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Food, farmers, and the future: Investigating prospects of increased food production within a national context

1. Introduction

1.1. Background and research problem

The international food crises of 2008 and 2011 were followed by a shift in national discourses and policies regarding agriculture and production (Almås and Campbell, 2012; Marsh, 2010). Umbrella terms such as "neoproductivism" (e.g. Evans, 2013; Wilson and Burton, 2015) were proposed to describe the shift, and "sustainable intensification" was launched as prescription for future agricultural development (e.g. Wezel et al., 2015). The change in rhetoric and prescriptions has been linked to a number of factors, such as global population growth, climate change, biofuel production, and shifting food consumption patterns in developing countries (Schneider et al., 2011). The rhetorical and political shift implies a transition from multifunctionality and production control to a focus on production and production increase. Recent policy tendencies in the direction of increased nationalism and protectionism globally strengthen the need to study the possibilities and challenges of increased food production within national contexts.[1]

First, despite the buzz-word "sustainable intensification", the sustainability of many productivist strategies has been questioned (Fish et al., 2013; Lawrence et al., 2013; Marsh, 2010; Rosin, 2013; Tomlinson, 2013; Wirsenius et al., 2010). Second, it has become clear that the new productivism is not necessarily neo-liberal and market-oriented. There are multiple forms of new productivism (Evans, 2013; Wilson and Burton, 2015). In addition to market-

[1] Salient examples from 2016 are Brexit in the UK and the election of Donald Trump as US president.

oriented tendencies, we may observe "cooperative neo-productivism" (Burton and Wilson, 2012) and "repositioned neo-productivism" that include elements from multifunctional agriculture (Bjørkhaug et al. (2012). All these terms suggest intensified land use, although it is not clear how the intensification will take place. Most seriously, we do not know to what extent new discourses and national goals on food production, food security, and intensified agriculture actually lead to growth in food production. This is the key question addressed in this article.

Exploring the driving forces for increased production and the factors that hinder it is not straightforward. Neither rhetorical changes nor political shifts translate directly into agricultural output. Farmers are the primary agents who implement new agricultural practices. Therefore, in order to know to what extent new discourses on food security and intensified agriculture lead to growth in food production, we must study farmers' responses to these shifts and aggregate outputs over time. Furthermore, the forces that facilitate and hinder agricultural changes differ across the globe. In addition to specific agricultural conditions and markets for foodstuffs, general factors such as labor markets, welfare systems, and other economic conditions are likely to be influential. Food security and land use result from farmers' actions, which are situated in a broader political economy. Understanding the strategies of British farmers, for instance, offers little guidance to comprehending Spanish agriculture; and knowing the conditions of dairy farmers does not explain grain production in the same country. Context is critical when analyzing agriculture and the prospects for change.

On this basis, we elaborate a way to analyze increased food production that takes into consideration the agricultural environment, the political economy of various agricultural production systems, and national and regional contexts. As a plausibility probe we have chosen Norway. Norway is a particularly interesting and demanding case in this respect

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because of the multifunctional and pluriactive character of its farming. In Norway, as in most other developed countries, various branches of agriculture differ markedly in terms of resource and labor use, market conditions, and integration in the wider economy.

This paper assesses the prospects for increased agriculture-based food production within a high-income country where the conditions for agriculture are somewhat marginal. Why has production increased or not increased? To achieve this purpose, we seek answers to these research questions:

1. How has agricultural production on the aggregate level and in specific production systems developed in Norway since 2000?
2. On the farm level, what strategies do farmers have in various production systems? How do they evaluate the prospects for increased production and the importance of various production factors as drivers and as obstacles to expansion?
3. How do the findings compare to other countries with more or less similar economic and political contexts?

Hence, the *empirical* study addresses a set of specific cases within Norwegian agriculture. The combination of rather challenging agricultural conditions and a politically relatively protected agricultural sector within a well-functioning liberal capitalist economy is directly comparable to relatively few other countries around the globe. *Theoretically* and *methodologically*, however, the study is relevant for any country or region where domestic agriculture plays some role in securing food for the population.[2]

[2] This study is most easily transferable to countries with political, economic and agricultural conditions that are similar to Norway's. Based on international statistics, such countries are Switzerland, Iceland, Korea, Japan, Austria, and Finland. Source: http://data.worldbank.org. Typically, these countries export only small amounts of agricultural products and the state offers a relatively high degree of support to agriculture. Source: https://data.oecd.org/agriculture.htm. It must be noted, however, that well over 100 countries have less arable land per capita than Norway (0.15 ha/person), among them many EU countries.

1.2. The Norwegian context

In Norway, domestic agricultural products contribute about 45 percent of the food consumed by the country's approximately 5 million inhabitants.[3] In 2012 the Parliament approved, as a part of a new agricultural policy, a goal of a 20 percent increase in agricultural food production by 2030 to keep up with population growth. This was the main element in the government's new goals for food security (Meld. St. 9, 2011-2012). Other goals were 1) agriculture across the whole country, 2) increased value creation, and 3) sustainable agriculture. While most of the policy goals differed only slightly from previous policies, a concrete goal of 20 percent increase was new. The practical application of the goal was reduced by a precondition that there should be sufficient demand in the domestic market. Moreover, no explicit changes in policy instruments to reach the goal was adopted. Yet, by holding up increased production as a political goal, the discourse changed from problems of overproduction to problems of food security. Thus, with reference to rising international demand for food, Norwegian policymakers adopted neo-productivist lines of thought (Tønnessen et al., 2014). The new conservative government taking office in 2013 confirmed in 2016 the goal of increased production, however without an exact percentage for the increase. The new government emphasize cost efficient production as a goal and have shifted subsidies to benefit larger farms (Meld. St. 11, 2016-2017), and thereby even more pushed policy in neo-productivist direction.

[3] The remaining 55% of foodstuffs are supplied by imports (53%) and fish (2%) (Helsedirektoratet, 2015).

A recent study has shown that the agronomic potential for increased food production in Norway is between 10 and 20 percent under unchanged consumption patterns (Arnoldussen et al., 2014). As we will show, this potential is far from being realized.

Over a long period, the number of active farmers has declined by around 3 percent annually (Forbord et al., 2014) and labor productivity has risen correspondingly (Budsjettnemnda for jordbruket, 2015). Similar developments have taken place in other advanced economies. Yet farmers' strategic choices must be understood within their specific contexts, and Norway is not an average case. Less than four percent of Norway's land is suitable for agricultural use (Kartverket, 2015; Statistics Norway, 2015b). In many parts of the country much of the agricultural land is steep and scattered. In 2012, the total agricultural land constituted 1.1 million hectares, of which about 1.0 million hectares (88 percent) were in use (Arnoldussen et al., 2014). The country's northern location means that the productivity of agricultural land is lower than in zones that are more temperate. Internationally, Norwegian agriculture is of limited significance. Nationally, the agricultural sector is small: agriculture makes up around 0.4 percent of GNP, and 2.7 percent of the labor force works in agriculture. The economy is to large extent based on ample access to fossil fuel and hydropower energy, and its unemployment rate is low. In sum, Norway is a wealthy welfare state with abundant energy and capital but a scarcity of agricultural land and available labor. Moreover, during the 1990s Norway (along with the EU and other countries) changed its agricultural policy in the direction of dampening traditional agricultural production and reducing subsidies, emphasizing alternative production, special foods, and strong environmental regulation.

1.3. Theoretical approach

Numerous studies have focused on the on-farm factors that influence farmers' production preferences and practices. The approaches span agronomic to economic, structural, and cultural features. A combination of agronomic and management variables are shown to affect agricultural efficiency, sustainability, and performance (Bell et al., 2014; Dogliotti et al., 2014; Hansson, 2007; Kelly et al., 2012). Moreover, structural features, such as the size of fields and the distance between fields, as well as ownership of land, clearly matter (Demetriou et al., 2012; Forbord et al., 2014; Jabarin and Epplin, 1994; van Dijk, 2003).

Looking beyond the agronomic conditions, Bradshaw (2004) found output specialization to be a feature of productivism, while output diversification characterized post-productivism, and concluded that farmers specialize for reasons other than government subsidies. Gorton et al. (2008) showed that farmers retain a productivist mindset regardless of the orientation of agricultural policy. Other research has demonstrated that mindsets and cultural orientations influence farmers' agricultural behavior (e.g. Burton, 2004; Burton et al., 2008).

