specialised breeds of cattle. Discussions on the two strategies were further developed around the main issues of what possibilities and bottlenecks the stakeholders saw for the reduction of the negative climate impact of agriculture, whether they could they identify any 'lock-ins' within the beef and dairy system, and identification of the drivers of the dairy system.

Results: lock-ins and path-dependency in the Norwegian dairy and beef sector

In this section we present the lock-ins that emerged from the stakeholder meetings. Where appropriate, we also draw in findings from the other two NEWPATH project studies either to provide support for our assertions or to provide additional information to that obtained from the meetings. The issue we discuss is the extent to which the lock-ins make it more or less likely that two scenarios, namely intensification of production and reduced intensity of production, would be effective. Accordingly, we address the following question: To what extent is Norwegian dairy and beef farming locked into increasing or decreasing production levels? In addition, our analysis looks at areas where farming practices are believed to contribute directly to climate change, such as through the conversion of moorland.

Technology investment lock-ins?

Stakeholder discussions showed that technology in general and the introduction of milking robots in particular, is a strong driver for increased milk production. Both NEWPATH Study 1 and our research for this article revealed that for milking robots to be economically viable and to ensure that the robots was operate at full capacity, stakeholders needed 50–60 milking cows (the national average is 28 cows (Statistisk Sentralbyrå 2019)). Farmers often had to increase the number of dairy cattle on their farm in order to secure a capital loan from the bank to purchase a milking robot. Rogaland stakeholders pointed out that the move to milking robots reinforced the use of concentrates and discouraged grazing. It was further reported that automated milking robots required the use of good land concentrated around the milking unit, as exemplified by the following quote:

> How far the cow can or wants to walk becomes decisive in terms of what areas that can be utilised for grazing, and this has negative effects on the cultural landscape. So larger farm

units with more cows leads to poorer utilisation of land that is not close to the barn or is more difficult to get to.[4]

Stakeholders observed that the abandoned grazing land was then subject to forest regrowth and thus resulted in the loss of cultural landscapes. Better utilisation of existing distant grazing was seen by stakeholders as possible but uneconomic due to the requirement of additional labour to move the cattle. according to the Trøndelag farmers, the concentration of farming near the milking unit had been exacerbated by a recent policy decision to reduce subsidies for inbye land grazing in order to encourage outfield pastures. The farmers believed the decision could lead to significantly reduced grazing, with negative landscape consequences. In combination with increasing herd sizes, the concentration of dairy cattle was noted by Rogaland farmers as causing more damage to the land and muddying the farm tracks. To extend grazing farther out would require the construction of new track or improvements to old ones, However, such developments require municipal consent and applications are frequently turned down as they are seen to conflict with farmland preservation objectives and legislation (observed during both stakeholder meetings).

For some farmers, milking robots were not the only form of financial commitment that locked them into continued production. For many farmers there was a stark choice between the investment in new buildings, machinery and livestock or closing down their business. However, obtaining finance for expansion often comes with strings attached. Farmer stakeholders pointed out that investment loans and support from banks and Innovation Norway (the main funder of such investments) often set growth targets, such as increasing the numbers of dairy cattle or hectares farmed as a precondition for receiving grants.

[4] All quotes have been translated into English by Katrina Rønningen.

Overall, the introduction of milking robots appeared to lock farmers into a system of increasing herd size and intensity, with intensive land use around the milking robot associated with the abandonment of land in the outfields. At the same time, the linking of investments (including milking robots) to farm growth by organisations responsible for loaning money had meant that investments often necessitated increases in production. Thus, technological development has had a major role in locking farmers into a scenario of increased production and intensification.

Cultural lock-ins

From the stakeholder meetings it was clear that increasing production was supported by a wide range of community actors. The cross-community support was believed by the stakeholders themselves to contribute to maintaining lock-ins in the agriculture sector with suppliers, advisors and researchers, all of whom were contributing to move agriculture in the same direction. In particular, the stakeholders saw agricultural advisors as important for farmers' decision-making and mainly encouraged increased production, as did representatives from the dairy cooperative. Moreover, machinery sales agents encouraged increased production. One farmer said 'We often don't think of it because tractor and machinery suppliers are often overlooked, but can have great influence upon investments, and they often don't know the local conditions.' The statement illustrates how the advice of the machinery suppliers may leave farmers in a position where their business is overcapitalised or holds machinery that does not have an economic contribution to the farm, thereby effectively increasing the need to borrow capital without enhancing the ability to pay it back. Furthermore, for some of the students attending the stakeholder meetings the possibility of working with machinery and technology was a major reason for them to want a future in agriculture.

