The European Journal of Plant Science and Biotechnology ©2011 Global Science Books

Norwegian Agriculture: Structure, Research and Policies

Peder Lombnæs* • **Olav Arne Bævre** • **Nils Vagstad**

Norwegian Institute for Agricultural and Environmental Research, Høgskoleveien 7, 1432 Ås, Norway

Corresponding author: * **peder.lombnaes@bioforsk.no**

ABSTRACT

Norway has a land area of 324.000 km^2; 3% of the total land area is cultivated, which constitutes 1 million ha. Agricultural production takes place in all parts of the country under highly variable climatic conditions. Most of the cultivated land is used for grass (65%) and cereal (30%) production. Even if the size of the arable land has been mainly stabile the last decades, there have been a decreasing number of active farmers. The organisation of higher education and applied research in agriculture is divided between universities and research institutes. Bioforsk – the Norwegian Institute for Agricultural and Environmental Research – is a national research institute under the Norwegian Ministry of Agriculture and Food and it is the dominant institute in agricultural research. The main overall areas of competence in Bioforsk are agricultural and environmental research, and innovation based on the utilization of land resources. This includes research and development within (i): Multifunctional and sustainable agriculture including rural development, (ii): Plant science, plant protection and bio-technology, and (iii): Environmental protection and natural resource management. The Norwegian agricultural policy has close relationships with the regional policy, rural development and settlement at the countryside. There has been a long-term goal to maintain agriculture in all parts of the country. The agricultural policy has comprehensive systems of agricultural subsidies with little export and little import of competing agricultural products. Multifunctionality of agriculture is an important part of the Norwegian agricultural policy, emphasizing social and environmental sustainability in the agricultural mode of operation. Food security and rural activities represent the sound basis that has given long-term legitimacy to the agricultural policy.

Keywords: agricultural policies, agricultural research, Norwegian agriculture

AGRICULTURAL STRUCTURE

Geography

Norway is located west on the Scandinavian peninsula from 58 to 71°N, and covers the longitude from 5 to 31°E. The total land area is 324.000 km^2 (excluding Svalbard and Jan Mayen), and the mainland is sharing borders with Sweden, Finland and Russia. Approximately 3% of the total land area is under agriculture production, which constitutes 1 million ha of arable land. A considerable part of the country constitutes of plateaus and mountains (45%), forests (38%), lakes (6%), bogs (6%), and glaciers (1%) (Norwegian Mapping Authority 2010).

The agricultural production is longitudinally spread from South to North, with a wide variation in cultivation practices and production methods. The productive land is also characterised by a wide range of altitudes, i.e. growing crops from sea level to up to mountainous grassland at 500-900 m above sea level. The most productive areas are located in eastern inland and central parts, which consist of continuous plains with sedimentary soil types (Lombnæs and Singh 2003). Some of these areas also have highly fertile calcareous moraine soils with cambro-silur origin. Since the Scandinavian glacier icecap redraws approximately 90000 years ago, the soils of Norway are relatively young and undepleted. Soils of podzolic origin are dominating in Norway (Steinnes *et al*. 2005); therefore, most agricultural soils are falling in the acidic pH range.

Climatic conditions

The climate in Norway includes wide variations in climate parameters between regions. The overall climate is influenced by the North Atlantic Current, which results in temperate climate along the coastline with an average colder interior. The climate varies in a range from nemo-boreal along the south coast to sub-arctic in the mountainous areas and in the north (Arnoldussen 2005). Due to the North Atlantic Current, the average temperature is higher than in other parts of the world at the same latitude, and it is characterised by moderate to high summer temperature and cold winter temperature (Norwegian Meteorological Institute, 2011). Even though the growing seasons are short in northern regions, it is partly compensated for by long days and midnight sun in the northern and arctic areas of Norway.

The precipitation is well distributed in most regions and is characterised with an annual variation from less than 300 mm in eastern and northern valleys to more than 3500 mm in certain locations along the West coast (Norwegian Meteorological Institute 2011). In eastern valleys artificial irrigation is commonly applied, where water is taken from mountain streams.

Midt summer draught is sometimes occurring in all regions limiting crop yields. However just a small part of the total agricultural areas are artificially irrigated, mainly used for vegetable crops, fruits, berries and potatoes. Multiple cropping is not usual, except for intensive vegetable cropping systems.

Agricultural resources

Most of the Norwegian agricultural area is used for grass (65%) and cereal (30%) production (**Table 1**) (Statistics Norway 2010). The cereal species are barley (44%), wheat (27%), oats (26%), rye and triticale (2%) (Statistics Norway 2010). All species except wheat are mainly used as cereal fodder crops (concentrates), while most of the wheat is used for human consumption most years, if the quality is good enough for baking purposes.