The wider political economic context can be expected to affect agricultural production on farms. In political economic terms, pluriactivity and farm diversification may be significant because they create economic, cultural, and social links between agriculture and the political economy outside agriculture (for an early literature review, see Salter and Diehl (1940). Even though there are studies showing that factors such as regional labour markets and linkages with the regional economy heavily impact agricultural change (e.g. Eikeland and Lie, 1999; Knickel, 1997), most European and Norwegian studies have concentrated on factors internal to the agricultural sector. Pluriactivity is a key feature of farm families in Norway; most have additional income either from off-farm work or from diversified activities related to the farm (Vik and McElwee, 2011). In a study of the development of the Norwegian fishery sector that

follows the push-pull line of Fuguitt's (1959) reasoning, Johnsen and Vik (2013) found that the general development of the welfare state was important for individual decisions to leave fishing, as well as for structural developments in the fisheries. There is reason to believe that a similar logic applies to agriculture.

Thus, to understand the complexities of agricultural developments it is necessary to use an approach that combines on-farm factors with factors related to societal and economic factors outside agriculture. Farmers' decisions about agricultural operations need to be analyzed in the context of macro-level phenomena, such as sectoral developments, labor markets, and the welfare state. Classic political economy contributions, such as Weingast and Wittman (2006) analysis of the availability and utilization of basic factors of production such as land, labor, and capital are useful in order to understand how the agricultural sector develops and connects to changes in the broader society. Such an approach acknowledges the interconnectedness of economy and politics in agricultural developments (Stilwell, 2012). Thus, in addressing a relative rare agricultural case, our article presents a study with wider applications in terms of its approach and logic.

2. Methods and data

2.1. Methods

The broad societal connectedness of agriculture as well as its multifunctional characteristics suggests that a multitude of factors influences food production. Therefore we chose a mixed method combining quantitative and qualitative data from various sources (Bryman, 2004). The types of data we used are: i) aggregated, national-level statistics on agricultural production output; ii) a national representative survey of farmers; and iii) in-depth interviews with a selection of farmers. To capture how various contexts influenced farmers,

we differentiated four production systems: a) milk production; b) grass-based meat production; c) combined pig and grain production; and d) grain production. In the Norwegian context, the systems are typically located in different parts of the country. In addition to varying in their inputs and outputs, these production systems also vary in terms of their centrality, connections to labor markets, market situations, and policy measures. Taken together, these four production systems contribute 80 percent of the food and nearly all of the feed produced in Norwegian agriculture (Budsjettnemnda for jordbruket, 2015). The four systems gave us a common framework for analysis across types of data[4] and a structure for exploring the significance of the political economy in which agricultural food production is embedded.

2.2. Data

First, the study presents time series data on national level over the years 2000–2015 for the main categories of food and feed. Because the information that is readily available from public sources is fragmented and not always comparable, we had to compile data from various sources: Statistics Norway (2015a), Norske Felleskjøp (2016), and Budsjettnemnda for jordbruket (2015). In order to aggregate and compare the various products, we made new calculations using conversion parameters from mass to nutritional content in terms of energy; those for food are derived from Helsedirektoratet (2015)[5], and those for feed from Norsk

[4] The study was carried out within a cross-disciplinary project (Agropro) that researched ways to sustainably increase food production through enhanced agronomic practices. The four production systems constituted a general approach for the whole project. Source: http://www.bioforsk.no/ikbViewer/page/prosjekt/hovedtema?p_dimension_id=97437&p_menu_id=97449&p_sub_id=97437&p_dim2=97438

[5] The totals for the annual aggregate agricultural production of food (Figure 1) were controlled and verified in e-mail on 20 October 2015 by Mads Svennerud, the person responsible for public statistics on food production at the Norwegian Institute of Bioeconomy Research (NIBIO).

landbruksrådgivning (2015). We measured both food and feed in Terajoule (TJ).[6] In order to detect underlying patterns and trends we applied two analytical tools: linear regression (Ringdal, 2007), and grouping in four-year sub-periods (Nilsen, 1998).

Second, we used quantitative data from a survey of Norwegian farmers in 2014. Our data come from the 2014 version of a large biennial survey, "Trends in Norwegian agriculture". The survey maps key developments in Norwegian agriculture and concerns personal characteristics, productions, plans, attitudes, and motives of the farmers. In 2014, the survey consisted of answers from 1737 farmers. The response rate was 44.6 per cent. The survey has been shown to be representative of the farmer population in Norway (Storstad and Rønning, 2014).

In our analyses, we selected farmers whose operations corresponded to these four production systems. For each system, we addressed two questions: 1) farmers' assessments of future production on the farm; and 2) farmers' opinions on how the factors of land, labor, and capital influenced their likelihood to increase production. For capital we built on three statements reflecting different aspects of capital: technical (machinery, equipment, buildings), financial (operating capital and credit), and knowledge (immaterial capital). In addition, we included a question regarding what the farmers thought they could gain from increased production in terms of profitability.

Third, in order to develop a deeper understanding of the rationales behind, and context for, farmers' production strategies and plans we conducted personal interviews with three farmers in each of the four production systems. We selected the farms by first analyzing municipal statistics on agricultural production and choosing one municipality to represent each

[6] One TJ equals 10^3 gigajoule (GJ), which equals 10^6 megajoule (MJ), which equals 10^9 kilojoule (kJ). The average daily consumption of food per inhabitant in Norway in 2014 was 11.600 kJ (2800 kcal).

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production system.[7] Next, we contacted the agricultural authorities in the municipality, informed them about the purpose of the project and asked if they could find 6-8 farmers that could be willing to be interviewed. We requested farmers in different age groups and parts of the municipality. We then chose three farms on the list and contacted the farmers, asking to visit and interview them, preferably with both partners on the farm and, if members of two generations farmed together, with both generations (see details in Table 1). As can be seen from Table 1, we did not succeed in recruiting full-time farmers with grain only. This is simply because such farmers hardly exist in Norway. Either grain farmers combine grain growing with another occupation (such as farmer D1) or with other agricultural productions (like farmers D2 and D3). That notwithstanding, farmers D2 and D3 have considerably larger areas of grain than the farmers in the combined pig & grain system (C). We based the interviews on a semi-structured guide we developed for this study. Each interview lasted 60–90 minutes and was carried out between November 2014 and March 2015. The interviews were transcribed and the texts coded and analyzed in NVivo10. In Table 1, we present background data for the 12 farms. We refer to the informants by using the code for the production system (A-D) with the farm number (1–3). For example, A2 is the second farmer in the production system "milk".

Table 1: Key characteristics of interviewed farmers in the four production systems

Produc-tion system	Farm #	Production on the farm	Time devoted to farming	Agricul-tural land used (owned + rented)	Animals	Milk production quota (1000 liters) (owned + rented)	Age category

[7] These municipalities and production systems were located in different regions: milk: western Norway; grass-based meat: northern Norway; pig and grain: mid-Norway; grain: southeastern Norway.

A= Milk	1**	Milk	Full-time	42 (10+32)	Around 40 milking cows	400 (100 + 300)	Young (<40) Old (60+)
A	2	Milk	Part-time	33 (9+24)	Around 50 milking cows	490 (130 + 360)	Young (<40)
A	3**	Milk	Full-time	58 + pasture	Around 70 milking cows	700 (550 + 150)	Young (<40) Old (60+)
B= Grass-based meat production	1	Sheep	Full-time	30 (15+15) + pasture	200 ewes	-	Middle aged (40–59)
B	2*	Sheep	Part-time	43 (3+40) + pasture	110 ewes 20 calves	-	Middle aged (40–59)
B	3	Cows	Part-time	75 (0+75) + pasture	40 suckler cows	-	Middle aged (40–59)
C= Combined pig and grain	1*	Pigs + grain	Part-time	33 (20+13)	1400 slaughter pigs	-	Young (<40)
C	2*	Pigs + grain	Full-time	15 (15+0)	60 sows, 1200 slaughter pigs	-	Young (<40)
C	3*	Pigs + grain	Full-time	39 (39+0)	60 sows, 1400 slaughter pigs	-	Middle aged (40–59)
D= Grain	1*	Grain	Part-time	38 (38+0)	-	-	Young (<40)
D	2	Grain Pigs	Full-time	120 (120+0)	2100 slaughter pigs	-	Old (60+)
D	3*	Grain Turkeys	Full-time	97 (76+21)	Up to 30,000 turkeys	-	Middle aged (40–59)