In the NEWPATH project, the primary focus of Study 1 was cultural lock-in. In that study Burton & Farstad (2020) found that the lock-in to purchasing milking robots was driven by changing cultural expectations in Norwegian society, particularly expectations of increased leisure time and changing gender roles. In the past it had been acceptable for the farmer to spend hours in the milking shed rather than taking responsibility for their share of childcare but increasingly this option has become unacceptable to farmers. As a result, passing the farm onto the next generation has almost invariably necessitated the purchase of a milking robot (now a cultural norm) which, in turn, has had implications for intensifying production on the farm in order to increase incomes to cover the investment costs. The purchasing of a milking robot often also leads farmers to convert moorland in order to increase farm size, so that size of the milking herd would reach the 60-cow level, albeit with negative impacts on GHG emissions.

In the stakeholder meetings participants referred to an inherent drive to transfer the farm in an improved form to the next generation, which generally meant being larger, more efficient and more profitable. Many farmers considered that increasing production was 'satisfying', although some stakeholders, particularly organic farmers, pointed out that increasing quality could be just as satisfying as increasing quantity. However, an important point made in both stakeholders meetings, was that few of them were enthusiastic about making significant investments if it meant increasing debt levels or taking on additional hired labour. While many farmers hired workers, either seasonally or all-year round, the responsibilities and debt attached to becoming 'too big' meant that the stakeholders preferred limited growth.

Further to the main cultural lock-in explored by Burton & Farstad (2020), our research for this article revealed that, while farmers were not enthusiastic about the additional work or debt required to expand the farm, there was nevertheless some satisfaction in increasing production on the farm as per the intensification scenario, while there was little mention of satisfaction from maintaining low levels of production. Furthermore, the various stakeholders who were in support of intensification suggested that the social pressure across the community was predominantly on increasing production.

Feeding strategy lock-ins

The feasibility of different feeding strategies was at the core of discussions regarding the combined dairy and beef alternative versus specialisation in either high yielding beef or dairy. Reactions to the notion of increasing combined dairy and beef production, and the reduction in the milk yield per cow varied. Some farmers simply did not wish to reduce the yield per cow, as that was contradictory to their identity as dairy farmers (a cultural lock-in), while others suggested they would be willing to reduce the use of concentrates needed for more intensive production and increase the grass-based share of their feed. For example, one stakeholder commented 'I think it would be easier psychologically to introduce alternative energy measures on the farm than to reduce production per unit cow or land', while another stated: 'If society decides it wants grass-fed [cows], we have no problems delivering that.'

Targets for concentrate to grass ratios set for climate friendly agriculture appear to be affected by lock-ins. The stakeholders referred to a normal target of 9.5 tons of concentrate per cow per year but the recommendation for climate friendly agriculture was 7.5 tons of concentrate per cow per year, a shortfall that would require additional grazing or a reduction in the number of dairy cattle. Neither option was thought viable, as additional grazing was difficult to obtain and capital could not be borrowed to expand the farm unless production were increased (see the section '*Technology investment lock-ins*'), while decreasing the number of dairy cattle on the farm would be prevented by both cultural and technological investment lock-ins.

One area that appears to lock farmers into particular feeding strategies is the need for more research. In particular, the participants suggested fewer but higher yielding dairy cattle might be more favourable and would result in a decreased need for farmland. To clarify this situation, the stakeholders asked for research on increasing yields and improving the farm economy while reducing input. Additionally, breeding strategies and genetic research were identified as factors with consequences for the utilisation of land resources and farming strategies. The stakeholders were somewhat reluctant to discuss combined dairy and beef production versus specialisation as a climate strategy, although many referred to claims that the combined production using the Norwegian Red breed is more climate friendly, as the dairy cattle deliver both milk and beef. The stakeholders were also concerned that the GHG emissions generated through the use of feed concentrates and generated by domestic grazing and fodder had not been sufficiently investigated and therefore they suggested that more research was required.