The total agricultural land is mainly stable, but with a slight decrease over time and a sharp decrease in number of

Received: 29 October, 2010. Accepted: 12 February, 2011.

Research Note

Table 1 Total arable land in 2009 and distribution among field crop species (Statistics Norway, 2010).

	ha	%
Total arable land	1 011 284	100
Cereals	304 807	30.1
Oilseeds	4 345	0.4
Potatoes	13 765	1.4
Annual crops for feed	11 881	1.2
Vegetables	7 257	0.7
Grass and pastures	656 194	64.9
Other field and horticulture crops	13 036	1.3

stakeholders. In the period from 1979 -2009 there has been a reduction from 125.000 to 48.000 active farming units (Statistics Norway 2010).

The last decades there has been a substantial development in the direction of more efficient production techniques, which has resulted in fewer and more efficient agricultural units. At the same time the total area under crop production has been quite stable. Structural changes in the agricultural policies the last 40-50 years has given an allocation of milk, beef, veal, and sheep production to the areas most suitable for grassland, i.e. humid areas in the west, valleys and mountainous areas not suitable for cereal production. In the same period cereal and vegetable production has been allocated to central east and mid parts of Norway with moderate precipitation levels. Traditionally, mountain diary farming was a normal part of milk production during summer, for utilizing mountainous grass areas. Today this practice is little used, and there is just about 1750 diary farm holders still using that practice, which has been reduced by 38% since 1996 (Gundersen *et al*. 2009).

The Norwegian horticultural production has increased the last years (last update 2008) in spite of fewer producers. The area under production of field grown fruits (2600 ha), berries (2 400 ha) and vegetables (7200 ha) and the greenhouse area is about 220 ha (Statistics Norway 2010). The main fruit crops are apples, plums and sweet cherries produced on the South-West coast (Hardanger/Sogn) and South-East of Norway (Telemark). Strawberries are the dominant berry crop followed by raspberry. The production of both strawberries and raspberries under plastics has increased very fast the last years. The principal field grown vegetable crops are cabbage, carrot, lettuce and onion.

The number of greenhouse establishments has been reduced by a quarter from 1999 to 2006 (Statistics Norway 2010/The Norwegian Horticultural Growers Association 2010) and this trend seems to continue, but on the other hand the greenhouse area and production level have increased. The main greenhouse crops are flowers (cut flowers, flowering pot plants, decorative plants, bedding plants) and vegetables (tomatoes, cucumbers, lettuces) which represent a sale value from producer at about 1.8 billion NOK (2006) (The Norwegian Horticultural Growers Association 2010).

As for greenhouse establishments nurseries producing ornamental plants, fruit trees and berry shrubs has decreased in number but have increased in size. The total area is about 260 ha, which mostly is outdoor area, but also 50 ha container-grown plants and 7.5 ha of greenhouse (The Norwegian Horticultural Growers Association 2010).

ORGANISATION OF EDUCATION AND RESEARCH

The Norwegian research community is, similar to most European countries, divided between universities and independent research institutes. In Norway, the research institutes accounts for about 50% of the total research activities, and cover most scientific disciplines. The institute sector is mainly focused on applied research. A majority of the research institutes are private, non-governmental organisations, organised either as foundations or as shareholder companies. Some institutes are however governmental organisations linked to a specific ministry.

Most of the Norwegian universities have biology study programs which include botany – more or less specialized in genetics, morphology, systematic, cellular- and molecular biology, evolutionary biology, physiology and ecology. The studies yield a valuable competence for many areas including production of plants. The Norwegian University of Life Sciences has both bachelor and master programs in plant science and agroecology related to production of plants for food, fodder and ornamentals, product quality and health aspects, development of green areas for recreation and sport and maintenance of cultural landscape. The studies give a foundation for applying to positions in agriculture and green areas.

Bioforsk – the Norwegian Institute for Agricultural and Environmental Research – is a national research institute under the Norwegian Ministry of Agriculture and Food and it is a dominant institute in applied agricultural research. The institute cooperates closely with The Norwegian University of Life Sciences. The research institute was established in 2006 after merging three former institutes. The main overall areas of competence in Bioforsk are agricultural and environmental research, and innovation based on the utilization of land resources. This includes research and development within (i): Multifunctional and sustainable agriculture including rural development, (ii): Plant science, plant protection and bio-technology, and (iii): Environmental protection and natural resource management.