* Couple
** Two generations

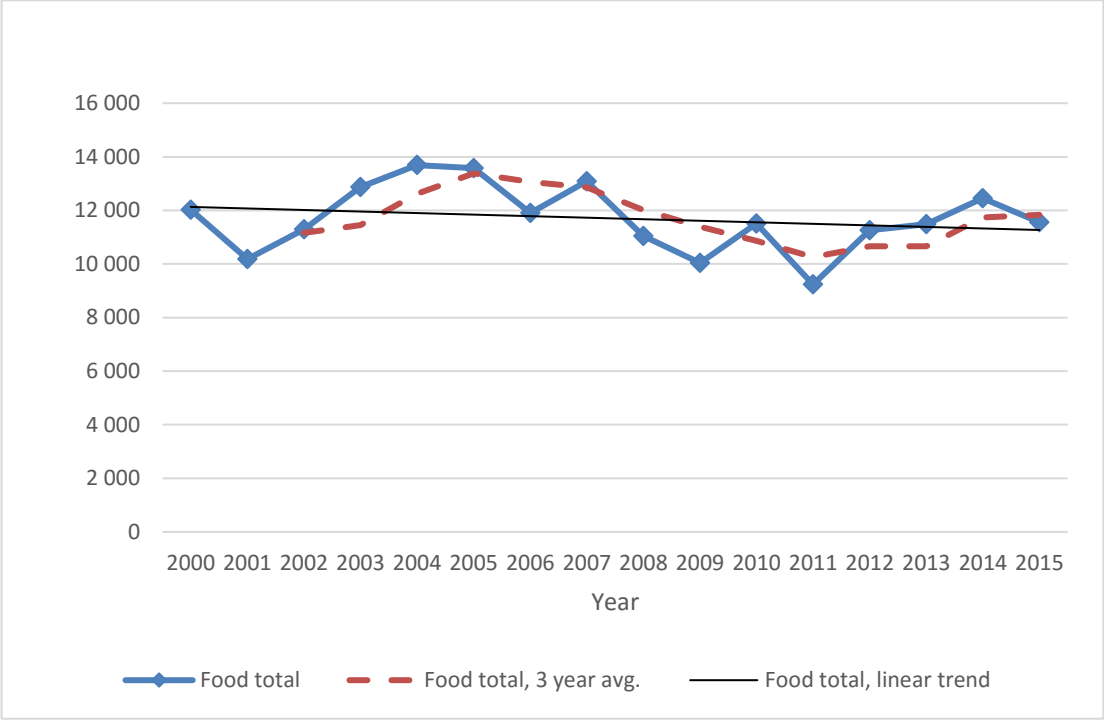
3. Results

3.1. Food and feed production

Food security is a multifaceted concept and may be analyzed on different levels and from the demand side (see, e.g., Richards et al., 2016) as well as the supply side; the study focuses only on supply. We start with Figure 1, which shows the aggregated production of food from

agriculture in Norway for the years 2000–2015 measured in Terajoule (TJ). We present the data in three ways. The solid line corresponds to the actual data. The straight line indicates the long-term *trend* (linear regression), while the stippled line shows the three-year *moving average.*

Figure 1. Annual agricultural production of food in Norway 2000–2015



The solid line shows that total annual food production over the 16-year period varied between 9000 and 14,000 TJ, with an average slightly below 12,000 TJ. The linear trend line shows that there was a long-term slight downward trend in total food production of nearly 1000 TJ, which corresponds to around a 0.5 percent annual decrease. Moreover, the stippled line indicates that there was a wave-like pattern in total food production.

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The overall trends in agricultural food production hide some important differences that are revealed in Table 2.

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Table 2: Agricultural production of food and feed in Norway 2000–2015: Energy content (TJ)

	Produced output in Terajoule (TJ)											
	Food								**Feed**			
	Milk 1)	**Meat, cattle and sheep 2)**	**Meat, pigs 2)**	**Grain for food 3)**	**Potatoes 2)**	**Fruits and vegetables 2)**	**Meat, poultry 2)**	**Food, total *****	**Grain for feed** 3)**	**Harvested grass (dry matter)* 2)**	**Green fodder crops (dry matter) 2)**	**Feed, total**
Production system	**Milk (A)**	**Ruminant meat (B)**	**Grain & pigs (C)**	**Grain + pigs (C); Grain (D)**	-	-	-		**Grain & pigs (C); Grain (D)**	**Milk (A); Ruminant meat (B)**	**Milk (A); Ruminant meat (B)**	
Share of food or feed production	**40 %**	**7 %**	**10 %**	**28 %**	9 %	2 %	4 %	**100 %**	**26 %**	**66 %**	**8 %**	**100 %**
Annual average	**4696**	**816**	**1148**	**3257**	1047	282	454	**11709**	**11987**	**30396**	**3424**	**45806**
Standard.deviation	**1 %**	**4 %**	**9 %**	**39 %**	10 %	5 %	30 %	**11 %**	**12 %**	**6 %**	**57 %**	**9 %**
2000-2003	**4724**	**835**	**1013**	**3325**	-	-	-	**11591**	**12156**	**31467**	**6187**	**49810**
2004-2007	**4699**	**839**	**1107**	**4685**	-	-	-	**13065**	**11475**	**30128**	**3239**	**44841**
2008-2011	**4648**	**812**	**1217**	**1948**	-	-	-	**10454**	**12815**	**29192**	**2227**	**44234**
2012-2015	**4712**	**781**	**1255**	**3069**	-	-	-	**11688**	**11501**	**30795**	**2042**	**44338**

* Except pasture. ** Except oil and protein seeds. *** Except eggs (annual production around 390 TJ (about 3 % of total agricultural food production).

Sources: 1) Budsjettnemnda for jordbruket (2015), 2) Statistics Norway (2015a), 3) Norske Felleskjøp (2016).

Table 2 shows that the four production systems we have studied represent about 85 percent of total domestic agricultural food production in Norway; the other three food production systems make up 15 percent. The first row shows that the average annual total production of food was 11,709 TJ. Two of the four core products, milk and grain, contributed 68 percent of the total, while meat production from ruminants contributed 7 percent and another 10 percent came from pigs.

There are substantial differences between products when it comes to annual variations. Milk production was very stable, while food grain varied substantially from year to year. The production of grass-based meat varied less. By grouping the time-series data into four-year sub-periods, we see more details: i) milk production exhibited a slight downward trend in the first three periods and an upward trend in the last period; ii) ruminant meat production had a small downturn in the last two periods; iii) pig meat production experienced a steady upward trend over the whole period; and iv) food grain production varied considerably between periods. Since food grain constituted a significant proportion of total food production, this variation explains the wave-like pattern in total food production shown in Figure 1. The fluctuations for food grain can mainly be explained by shifting weather conditions leading to significant variations in both yields and quality (Helsedirektoratet, 2015).[8] The right hand side of Table 2, which shows figures for three main categories of feed production, indicates that there was a small downward trend over the period as a whole.[9]

[8] The classification of grain for food depends on starch quality and protein content (Norske Felleskjøp, 2016), which are both affected by weather conditions, choice of species, and fertilization. Norway's climatic conditions mean that food grain production is vulnerable. When the portion of food grain decreases, however, feed grain production tends to increase.

[9] Grass from pasture is not included in the figures for feed. Production of feed on pastures has increased since 2000 due to conversion of marginal arable land into pasture (Arnoldussen et al., 2014).

In conclusion, we can say that the long-term trend in aggregate production over the entire period was a small decrease both for food and for feed. That decline appears to have stopped after 2012. However, it is too early to conclude that this represents a new trend. What we can say is that the significant differences between production systems indicate that explanations should not be sought on the general level. Rather, to be able to explain the observed patterns and assess future possibilities, we need to analyze the developments in each production system.

3.2. The milk production system (A)

Dairy production is central to Norwegian agriculture. Milk production alone made up 40 percent of food production in the period 2012–2015. Dairy production, together with most grass-based meat production, is located outside central Norway where the best agricultural land is located. Rather, it is found in marginal areas, in mountainous areas, along the coast line, and in the north. This pattern is a core element of the so called "canalization policy" that stems back to the 1950s (Almås 2004). The underlying idea was that to ensure enough production of meat, milk, and grain, it was necessary to ensure that land resources were used optimally. The policy aimed, above all, to avoid using the only areas that were suitable for producing grain for the production of milk and meat, which were relegated to marginal areas. This policy was implemented through quotas, region-specific support schemes, and transport subsidies. So grain production is located in the best agricultural areas in southeastern and central Norway, while grass-based animal production is located on the periphery.

Over the last decade a rapid structural development of the dairy sector has taken place (see e.g. Almås and Vik, 2015). Automated milking systems, together with relaxations of production restrictions, have led to increased scale, efficiency, and concentration. There are

still quota regulations, but a dairy farmer may now increase production up to 900,000 liters of milk annually by renting or buying milk quotas. If the farmer needs more land s/he may rent or buy available land in the region. On a systemic level, quotas may not be sold or rented outside of fixed quota regions, keeping the regional distribution relatively fixed. The farmer-owned dairy cooperative Tine SA is responsible for regulating overall production. If production exceeds the demand, Tine may lower production limits. Thus, although the overall production of milk has been relatively stable over time, the production system has become significantly more dynamic. Since most dairy production takes place outside the best agricultural areas, however, farmland is not always optimal for increased production. The canalization policy implies that dairy farms often are located where there are few well-paying job opportunities within and outside the agricultural sector. Available labor may also be short in supply, as these areas are sparsely populated.