Existing feeding strategies appear locked in by a combination of a psychological and/or cultural desire to maintain production, the inability to increase the ratio of concentrates to grass and/or fodder, and uncertainty related to the efficacy of the options. These areas would need to be unlocked in order to move to a more climate friendly production system.

Agricultural policy lock-in

Agricultural policy was seen by the stakeholders as having two lock-in effects. First, the influence of the generous subsidy system in Norway was acknowledged by the stakeholder groups from the meetings in Trøndelag and Rogaland. Some stakeholders suggested that a more market-based approach might assist in meeting climate goals if the general public was willing to pay for more climate friendly agriculture. The current policy of increasing agricultural production (Brobakk 2018) makes any reduction in production intensity or scale to meet climate goals difficult. A further issue was raised at the Trøndelag meeting, which was that the main agricultural research institutions continued to push production oriented approaches and this institutional lock-in influenced agricultural policies. With the government pushing dual objectives of increasing production and addressing climate goals, government policies appear already to be pushing agriculture down the pathway of intensification.

Cultivation of moorland

Both stakeholder groups (and farmers in the other NEWPATH studies) were of the opinion that bringing more moorland into cultivation would be a positive development for agriculture. In Trøndelag significant amounts of farmland have been lost to large road developments, while Rogaland has experienced significant losses of farmland to roads, infrastructure and housing developments. In part due to a severe drought in 2018, the Rogaland farmers contended that moorland represented a valuable land reserve for agriculture. However, irrespective of this, they had observed that many farmers were constantly looking out for more land to buy or rent. The desire to increase farm size by converting moorland was also noted in NEWPATH Study 1, but in that case moorland conversion was specifically driven by the need to install a milking robot to meet changing lifestyle goals (see the section '*Cultural lock-ins*').

Given the importance of increasing farm size and lack of alternatives, it is unsurprising that despite a general awareness that cultivating moor soil contributes to climate change, the farmers were generally opposed to the ban on moorland cultivation which was decided in June 2020 (Landbruks- og matdepartementet 2020). First, they considered it was unfair that other sectors such as road construction were allowed to build on both farmland and moorland without incurring sanctions. These land use changes and land losses forced farmers to try to compensate (e.g. through moorland cultivation). Other arguments to defend the practice of moorland cultivation were forwarded by the farmers, including a lack of public and political understanding of the processes of handling waterlogged soil, references to experiments that suggested there was a scientific means of converting moorland without damaging the environment, and the opinion that conversion to moorland to produce food in Norway was necessary to prevent food having to be imported from overseas, which itself would contribute to climate change.

The key moderators for intensifying production by converting moorland soils were the perceived need for agricultural land and the perceived lack of certainty in science-based advice. The emergence of an uncertainty lock-in indicates how strongly the established or 'known' ways of doing things locks in the status quo and makes any new advice uncertain and therefore questionable. Alternative suggestions can be ascribed to simple ignorance or ulterior motives, as was ascribed by the participants.

Ownership of the climate issue as a lock in

While the stakeholders agreed that the agricultural sector needed to take some responsibility for the climate, they stressed that through the use of grassland the dairy and beef sector should be seen as part of the solution to climate change rather than simply a cause of it. A major theme in the Rogaland meeting was the concern that the debate on climate change was being misrepresented in the public sphere and that particularly agriculture was being unfairly treated. For example, two stakeholders respectively stated:

> We need to look at what works. It's just silly that things are taken out of context. I wish there was a way to calculate climate emissions from my farm, how high would that be? What about those who fly every day?

> I am afraid that climate requirements … and the debate is increasingly dominated by people who lack knowledge and by consumer populists such as the Animal Welfare Alliance [Dyrevernalliansen].

The quotes represent two aspects of the debate in climate change. First, there was a degree of confidence that relative to other parts of the economy agriculture was not the main sector responsible for climate change but nevertheless was receiving a disproportionate amount of blame. The stakeholders stressed the circular biological system of which agriculture is a part and they saw this as part of the solution. Second, there was concern that the debates were being controlled by outsiders to the farming community – people who were simply against the dairy and beef sector in general and used the climate issue as a means of reducing livestock farming. The belief that agriculture was being given too much responsibility and/or that others were using the climate issue simply to express an existing bias against farming caused resistance to change among the participants during the meetings.