Bioforsk has a total staff of approximately 450, with an annual turnover of 50 million EURO. The head office is located in Ås, just outside the capital Oslo. The major financial sources come from various research funds, both nationally and internationally e.g. through the European Union. Approximately 55-60% of the budget is based on research contracts and is exposed to market competition, whereas the remaining 40-45% is more or less fixed allocations from the government. The scientific and organisational structure is based on the following 7 research divisions, located in different regions of Norway, which each has the responsibility of the following scientific areas: Arctic Agriculture and Land Use (I), Arable Crops (II), Organic Food and Farming (III), Horticulture and Urban Greening (IV), Grass-land and Landscapes (V), Soil and Environment (VI), and Plant Health and Plant protection (VII).

One major goal for Bioforsk is to have a key role in supporting the development of Norwegian agriculture, in terms of sustainable farming practices and knowledge based policy support for ministries and public agencies. Therefore, Bioforsk maintain research groups that are specialised on all major crops in Norwegian agriculture, – with both food security and food quality as important focal areas. Another clearly stated goal is that Bioforsk should continuously develop international relations and research activities, which is considered necessary in order to secure an international level of competence and research.

AGRICULTURAL POLITICS AND POLITICAL PRIORITIES

The Norwegian agricultural policy has close relationships with the regional policy, the rural development, settlement and work at the countryside. The policy takes into account that there is a close relation between climatic conditions, crop production and livestock. Even there has been a reduction in number of farms, the goal of maintaining the agricultural acreage in all parts of the country has been a long-term political goal in the Norwegian agricultural policy. The agricultural policy has comprehensive systems of agricultural subsidies with little export and little import of competing agricultural products (Bjørkhaug and Richards 2008).

The main objectives of the politics are (Stoltenberg *et al*. 2009): a) to maintain active agriculture throughout the country and b) innovation and increased added value, – and high standard of rural livelihoods based on sustainable management of agriculture and rural resources. To achieve

the main goals there is given a number of specific targets as: 1) safe food, 2) diversity in food products and production – consumer orientation, 3) plant health and animal welfare, 4) sustainable management of resources – soils, cultural landscapes and bio-diversity, 5) agriculture that contributes to employment and vital rural societies, and to spin-off effects into new business opportunity (multi-functionality) and 6) ensure the national food supply, a competitive food industry and an innovative and sustainable production of products and services.

In order to implement agricultural policy the Government and the Farmers Unions negotiate an annual agreement, included both budget and professional activities. The Government combines a direct subsidy payment for crops and land which may be cultivated with price support mechanisms, including guaranteed minimum prices tariffs and quotas on certain goods from abroad. The government has declared a national goal for organic farming: 15% of the total production and consumption of food shall be organic within 2020 (Stoltenberg *et al*. 2009). To achieve this, the government subsidies the organic production more than conventional production.

Challenges for the growers on production and environmental goals

In spite of high subsidy level, increased farm size and high production, the private economy for the farmers and for the farm are important questions. Many farmers leave agriculture and there are questions related to recruiting into agriculture.

1. Organic farming

The total organically cultivated area in Norway is increasing year by year. It was in 2008 constituted of 3.9% of the total productive agricultural area, and the number of holdings with organic farming was 2 700, this constitutes of about 5.5% of the total number of agricultural holdings in Norway. At the same time, only 2.9% of the egg production and 2.1% of milk production were organic. The corresponding figures for mutton/lamb and pork were 2.2 and 0.1%, respectively. The market for organic products has not increased much the last years. The consumers seem to have confidence in the conventional produced food and will not pay higher price for organic.

2. Biological diversity

The government wants to preserve the biological diversity in the agricultural landscape and pay the farmers for taking care of habitats for plants and wild animals. Within the framework of the subsidies, the farmers follow up the local strategy on this area.

3. Cultural landscape

Both for the Norwegian population and for the tourists the cultural landscape is important for the experience. The subsidy payment for agricultural land generally and for particularly valuable areas is an important contribution to prevent overgrowth and taking care of the open agricultural landscape (Mittenzwei *et al*. 2010). Use of grazing animals as cows and sheep are necessary to keep maintenance of the traditional landscaping of the many steep hillsides, especially on the west coast and in the north of Norway.

4. Fertilizer and pesticides

Through environmental programs and payment the farmers are urged to reduce the use of fertilizers and pesticides, and to use manure optimally. The consumption of N-fertilizer has remained at the same level the last 30 years, but in the same period the use of P-fertilizer has decreased about 50%. One fourth of all nitrogen and one half of all phosphorus used in agriculture, comes from manure (measured in nutrient content). The consumption of pesticides is rather stable. Most pesticides are used to control weeds in grain production.