Table 3 presents the plans of dairy farmers. The largest group (45 percent) foresee no change in production; more than a third (36 percent) expect to increase production, while one fifth (19 percent) think they will decrease or quit production.

Table 3. Farmers' assessment of future development in production: Milk

Production system	**Production**	**N**	**How do you foresee development in production? Percent**			
			Increase	No change	Decrease	Quit production
Milk	Milk production	588	36	45	4	15

Source: Centre for Rural Research, Trend-survey 2014.

Farmers' choices are influenced by a multitude of factors. In order to understand what dairy farmers themselves see as restricting their ability to increase production, we asked them

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to indicate the degree of their agreement or disagreement with a set of statements about possible limitations. The results are presented in Table 4.

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Table 4. Farmers' assessment of factors influencing increased production: Milk

Factor	Statement	N	Percentage					
			Completely agree	Partly agree	Neither/ nor	Partly disagree	Completely disagree	P-value 1)
Land	"I lack access to farmland to be able to increase production"	581	24	24	17	11	24	.391
Labor	"I will not increase production because I cannot work more than I do"	589	28	21	18	12	21	.703
Capital	"I lack required machinery and equipment to increase production"	577	6	9	14	21	50	.022*
	"I do not want to increase production because I lack access to credit/loans"	579	6	7	13	17	57	.234
	"I lack required knowledge to increase production"	577	3	2	9	23	63	.002**
Profit-ability	"Increased production will not be profitable on my farm"	584	10	14	20	20	36	.142

1) In relation to rest of sample. * Significant on 5 % level ** Significant on 1 % level
Source: Centre for Rural Research, Trend-survey 2014.

Dairy farmers regard lack of access to labor and land as the two main factors that restrict increases in production: almost half (49 percent) completely or partly agree that access to labor is a limitation, and the same proportion (48 percent) holds that opinion about access to land. One fourth (24 percent) think that increasing production would not be profitable. Dairy farmers see other factors as less important (15 percent identify lack of machinery, 13 percent identify lack of credit, and 5 percent identify lack of knowledge as limiting factors). To understand the reasoning behind these answers, we turn to the interviews with dairy farmers.

In milk production, land is important in order to produce coarse fodder and dispose of manure. To some degree, however, capital in the form of concentrated feed or more fertilizer may be substituted for land. Farmers who have invested in automatic milking systems (AMS) and new barns use significant amounts of feed concentrates. Farmer A1 said that cost was an important reason, as feed concentrates "are relatively cheaper per feed unit." But he and the

other two milk producers saw this as a situation they wanted to escape. Farmer A1 explained: "I got an offer to rent more milk quota and lease more land", so increasing production "has in a way come easily". Yet he did not plan for further growth; rather, his strategy for improving the operation was to produce more of his own, high quality fodder to replace some of the concentrated feed he had to purchase. He thought that competition for decent farmland and the amount of labor required to grow fodder led farmers to use concentrates. Farmer A2 shared this opinion: "Much land is not in use because it is laborious". This farmer said that he could raise more grass by renting neighboring farms. Farmer A3's strategy was to fertilize his existing fields more heavily in order to obtain higher yields of grass.

These dairy farmers had quite different patterns of labor. Two were full-time farmers, while the third (A2) operated a quarry as well. This business influenced his priorities: "I am not seeking honors from the dairy company. I have a pragmatic approach. […] Rather, I forego 100,000 NOK in milk production to gain a couple of million from the other business." Farmer A1, a young unmarried man who worked alongside his father on the farm, had a different attitude. He proudly showed us that he was among those farmers with the highest production per cow. He had worked hard for this result: "Some farmers choose to invest little and work more in order to have more money left for private life. I prefer to spend less money privately and have a nice time at work". He had invested heavily, in both capital and labor, to build a modern production unit with AMS. Neither of the two full-time farmers was motivated to make such heavy capital investments by a wish to work less. As farmer A3 said, "Thinking that investing in a robot will eliminate work is stillborn. Without work you do not obtain results."

Labor is short in supply for these milk producers. Although two of them run the farm together with the older generation, other family members do not take an active part in the

work. "Hiring local people here is very difficult. Some larger farms have hired foreign workers, though," said farmer A1. For the farmers we spoke with, it seemed that the natural limit in terms of labor was what they (and, in some cases, their older relative or partner) could find time for, given the available technology. Investments were always an option, but hiring foreign workers was not a step they would willingly take.

Milk production is capital intensive. All the milk producers we interviewed had invested heavily in technology such as AMS, automated feeding systems, and harvesting equipment for fodder (bales and/or silage). These technological changes had been accompanied by increases in production, not simply because they facilitated it, but also because they made it financially imperative. Milk production became less dependent on available agricultural land. Thus, making the operation more capital intensive led to more efficient use of land *and* labor. Two preconditions were necessary. First, they all had access to capital by obtaining credit from their local banks and through national investment schemes. They also used non-farm sources of income in periods of heavy investment. Second, political changes in the regulation of the dairy sector made expansion permissible. The balance of labor, capital, and land use is the result of political choices as well as socioeconomic reasoning.

3.3. The grass-based meat production system (B)

In Norway, grass-based meat comes mainly from cattle and sheep (ruminants). Most ruminant meat production, like milk production, takes place in the more marginal agricultural areas. In contrast to milk production, however, ruminant meat production is labor extensive and has low profit margins. Consequently, most meat producers hold jobs outside agriculture. Production is not regulated through quotas; rather, the level of support varies with regional

location and farm size. The farmers' cooperative Nortura SA, which is responsible for regulating meat production, does so through a target price system, quotas and fees on imports.

In recent years, in response to an observed undersupply of lamb as well as beef, the government has stimulated increased production through greater support for investment in large farm buildings and the reduction or partial removal of ceilings on support for animals and land. Table 5 shows how grass-based meat producers foresee future production on their farm.

Table 5. Farmers' assessment of future development in production: Grass-based meat

Production system	**Production**	**N**	**How do you foresee development in production? Percent**			
			Increase	No change	Decrease	Quit production
Grass-based meat	Cattle	766	30	53	8	9
	Sheep	830	28	54	10	8

Source: Centre for Rural Research, Trend-survey 2014.

The plans of these two groups of farmers have rather similar distributions: about two-fifths of cattle and sheep producers (30 percent and 28 percent respectively) foresee an increase, while about one-sixth of cattle and sheep producers (17 percent and 18 percent respectively) foresee reducing or quitting production. Just over half of those in both groups foresee no change. Thus, around 70 percent of farmers who produce grass-based meat do not expect to increase production.

To get a better grasp of what lies behind these expectations, we analyzed their responses to a set of statements about factors limiting increased production; the results are presented in Table 6.

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Table 6. Farmers' assessment of factors influencing increased production: Grass-based meat

Factor	Statement	N	To what extent do you agree with the statement? Percent					
			Completely agree	Partly agree	Neither/ nor	Partly disagree	Completely disagree	**P-value 1**
Land	"I lack access to farmland to be able to increase production"	1356	22	22	17	14	25	.004**
Labor	"I will not increase production because I cannot work more than I do"	1377	29	22	18	11	20	.192
Capital	"I lack required machinery and equipment to increase production"	1349	6	11	17	21	45	.005**
	"I do not want to increase production because I lack access to credit/loans"	1336	6	6	11	16	61	.2
	"I lack required knowledge to increase production"	1340	2	4	9	22	63	.000**
Profit-ability	"Increased production will not be profitable on my farm"	1352	11	15	22	18	34	.049*

1) In relation to rest of sample. * Significant on 5 % level ** Significant on 1 % level
Source: Centre for Rural Research, Trend-survey 2014.

For farmers who produce grass-based meat, as for dairy farmers, lack of access to more land and labor are most critical in limiting production: half (51 percent) view a lack of labor as restricting, and a substantial proportion (44 percent) view a shortage of land as limiting. Lack of access to financing or knowledge is rarely seen as a hindrance. Half (52 percent) of them think that increasing production would be profitable. Let us take a more detailed look at how grass-based meat producers are affected by these various factors.

Access to grassland is critical for this production system. In the municipality in northern Norway where the grass-based meat producers we interviewed are located, most agricultural land is in use. According to Farmer B2, "The outfield grassland here is fantastic." Farmer B1 has increased sheep production gradually since she started farming. The main factor, she said, "is the [outfield] grassland. Because of that I have capacity [to produce]."