Discussion

In this article we have identified six lock-ins within the beef and dairy system that are currently leading the agricultural sector down a specific development pathway, namely one of increased production through intensification. A combination of factors is involved and in particular pressure from stakeholder businesses across the wider community appears to be encouraging intensification, with the banking sector seeking to obtain security for loans, the machinery sector seeking to sell large (and expensive) machinery, and ~~the~~ agricultural cooperatives seeking to obtain as many raw products as possible. This development is further reinforced by cultural factors within the farming community, which exhibits a general ethos of productivism (Wilson 2013). The farmers claimed it was against their identity as farmers to produce less, while they maintained that increasing production was a source of considerable job satisfaction. At the same time, many farmer stakeholders stressed that they were not interested in any strong increase in production, as that would means more work, more debt, and possibly the need to hire additional labour. While Norwegian agriculture is highly multifunctional (Flemsæter et al. 2018), productivist values are part of the agricultural policies and to some degree influence practices both among the farmers and among the supporting industries. Although the stakeholders' discussion on agricultural policy was relatively limited, this does not reflect the strong role played by the Norwegian state in guiding agriculture, with major changes in farming to address climate change unlikely without state incentives (Flemsæter et al. 2018).

In a country where agriculture is severely limited by geographical and climatological factors it may not be surprising that geographical factors combine with other lock-ins to push farmers towards intensification. Dairy and beef farmers are caught between a need to install milking robots to meet changing social expectations (Burton & Farstad 2020; Vik et al. 2019), a lack of usable grazing land in the vicinity of the milking sheds, the lack of nearby land to purchase or rent, the frequent availability of moorland for conversion, and the demands of lenders to increase the size of the business in order to secure a loan for the milking robot. The end result is that conversion of moorland is often seen as the only option and, according to the study participants, the notion that moorland should be used (and opposition to the moorland conversion ban) was felt across the entire community.

One of the most interesting findings from the stakeholder meetings was the repeated calls for evidence that their agricultural practices were harmful. Arguments for the continued conversion of moorland were based in part on a belief that existing evidence of its effectiveness in reducing emissions was not sufficient. Some stakeholders stated that there were ways of converting moorland in a climate-friendly fashion combined with claims that the public and policymakers do not understand the processes of handling waterlogged soil were central to the farmers' objections to the ban on moorland conversion. Furthermore, the stakeholders wanted more information on feeding systems, both in terms of how to increase yields while reducing inputs and through the provision of more evidence of the impact of domestic grazing versus imported feed concentrates on GHG emissions.

Knowledge lock-in and uncertainty about alternative outcomes is one of the key drivers of path dependency (Stassart & Jamar 2008). In the studied case, uncertainty or rather the lack of evidence that the community wanted to accept or relate to, appeared to account partly for locking farmers into a path of continued intensification, as also observed in Belgium by De Herde et al. (2019). Norwegian agricultural policy has a credibility issue in that it pushes intensification and upscaling of agricultural production and simultaneously reduces the use of infield grazing resources, while encouraging a reduction of GHG emissions. Further, agricultural policy operates in an environment in which 'researchers and other experts disagree about Norwegian agriculture's effects on climate change and on what future steps should be taken' (Flemsæter et al. 2018, 2053) and leads to what Brobakk (2018, 19) terms 'solution scepticism', meaning that farmers are unsure of both the efficacy of the climate measures in terms of reducing climate change and the effect on the productivity of their farms and economy in the long term.

In general, the stakeholders stressed the belief that the dairy and beef sector should be seen as part of the solution to climate change rather than a cause of it. Grass production was perceived by the stakeholders as a means of binding carbon in the soil while, at the same time, the growing of food for the local market was perceived as having benefits for the climate. GHG reductions were seen as best achieved through maintaining the status quo but also through improvements in agronomic practices, mainly by optimising soil and resources, and by keeping fields clear through grazing to enhance the albedo in the winter months. The stakeholders recognised that some current practices might have to change. For example, measures could be taken to reduce the use of feed concentrates (currently a combination of Norwegian-grown and imported soy feed), thus potentially freeing up land in Norway and elsewhere for human food production. ‘Agriculture as part of the solution’ is the translated subtitle of a Norwegian White Paper on agriculture and climate (St.meld. nr. 39, 2008–2009), thus indicating that the argument is part of the current formal debate and one that appears to have been widely adopted by the agricultural sector.