5. Discharges of nutrients to waterways and ocean environment

The EU Water Directive, which Norway is obliged to follow, divides the country into water regions. The main purpose of the directive is to achieve "good conditions" in all waterways, etc. as regards to pollution and ecological conditions. The size of man-made discharges of nutrients – phosphorous and nitrogen – from agricultural activities into the waterways and oceans vary markedly between the different water regions. Agriculture ranks high in relative contribution of discharges in the south-eastern and mid-areas of the country with big rivers through agricultural landscapes. Targeted subsidies are used to achieve less soil erosion by changing tillage methods in cereal production and in that sense reduce water pollution and achieve better soil conservation methods (Lundekvam *et al*. 2003).

6. Emissions into air from agriculture

Agriculture alone accounted for more than half of the total emissions of nitrous oxide (N_2O) in Norway. Emissions derived from manure and commercial fertilizer accounted for 78% of nitrous oxide from agriculture (Gundersen *et al*. 2009). Animal husbandry accounts for almost all emissions of methane (CH_4) in agriculture, and together with waste disposal, it constitutes the main source of emission of methane in Norway. Domestic animals release methane directly from enteric fermentation and indirectly from manure applied to the fields and accounted for 50% of the total emissions of methane in Norway. Around 90% of the emissions originate from different agriculture activities. The emission of greenhouse gases is a serious problem for an animal based agriculture producing fodder crops in a wet and cold area, but today few solutions seems to reduce the intensity of the emission.

FINAL COMMENTS

The growing import of staple foods and meat products represent major challenges for both the farming industry and the food industry in Norway by pressing the prices of domestic agricultural products. Due to the structure of the geographically widespread agriculture, there are challenges in maintaining cost-effective systems for logistics and infrastructure. However, Norwegian agricultural policies has continuously since after world war two, had a political goal and economically incentives to maintain the agricultural production in all geographic regions of Norway. Multifunctionality of agriculture is an important part of the Norwegian agricultural policy (Bjørkhaug and Richards 2008), emphasizing social and environmental sustainability in the agricultural mode of operation. Food security and rural activities are two main reasons that have given long term legitimacy to agricultural policy, to maintain regional food production; mainly out from a food security point of view, and secondly out from the economical value that agricultural products represent, both direct and indirectly for the rural communities.

REFERENCES

Arnoldussen AH (2005) Soil survey in Norway. In: Jones RJA, Houšková B, Bullock P, Montanarella L (Eds) *Soil Resources of Europe* (2nd Edn), European Soil Bureau Research Report No.9, EUR 20559 EN, Office for Official Publications of the European Communities, Luxembourg, pp 257-262

Bjørkhaug H, Richards CA (2008) Multifunctional agriculture in policy and practice? A comparative analysis of Norway and Australia. *Journal of Rural Studies* **24**, 98-111

Gundersen GI, Bye AS, Berge G, Hoem B, Knudtsen SS (2009) *Jordbruk og miljø- Tilstand og utvikling. Statistics Norway.* Available online:

http://www.ssb.no/

Lombnaes P, Singh BR (2003) Predicting Zn and Cu status in cereals – potential for a multiple regression model using soil parameters. *Journal of Agricultural Science* **141**, 349-357

Lundekvam HE, Romstad E, Øygarden L (2003) Agricultural policies in Norway and effects on soil erosion. *Environmental Science and Policy* **6**, 57-67

Mittenzwei K, Lien G, Fjellstad W, Øvren E, Dramstad W (2010) Effect of landscape protection on farm management and farmers income in Norway. *Journal of Environmental Management* **91**, 861-868

Norwegian Mapping Authority (2010) Available online: http://www.statkart.no/

Norwegian Meteorological Institute (2011) The climate of Norway. Available online: http://met.no/

The Norwegian Horticultural Growers Association (2010) Available online: http://www.gartnerforbundet.no/gartnerstatistikk.asp?meny=6

Statistics Norway (2010) Available online: http://www.ssb.no/

Steinnes E, Sjøbakk TE, Donisa C, Brännwall M-L (2005) Quantification of pollutant lead in forest soils. *Soil Science Society of America Journal* **69**, 1399-1404

Stoltenberg J, Halvorsen K, Navarsete LS, Pedersen H, Lysbakken A, Brekk LP, Johansen R, Solhjell BV, Vedum TS (2009) Political platform as basis for the Government's work. 2009-2013. Available online: http://www.regjeringen.no