In Norway, there is a long indoor feeding season, so farmers need land for the production of winter forage. The distance from those fields to the farmstead is important. Farmer B1 stated that, despite the abundant outfield grassland, "Neither I nor my husband is interested in driving for miles after forage." B2, a sheep farmer who had expanded over 30 years by renting and improving land, experienced similar challenges. His parcels of land were scattered over a huge area, requiring a great deal of transport. Even though he is sometimes offered more land, he stated: "I feel that I am at the [upper] limit when it comes to land." For him, the limitation pertains not to the land itself but rather to his own labor capacity. Farmer B3 runs a farm with suckler cows. He said: "When you have 25 km to 10 hectares there and 25 km to 10 hectares there, then . . . I spend some work hours on the road rather than on the farmland . . . So land is perhaps the biggest uncertainty factor." He did not expect to increase his herd of suckler cows further. The scattering of the many plots he utilizes is the key problem: "I do not have time. [. . .] I cannot hire 30 farmers to look after the 30 parcels that I rent." Thus, in regions where agricultural land is scarce and geographically dispersed, pressure is put on labor as well.

For the sheep farmers, despite abundant grazing land in the mountains, the predator situation makes the land there less attractive. Farmer B2 explained how it reduced his motivation: "For us, if we lose 10–12 sheep a year, that is not a big problem. However, if we lose 40–50 sheep a year, then it is over. [. . .] We do not farm in order to make our animals suffer." Even though abundant outfield grassland is available, which is quite typical of many marginal agricultural regions in Norway, its scattered location of land and the carnivore situation make usable land a scarce resource.

The households of the farmers who produced grass-fed meat were more pluriactive than those of the dairy farmers we interviewed. Farmer B1 took care of the farm and the kids while

her husband worked full time in the public sector. On farm B2, both partners held off-farm jobs. Farmer B3 worked part time as a machine entrepreneur. In this region, the public sector is the major employer, but small towns also offer job opportunities in the private sector. As in milk production, meat production is rewarding. But labor is a scarce resource. As farmer B1 put it: "I am a total control freak. 200 sheep I can manage myself. 300 . . . then I need help. And this help does not exist. [Moreover] I will not drive full speed economically. [. . .] I am looking for a nice harmony."

While the dairy farmers had a lot to say about technology, the farmers who produced grass-fed meat were less concerned about technology. Farmer B2 mentioned the choice of sheep breeds and cooperation among farmers to increase the availability and lower the cost of machinery and equipment. Farmer B1 cited technological improvement as a motivation for farming and wanted to expand the barn and thus production, but both the limits of her labor capacity and the problems with utilizing mountain grazing because of predators made her dubious concerning future expansion. In contrast to the dairy farmers, none of these farmers considered increasing production through using feed that is more concentrated. None of the grass-fed meat producers mentioned lack of access to credit as a limiting factor.

3.4. The combined pig and grain production system (C)

Grain production can conveniently be combined with other activities on or off the farm. One common combination, especially in mid-Norway, is pigs and grain. Farmers may raise piglets and fatten pigs, or just fatten pigs. Table 7 shows how farmers who combine pig and grain production see future developments in these two operations. Three out of five (60 percent) foresee no increase or decrease in either product. Regarding grain production, these farmers regard the prospects rather favorably: one third (33 percent) foresee an increase, only

7 percent plan on a reduction, and none expects to quit. Regarding pig production, in contrast, one fifth (21 percent) foresee increasing it, while one sixth (17 percent) expect to reduce or terminate it.

Table 7. Farmers' assessment of future development in production: Combined pig and grain

Production system	**Production**	**N**	**How do you foresee development in the production? Percent**			
			Increase	No change	Decrease	Quit production
Pig & grain	Pig	58	21	62	9	8
	Grain	54	33	59	7	0

Source: Centre for Rural Research, Trend-survey 2014.

Table 8 shows how farmers combining pig and grain production see the factors limiting increased production.

Table 8. Farmers' assessment of factors influencing increased production: Combined pigs and grain

Factor	**Statement**	**N**	**To what extent do you agree with the statement? Percent**					
			Completely agree	Partly agree	Neither nor	Partly disagree	Completely disagree	**P-value 1)**
Land	"I lack access to farmland to be able to increase production"	59	20	27	5	15	32	.112
Labor	"I will not increase production because I cannot work more than I do"	60	12	31	27	15	15	.018*
Capital	"I lack required machinery and equipment to increase production"	60	2	3	8	25	62	.014*
	"I do not want to increase production because I lack access to credit/loans"	61	5	3	8	26	58	.412
	"I lack required knowledge to increase production"	61	2	5	11	18	64	.888

Profit-ability	"Increased production will not be profitable on my farm"	61	7	5	20	29	39	.040*

1) In relation to rest of sample. * Significant on 5 % level ** Significant on 1 % level
Source: Centre for Rural Research, Trend-survey 2014.

Very few of these farmers see lack of access to machinery, credit, or knowledge as a limitation. Regarding land and labor, there is a rather even distribution between those who see them as limiting factors and those who do not. Perhaps this pattern reflects the fact that grain production depends heavily on land, while pig production, especially raising piglets, is labor intensive. Very few of the farmers view lack of profitability as a hindrance to increased production.

For farmers with combined grain and livestock production, land has an extended function. As farmer C3 put it: "You cannot escape the fact that land matters. I could well double pig production, but at some point that would be in disproportion to the available land". Land is necessary to dispose of the manure from livestock, both due to regulations and necessity. Farmer C2 had solved this problem by cooperating with a neighboring grain farmer who spread all the manure and, in return for the labor, used the surplus on his own farm. Another neighboring farmer emptied chicken manure into the manure storage, resulting in improved fertilizer. All three farmers who combined grain and pig production tried to increase the productivity of their land through such measures as improved drainage and better agronomy. Their situations with regard to land differed, however. Farmers C1 and C2 were both young and expanding their operations, but C1 had options to lease more land in his area, while all the available land in C2's area was already rented out. In contrast, C3, an older farmer, was satisfied with the amount of land he utilized, all of which he owned.

These farmers had expanded or planned to expand production because they saw this as necessary for survival as farmers. As farmer C1 said: "To farm properly today, it must be

industrial farming". But he warned against becoming too big, because then one can lose control. Farmer C3 commented that they had had a hired worker on the farm until the late 1970s, and when this worker retired, they no longer had enough labor to continue diversified production and decided to specialize in pigs and grain. He (the husband) then said: "There are farmers around here that expand their production through hiring labor in order to obtain more time off. To me that seems rather meaningless. [. . .] But clearly, over the recent years more foreign labor has come to this district. Most of them work on dairy farms and in vegetable production."

For the combined grain and pig farmers, livestock production requires more capital investment than grain production. The couple on farm C2 experienced a much more family friendly labor situation after investing in a new barn with automatic feeding. They no longer have to feed the pigs manually every morning and afternoon. As the wife, who works full-time on the farm and has the responsibility for the pigs said: "Now, I can work when the kids are at school, and be with them in the afternoon". Moreover, they were able to double their pig production, and the pigs grew much faster in the new barn than in the old barn. So this capital investment has led to both increased production and decreased labor, improving the farmers' quality of life.

3.5. The grain production system (D)

Grain production in Norway takes place mostly in the southeastern low land, where much of the best arable land is located. However, grain production at the scale that is normal in Norway is usually combined with off-farm work or other operations on the farm, even though these farms are among the largest in the country. Moreover, as we have seen in the statistics on food and feed production (shown in Table 2, section 3.1), grain yields are unpredictable

and vary a great deal from year to year. Consequently, the availability of employment opportunities is crucial. Fortunately, for historical reasons most grain-producing areas are located near Norway's largest and most attractive labor markets.

As Table 9 shows, most grain farmers (70 percent) foresee no change, while more of them (19 percent) expect to increase than to reduce or terminate production (13 percent). Despite the large fluctuations in yields, grain farming seems to be relatively stable compared with any form of livestock production.

Table 9. Farmers' assessment of future development in production: Grain

Production system	**Production**	**N**	**How do you foresee development in the production? Percent**			
			Increase	No change	Decrease	Quit production
Grain	Grain	688	19	68	10	3

Source: Centre for Rural Research, Trend-survey 2014

In the specialized grain production system, lack of access to land and labor are regarded as the most limiting factors: a slight majority (53 percent) agree completely or partly that lack of land is limiting, while just under half (48 percent) see lack of access to labor as a limitation. The labor requirements for grain production vary seasonally, with a substantial concentration of work during spring and autumn. Since these farmers normally work outside the farm, they cannot do much more labor themselves. Lack of access to capital and knowledge was seen as important by only a few. Although a majority (53 percent) of grain farmers view increased production as profitable, only a minority (19 percent) expect to increase production. Thus, lack of profitability alone is a poor explanation for the failure to increase grain production.