An interesting observation from the participants’ responses is that what is considered valid scientific knowledge and what is considered invalid scientific knowledge (thus requiring further research) appears to depend on whether the knowledge supports the continuation of productive agriculture. For example, the stakeholders used the arguments that livestock production was good for carbon storage and that the albedo effect from open fields undoubtedly contributed to a cooling effect. Whereas scientific knowledge about the impact of the conversion of moorland and the overall emissions from the agricultural sector required further research. What is critical is not more scientific certainty as to how measures affect GHG emissions (although this is still important) but more knowledge of how mitigation measures will affect dairy and beef businesses. Some studies have shown that providing farms do not suffer economically when Norwegian farmers are willing to accept climate change measures on the advice of the government (Brobakk 2018; Flemsæter et al. 2018).

Conclusions

The most important finding from our research is that dairy and beef farming in Norway are locked in to enhanced production. The current policy of increasing agricultural production in Norway makes reduction in production intensity or scale to meet climate goals difficult. Hence, we can conclude that the easiest option for mitigating GHG emissions within the current pathway would be to increase production per animal. Less intensive production would involve tackling numerous lock-ins simultaneously. Three main issues emerged from our study out. First, the mindset of the farmers was strongly oriented towards maintaining or increasing production, at least to a moderate degree, with some farmers claiming that enhancing production was part of their identity. Second, the supporting industries have all been configured in the same direction. Whether it is the dairy cooperative's need for high levels of product, machinery companies' need to meet profit margins by selling large and expensive machinery, or banks demanding increased production levels to provide security for new loans, all are pushing the system in the same direction: growth and increased production. Third, also the structural nature of farming in the two study regions is pushing farmers in the same direction of growth and increased production. The dispersed nature of land suitable for agriculture (due to the geography as well as to land losses to road developments and other infrastructure) has encouraged farmers to convert moorland on their existing farms to meet expansion needs. These three areas would need to be addressed simultaneously if policy were to be used to implement a 'painless' process of change, which might involve both economic compensation and political compromise. However, this does not seem to be the path the government has taken.

As noted in this article, a ban on moorland conversion has recently been implemented in Norway. Without moorland to convert to grazing, many farms will be unable to increase their stocking rates, thus leading to an inability to secure loans for purchasing a milking robot, which in turn could lead to farmers who are unable to secure the desired quality of life in any other way to seek alternative means of generating income on their farm or simply to close down the business and rent the land, as many already have (Forbord et al. 2014). Alternatively, the ban could push farmers to rent land distant from their farm to grow fodder in order to increase production. All eventualities would have implications for both the climate and production levels in Norwegian agriculture, but ascertaining what these might be is beyond the scope of this study.

Possibly the best policy path would be to choose the middle ground between the using local grass resources, reducing GHGs and keeping production levels up in order to meet market demand. While the stakeholders were locked into production, they did not have any desire to introduce more large-scale agriculture to Norway, nor did most of them wish to manage very low intensity grazing systems. The stakeholders did not suggest that any of the lock-ins were impossible to overcome, nor did they accept that extensification and intensification represented two extreme solutions from which they had to choose. They considers that a compromise or dual position was possible. The general consensus among the stakeholders was that as long as they used the resources available on their farms as efficiently as possible, the traditional Norwegian dairy and beef sector would be not the cause of climate change but a solution to it.

Acknowledgements

The Research Council of Norway is thanked for funding the research (Klimaforsk grant nr. 235670). Also, many thanks are given to the reviewers for their very useful comments, and to the stakeholders who participated in the meetings.

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Figure captions

Fig. 1. Moorland in the process of conversion to dairy pasture in Trøndelag (right), with unconverted moorland (left) (Photo: Rob Burton, 2019).

Fig. 2. Location of the studied in Norway