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Table 10. Farmers' assessment of factors influencing increased production: Grain

Factor	Statement	N	To what extent do you agree with the statement? Percent					
			Completely agree	Partly agree	Neither/ nor	Partly disagree	Completely disagree	P-value 1
Land	"I lack access to farmland to be able to increase production"	696	27	26	15	13	19	.002**
Labor	"I will not increase production because I cannot work more than I do"	701	22	26	18	15	19	.000**
Capital	"I lack required machinery and equipment to increase production"	696	7	12	12	23	46	.007**
	"I do not want to increase production because I lack access to credit/loans"	696	6	5	10	20	59	.137
	"I lack required knowledge to increase production"	694	3	7	15	26	49	.000**
Profit-ability	"Increased production will not be profitable on my farm"	697	11	12	24	21	32	.007**

1) In relation to rest of sample. * Significant on 5 % level ** Significant on 1 % level
Source: Centre for Rural Research, Trend-survey 2014.

For grain farmers, large parcels of relatively flat land with straight edges allow for efficiency in planting and harvest. Modern grain production demands a quality of land that is found only in a few places in Norway. Such land is expensive to rent or buy, while land that is more marginal is cheap but inconvenient, especially for food grain production. Fragmentation of parcels adds to the problem. As farmer D3 emphasized: "If the question is access to more farmland, my main interest is to establish a functional farming unit around here. I cannot think of driving 20 km to operate an extra 20–30 hectares". The grain farmers could be interested in operating more land, but not if the price was too high or its location made operating it cumbersome. In consequence, the grain farmers we spoke with had a sharp focus on improving yields through drainage and crop rotation. "Obtaining high yields has always been my goal," said farmer D2; he grew several types of grain in order to reduce weather-related risks.

From the interviews, we learned that these farmers were continually considering whether they should work off the farm or, alternatively, run the farm full time by adding other specialized operations. Farmer D1 worked full time off the farm, as did his partner, but they had flexible jobs so they could put in the necessary hours during the busy seasons. The husband cooperated with a neighbor in the use of machinery, which increased his capacity. Farmer D2, who operated a very large farm in Norwegian terms and cultivated both conventional grain and special seed grain, was skeptical about having another occupation in addition to farming: "I think that would be hectic. I think it would reduce the quality of some farming operations". Farmer D3, who had a much smaller farming unit, combined grain production with raising turkeys and some off-farm activities. All three grain farmers were highly conscious of how much work they invested on and off the farm, and the balance they struck was closely connected to the amount of land they operated.

For the grain farmers, technological issues for the most part concerned machinery and its financing. Farmers D1 and D3 both cooperated on machinery with their neighbors and regarded this solution as very important. Farmer D1 had made heavy investments in both buildings and machinery that were financed partly through credit; farm borrowing was, in effect, subsidized by off-farm labor, which is seen as normal across production systems. Farmer D2, who had a larger farm, had put great effort into draining his land and purchased his own machines. He pointed to the ease of operating machinery: "The combines today, you push a button, and then they set themselves".

4. Discussion

All forms of agricultural production require land, labor, and capital. Access to agricultural land is crucial, and lack of access to suitable land is one of the two most important barriers

that farmers identify to increasing production. The farmers we interviewed were not especially short of land for their current operations, however. The history of their farms varied, but several farmers stated that the opportunity to buy or rent more land had been crucial to their farm's previous growth. Since this connection has also been found in previous studies (Storm et al., 2015), we calculated the correlation between farm size (the amount of all agricultural land operated by the farmer) and the farmer's assessment of his or her farm's future development.[10]

Table 11. Correlation between amount of farmland and farmers' assessment of future development in production(s)

Production system	Production	N	Future development in production in relation to farm size (land) (Pearson Correlation)
Milk	Milk production	668	.242**
Grass-based meat	Cattle	820	.182**
	Sheep	873	.159**
Pigs & grain	Pigs	194	.124
Grain	Grain	742	.244**

** Significant on 1 % level.
Source: Centre for Rural Research, Trend-survey 2014; see Storstad and Rønning (2014).

For four of the five products, there are significant correlations between farm size and the farmer's plans to increase, continue, decrease, or quit production. The correlations are strongest for milk production and grain production (.242 and .244 respectively).[11] For cattle and sheep production, the correlation is weaker, but still significant. For pig production there is no significant correlation. These findings make sense, in that pig production is not dependent on fodder produced on the farm, while the other four products are directly

[10] Note that correlations for the combined pig and grain production have been calculated separately and not within the combination ("pig & grain" system).
[11] Correlations can be in the interval -1 to 1. A coefficient of 1 (or -1) means total (perfect) correlation.

dependent on the farm's agricultural land. Yet for all five products, the correlation coefficient is far below 1, which indicates that many other factors also influence farmers' plans for future production.

In the quantitative data, inadequate access to labor was the factor that most farmers emphasized as a hindrance to increased production. On a macro level, this limitation is to be expected in an oil-dependent, high-income welfare state such as Norway. Labor is costly, and during the process of industrialization and urbanization the rural districts supplied both industry and the growing public sector with labor, while technological innovations increased labor productivity in agriculture (see e.g. Almås, 2004; Almås, 2009). The micro-level experience of recruiting, retaining, and deploying labor in farming however, requires more consideration.

Labor as a factor of production is not necessarily about financial costs. Significantly, the farmers we interviewed hardly ever addressed the direct cost of labor. Hiring labor was not a topic of direct concern. The implications of both labor costs and labor scarcity are visible indirectly, however. Paid labor is one thing, but family labor is another, and the quality of family life matters to Norwegian farmers. Even in the modern economy of 2015, the dual logic of labor costs resembles Amartya Sen's (1966) findings. The fact that farmers have reached the limit of the labor they can do themselves does not mean that they look for labor to hire. Indeed, one reason why farmers do not want to increase production is that they fear losing control by delegating the work to others and being dependent on others.

Most Norwegian farmers are pluriactive or have diversified their agricultural activities. Therefore the household economy and labor situation are complex. For some, agriculture does not come out on top in a cost-benefit analysis. Most of the farmers we interviewed held that farm work paid off, though. The picture that emerges from the interviews is that most farmers

see labor through the lens of the "family farm". Within this frame, the optimal amount of labor is the labor the farmer and to some degree, the farm family can manage by themselves. The volume of production reaches a barrier when farmers approach the ceiling of available family labor.

To a large degree, the development of modern agriculture and land use is characterized by the systematic replacement of labor by capital—that is, by purchased inputs and technology. The survey shows that capital in its various forms rarely constitutes a hindrance to increasing production in the Norwegian context. Most of the farmers had up-to-date machinery for transportation, working on the land, and operations in the barn. For Norwegian farmers, investment in technology is necessary in order to complete operations within a short window of opportunity during the growing season. Climatic conditions make the speed with which outdoor tasks can be performed crucial. Farmers need quite a lot of machinery in order to manage planting and harvesting within the available time.

High levels of mechanization in the barn are also widespread. For instance, all the milk producers we interviewed had installed automated milking systems operated by robots, as well as automated feeding systems. This change had been accompanied by an increase in production on these farms, which was due partly to the new barn's capacity and partly to the greater use of concentrated feed. More intensive feeding, in turn, facilitated milking the cows more often than twice per day. Indeed, automated milking and feeding is so expensive that substantially increased production is financially imperative. Milk production becomes more capital intensive, less dependent on available agricultural land in the locality, and more efficient in utilizing labor. In an economy with relatively abundant access to capital and scarcities of both suitable labor and agricultural land, such farming strategies makes sense. Moreover, the capital costs of investment and expansion in agriculture in the Norwegian

political and economic context are subsidized through off-farm work, either the farmer's own or the partner's own work or the parents' off-farm income. Therefore, off-farm employment is crucial to the question of increasing production as well as stabilizing income. Without the self-subsidizing from off-farm work, many farms would not be able to increase production or renew their means of production.

The observed pattern of farmers' responses confirms the general picture of the Norwegian agricultural economy. Labor is expensive, and agricultural land is scarce and scattered. When we include machinery, credit, and knowledge in the more general category of capital, the overall picture is clear: capital is *not* experienced as a serious barrier to increased food production on farm level in the present situation, while many farmers experience access to adequate supplies of land and labor as hindrances. At the same time, the survey reveals important differences among farmers' viewpoints, since only two thirds of them agree with these statements concerning land and labor. There are important regional differences in the quality and use of agricultural land (Arnoldussen et al., 2014; Forbord and Vik, 2014). In productive areas, increases in production are limited because nearly all agricultural land is in use. In marginal areas it is difficult to increase production because the available agricultural land is less adequate (Forbord et al., 2014).

What can this investigation of a specific case tell us about the possibilities for increasing agricultural production? We have focused our study on farm-level factors that apply to any type of agriculture around the globe. In the specific context of Norway, we have identified structural shortages of land and labor as critical barriers. If increased production were achieved through utilizing more land and more labor, this would have to be supplied from sources that are *external* to existing farms, through a net increase in the quantity of agricultural land (for example, by bringing more land under cultivation) and in the supply of

labor. There *was* a considerable influx of foreign labor to Norwegian agriculture (especially in the fruit and vegetable sectors) after the liberalization of European labor markets in 2005 (Holm, 2012). As we have shown (Table 2), however, this extra labor has not resulted in significant increases in production. Some new land has been brought into cultivation in Norway since 2000 (Grønlund, 2015), but an equivalent amount of farmland has been converted to other purposes (such as public infrastructure), so the net supply of agricultural land has remained unchanged.

Hence, somewhat paradoxically, the most relevant opportunity to increase agricultural production in a political and economic setting such as Norway seems to be found in capital, the factor that few farmers experience as a barrier. On individual farms, the more intensive use of capital may increase the productivity of both land and labor. In fact, one of the most salient characteristics of the modernization of agriculture has been the replacement of labor by various forms of capital. In the period we have studied since 2000, Norwegian farmers have invested heavily in machinery and equipment, raising productivity, but without any increase in the aggregate output of food. During the period from 1970 to 2000, however, the development of new varieties of wheat adapted for climatic conditions in Norway led to increases in both productivity and production. From a situation with almost no production of food grain early in the 1970s,[12] production increased to an average of nearly 3000 TJ annually over the next 30 years (Bjørnstad, 2010), and now (as shown in section 3.1) contributes nearly 30 per cent to the total domestic food supply in an average year. Better agronomic knowledge and practices (immaterial capital) and the cultivation of more oil seeds and protein crops (Arnoldussen et al., 2014) could also contribute to increased production (Bioforsk, 2013).

[12] Unpublished statistics by Anne Kjersti Uhlen, Norwegian University of Life Sciences, 2016.

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Moreover, the fastest growing agricultural product in Norway in recent years has been chicken. Production has more than doubled since the 1990s, based to large extent on automation technology and breeding, much of which is supplied from abroad (Vik and Bjørkhaug, 2015).

5. Conclusion

Focusing on the farm level and individual productions is important, but not sufficient to understand the range of possibilities for enhanced food production. In addition to research and development, policy regimes and market demand influence the amount of food farmers produce. Food production is one of several goals in agricultural policy in many high-income countries, not only in Norway (Meld. St. 11, 2016-2017) but also in the EU (European Commission, 2010). Within a state budget, optimizing food production can reduce the possibility of attaining other policy goals, such as environmental conservation, value creation, and local community development (Rosin, 2013). Reserving the market for domestic food production is also challenging in a small, open economy as Norway, where foreign trade is crucial. The state can facilitate the creation of a domestic market for some products, as Norway has been doing for food grain (Forbord, 2015; Norske Felleskjøp, 2008). In addition, high quality domestic products may be preferred in the domestic market (Schermer, 2006).

Nevertheless, neither the international commodity price shocks in 2008 and 2011 nor the consequent adoption of a national goal of increased food production in 2012 ha led to a significant increase in agricultural food production in Norway. The Norwegian case resembles the trend in another small, high-income nation, New Zealand, but with the opposite sign. In New Zealand the price shocks *did not* change the prevailing productivist tendency in the

pastoral farming sector towards less intensive land use (Rosin, 2013). In Norway, the same shocks *did not* trigger a change in the opposite direction, from less towards more intensive agriculture. In both cases, the lack of change can be attributed to the integrative forces of prevailing political regimes and agricultural practices. These have a tendency to be path dependent, requiring rather strong measures to be altered. In the Norwegian case, the use of policy instruments has been too weak for the new goal to be achieved. Given the tight connections between the agricultural sector and the rest of the society on both micro and macro levels, ranging from family labor preferences to public policy and economic systems, we may well doubt whether the radical goal of 20 per cent increase in food production will ever be reached. More realistically, the goal may lead to *some* increase in the production of *some* commodities where the market demand is sufficient and suits domestic products: at the moment, in food grains, certain vegetables, ruminant meat, and pigs' meat. Moreover, there are potentials to increase yields and quality of coarse fodder, leading to an increase in the proportion of domestic fodder in the livestock productions (Simonsen, undated). However, even if the 20 per cent goal should be attained, Norway would still have to rely on significant imports of various foods.

References

Almås, R., Ed. (2004). *Norwegian Agricultural History*. Trondheim: Tapir academic press.

Almås, R. (2009). Landbrukspolitikk i Grues tid in A. Hompland *I Grues tid: Festskrift til Per Harald Grue*. Oslo: Tun forlag**:** 16-89.

Almås, R. and H. Campbell (2012). Introduction: Emerging challenges, new policy frameworks and the resilience of agriculture. in R. Almås and H. Campbell *Rethinking agricultural regimes. Food security, climate change and the future resilience of global agriculture. Research in Rural Sociology and Development*. Bingley, UK: Emerald. **18:** 1-22.

Almås, R. and J. Vik (2015). Strukturelle og institusjonelle endringsprosesser i den norske melkesektoren. in H. Bjørkhaug, R. Almås and J. Vik *Norsk matmakt i endring*. Bergen: Fagbokforlaget 267-286.

Arnoldussen, A. H., M. Forbord, A. Grønlund, M. E. Hillestad, K. Mittenzwei, I. Pettersen and T. Tufte (2014). *Økt matproduksjon på norske arealer. Rapport 6-2014*. Oslo: AgriAnalyse.

Bell, L. W., A. D. Moore and J. A. Kirkegaard (2014). "Evolution in crop–livestock integration systems that improve farm productivity and environmental performance in Australia". *European Journal of Agronomy* **57**(July): 10-20.

Bioforsk (2013). *Økt norsk kornproduksjon. Utfordringer og tiltak. Rapport fra ekspertgruppe oppnevnt av Landbruks- og matdepartementet*. Ås.

Bjørkhaug, H., R. Almås and J. Brobakk (2012). Emerging neo-productivist agriculture as an approach to food security and climate change in Norway. in R. Almås and H. Campbell *Rethinking agricultural regimes. Food security, climate change and the future resilience of global agriculture. Research in Rural Sociology and Development*. UK: Emerald. **18:** 211-234.

Bjørnstad, Å. (2010). *Vårt daglege brød. Kornets kulturhistorie*. Ås: Vidarforlaget AS.

Bradshaw, B. (2004). "Plus c'est la même chose? Questioning crop diversification as a response to agricultural deregulation in Saskatchewan, Canada". *Journal of Rural Studies* **20**(1): 35-48.

Bryman, A. (2004). *Social research methods*. Oxford: Oxford University Press.

Budsjettnemnda for jordbruket (2015). "Totalkalkylen for jordbruket." Retrieved 17.12, from http://nilf.no/statistikk/totalkalkylen/2015/BMgrupper/Totalkalkylen-gruppeoversikt.

Burton, R. J. F. (2004). "Seeing through the 'good farmer's' eyes: Towards developing an understanding of the social symbolic value of 'productivist' behaviour". *Sociologia Ruralis* **44**(2): 195-215.

Burton, R. J. F., C. Kuczera and G. Schwarz (2008). "Exploring farmers' cultural resistance to voluntary agri-environmental schemes". *Sociologia Ruralis* **48**(1): 16-37.

Burton, R. J. F. and G. A. Wilson (2012). The rejuvenation of productivist agriculture: the case for 'cooperative neo-productivism'. in R. Almås and H. Campbell *Rethinking agricultural regimes. Food security, climate change and the future resilience of global agriculture. Research in Rural Sociology and Development 18*. Bingley, UK: Emerald Group Publishing Limited. **18:** 51-72.

Demetriou, D., J. Stillwell and L. See (2012). "Land consolidation in Cyprus: Why is an Integrated Planning and Decision Support System required?". *Land Use Policy* **29**(1): 131-142.

Dogliotti, S., M. C. García, S. Peluffo, J. P. Dieste, A. J. Pedemonte, G. F. Bacigalupe, M. Scarlato, F. Alliaume, J. Alvarez, M. Chiappe and W. A. H. Rossing (2014). "Co-innovation of family farm systems: A systems approach to sustainable agriculture". *Agricultural Systems* **126**(April 2014): 76-86.

Eikeland, S. and I. Lie (1999). "Pluriactivity in rural Norway". *Journal of Rural Studies* **15**(4): 405-415.

European Commission (2010). *The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future*. Brussels: European Commission.

Evans, N. (2013). "Strawberry fields forever? Conflict over neo-productivist Spanish polytunnel technology in British agriculture". *Land use policy* (35): 61-72.

Fish, R., M. Lobley and M. Winter (2013). "A license to produce? Farmer interpretations of the new food security agenda". *Journal of Rural Studies* **29**(0): 40-49.

Forbord, M. (2015). Utfordringer i norsk kornproduksjon. in H. Bjørkhaug, R. Almås and J. Vik *Norsk matmakt i endring*. Bergen: Fagbokforlaget**:** 339-364.

Forbord, M., H. Bjørkhaug and R. J. F. Burton (2014). "Drivers of change in Norwegian agricultural land control and the emergence of rental farming". *Journal of Rural Studies* **33**(0): 9-19.

Forbord, M. and J. Vik (2014): *Motivation for increased production among Norwegian farmers. Paper in proceedings.* The 11th European International Farming Systems Association (IFSA) Symposium, Berlin, 1-4 April, http://ifsa.boku.ac.at/cms/index.php?id=135#c414.

Fuguitt, G. V. (1959). "Part-Time Farming and the Push-Pull Hypothesis". *American Journal of Sociology* **64**(4): 375-379.

Gorton, M., E. Douarin, S. Davidova and L. Latruffe (2008). "Attitudes to agricultural policy and farming futures in the context of the 2003 CAP reform: A comparison of farmers in selected established and new Member States". *Journal of Rural Studies* **24**(3): 322-336.

Grønlund, A. (2015). *Vurdering av klimatiltak i jordbruket. Beregnet reduksjon av klimagassutslipp av ulike tiltak innen 2050. Rapport nr. 24*. Ås: Bioforsk. **10**.

Hansson, H. (2007). "Strategy factors as drivers and restraints on dairy farm performance: Evidence from Sweden". *Agricultural Systems* **94**(3): 726-737.

Helsedirektoratet (2015). "Matvaretabellen." Retrieved 7.10, from http://www.matvaretabellen.no/.

Holm, F. E. (2012). *Arbeidsinnvandring i landbruket. Trender og utviklingstrekk 2004–2012. Rapport 10/2012*. Trondheim: Norsk senter for bygdeforskning.

Jabarin, A. S. and F. M. Epplin (1994). "Impacts of land fragmentation on the cost of producing wheat in the rain-fed region of northern Jordan". *Agricultural Economics* **11**(2–3): 191-196.

Johnsen, J. P. and J. Vik (2013). "Pushed or pulled? Understanding fishery exit in a welfare society context". *Maritime Studies* **12**(1): 4.

Kartverket (2015). "Arealstatistikk for Norge." Retrieved 21.12, from http://kartverket.no/.

Kelly, E., L. Shalloo, U. Geary, A. Kinsella, F. Thorne and M. Wallace (2012). "The associations of management and demographic factors with technical, allocative and economic efficiency of Irish dairy farms". *The Journal of Agricultural Science* **150**(06): 738-754.

Knickel, K. (1997). "Changes in agricultural production and their potential impact on the development of rural areas". *Quarterly Journal of International Agriculture* **36**(4): 353-378.

Lawrence, G., C. Richards and K. Lyons (2013). "Food security in Australia in an era of neoliberalism, productivism and climate change". *Journal of Rural Studies* **29**(0): 30-39.

Marsh, J. (2010). "Visions and Nightmares - Farm Policy in the 21st Century". *Journal of Farm Management* **13**(11): 765-777.

Meld. St. 9 (2011-2012). *Landbruks- og matpolitikken*. Oslo: Landbruks- og matdepartementet.

Meld. St. 11 (2016-2017). *Endring og utvikling. En fremtidsrettet jordbruksproduksjon*. Oslo: Landbruks- og matdepartementet.

Nilsen, J. E. Ø. (1998). "Teori for tidsserieanalyse." Retrieved 28.9, 2016, from web.nersc.no/~even/doc/tidsanal-art.pdf.

Norsk landbruksrådgivning (2015). "Fagforum Grovfôr." Retrieved 17.11, 2015, from http://www.grovfornett.no/.

Norske Felleskjøp (2008). "Markedsordningen for korn." Retrieved 12.5., 2014, from www.fk.no/Sider/Markedsordningen-for-korn.aspx.

Norske Felleskjøp (2016). "Prognose for tilgang og forbruk av korn i sesongen 2016/2017." Retrieved 22.9., from http://www.fk.no/markedsregulering/prognoser.

Ringdal, K. (2007). *Enhet og mangfold : samfunnsvitenskapelig forskning og kvantitativ metode. 2. utgave*. Bergen: Fagbokforlaget.

Rosin, C. (2013). "Food security and the justification of productivism in New Zealand". *Journal of Rural Studies* **29**(0): 50-58.

Salter, L. A., Jr. and L. F. Diehl (1940). "Part-Time Farming Research". *Journal of Farm Economics* **22**(3): 581-600.

Schermer, M. (2006). Regional development through organic territory: ecoregions in Austria. in G. Holt and M. Reed *Sociological Perspective of Organic Agriculture: From Pioneer to Policy*. CABI**:** 229-244.

Schneider, U. A., P. Havlík, E. Schmid, H. Valin, A. Mosnier, M. Obersteiner, H. Böttcher, R. Skalský, J. Balkovič, T. Sauer and S. Fritz (2011). "Impacts of population growth, economic development, and technical change on global food production and consumption". *Agricultural Systems* **104**(2): 204-215.

Sen, A. K. (1966). "Peasants and Dualism with or without Surplus Labor ". *Journal of Political Economy* **74**(5): 425-450.

Simonsen, H. (undated). "Gode grovfôrresultater i Avlingskampen 2014." Retrieved 28.2., 2017, from http://www.yara.no/gjodsel/Tools-and-Services/gjodselaktuelt/gjodselaktuelt-2015-1/gode-grovforresultater-i-avlingskampen-2014.aspx.

Statistics Norway (2015a). "Topic - Agriculture, forestry, hunting and fishing." Retrieved 7.10, 2015, from https://www.ssb.no/en/jord-skog-jakt-og-fiskeri.

Statistics Norway (2015b). "Topic - Nature and the environment." Retrieved 17.12., 2015, from http://www.ssb.no/en/natur-og-miljo.

Stilwell, F. J. B. (2012). *Political economy: the contest of economic ideas. Third edition*. South Melbourne, Vic.: Oxford University Press.

Storm, H., K. Mittenzwei and T. Heckelei (2015). "Direct Payments, Spatial Competition, and Farm Survival in Norway". *American Journal of Agricultural Economics* **97**(4): 1192-1205.

Storstad, O. and L. Rønning (2014). *Trender i norsk landbruk 2014. Med utviklingstrekk fra 2002 til 2014. Rapport 6 /2014*. Trondheim: Norsk senter for bygdeforskning.

Tomlinson, I. (2013). "Doubling food production to feed the 9 billion: A critical perspective on a key discourse of food security in the UK". *Journal of Rural Studies* **29**(0): 81-90.

Tønnessen, M., A. Syse and K. N. Aase (2014). *Befolkningsframskrivinger 2014-2100: Hovedresultater. Økonomiske analyser 4/2014*. Oslo: Statistisk sentralbyrå.

van Dijk, T. (2003). "Scenarios of Central European land fragmentation". *Land Use Policy* **20**(2): 149-158.

Vik, J. and H. Bjørkhaug (2015). Kyllingens politiske økonomi. in H. Bjørkhaug, R. Almås and J. Vik *Norsk matmakt i endring*. Bergen: Fagbokforlaget**:** 149-174.

Vik, J. and G. McElwee (2011). "Diversification and the Entrepreneurial Motivations of Farmers in Norway". *Journal of Small Business Management* **49**(3): 390-410.

Weingast, B. R. and D. A. Wittman (2006). The Reach of Political Economy. in B. R. Weingast and D. A. Wittman *The Oxford Handbook of Political Economy*. Oxford: Oxford University Press.

Wezel, A., G. Soboksa, S. McClelland, F. Delespesse and A. Boissau (2015). "The blurred boundaries of ecological, sustainable, and agroecological intensification: a review". *Agronomy for Sustainable Development* **35**(4): 1283-1295.

Wilson, G. A. and R. J. F. Burton (2015). "'Neo-productivist' agriculture: Spatio-temporal versus structuralist perspectives". *Journal of Rural Studies* **38**: 52-64.

Wirsenius, S., C. Azar and G. Berndes (2010). "How much land is needed for global food production under scenarios of dietary changes and livestock productivity increases in 2030?". *Agricultural Systems* **103**(9): 621-638.