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Barriers to Organic Agriculture in the Arctic

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Barriers to Organic Agriculture in the Arctic

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Preface

The Agricultural University of Iceland (AUI), with support from the Nordic Council of Ministers, established a Nordic working group in 2014 to identify and describe barriers that restrict the development of agricultural organic production in the arctic regions of the Nordic countries and to suggest solutions or alternative paths that can promote future agriculture in arctic regions. The working group had one intensive workshop in Iceland 16 - 19 November 2014, but continued communication between project members was mostly *via* e-mails.

Agriculture in the arctic zone is unique. It is affected by climate, natural landscape and remoteness to a greater extent than farming in the main agricultural regions in the Nordic countries. Most of the arctic farming is livestock based and extensive, which as a whole has little impact on the surrounding environment. The main products are milk, meat and wool for domestic markets (tourists included) and exports on the side. Horticulture exists but is limited, except in Iceland. Nitrogen emissions to water and air from the use of mineral N fertilizers and manure is considerably less compared to more southern agricultural areas, and the use of pesticides is limited. Therefore, the common perception is that organic farming systems are well suited to lands under the skies of the *aurora borealis*.

The working group on a visit to Neðri Háls, an organic dairy farm in Iceland. From left: Maria Wivstad, Jóhannes Sveinbjörnsson, Þóroddur Sveinsson, Timo Lötjönen, Christian Uhlig and the farmers Dóra Ruf and Kristján Oddsson (November 2014).

Arctic boundaries and terms for this report

Country	Regions
Iceland	All
Norway	Finnmark, Troms, Nordland
Sweden	Norrbotten
Finland	Lapland

Even though Iceland lies south of the Arctic circle it belongs to the Nordic arctic in this context since most of Iceland is north of the 10°Celsius isotherm line in July, and in fact the arctic regions in Norway, Sweden and Finland are all just south of this 10°C line. Iceland is the only country in the world that has substantial agricultural production north of the 10°C line in July.

Clarification of terms

Agriculture is a production system based on solar energy and soil resources, which cultivates crops for food, feed or industrial purposes and breeds livestock for milk, meat, leisure or other useful products. Reindeer farming and wild plant harvesting in undisturbed natural terrains are outside the scope of this report.

Agricultural area (UAA) is any area taken up by arable land for cultivation of annual or perennial crops like roots, potatoes, seed, whole crops and forage for grazing and/or curing.

Holding is an agricultural production unit (a farm), usually a family unit in the Nordic countries

Conventional farming is the common agricultural production system accredited by respective states and/or EU directives regarding human and animal welfare, food production safety, and use of fertilizers, pesticides or GMO's.

Organic farming is an accredited agricultural production system based on principles by IFOAM Organics International and EU regulations. However, the directives or rules for each state may vary between countries. The main distinction between an organic and a conventional system is the prohibition of mineral/industrial fertilizers, synthetic pesticides and use of GMO's.

The Nordic arctic

Land area and population

The land area in these four countries is about 1.3 million km^2, with 0.4 million km^2 in the arctic regions or 33% of the total land area (table 1). In Scandinavia, the arctic region is 22-29% of the total land area but only 2.6-8.0% of the population reside there. This means that the population density is much lower in the arctic or 3 residents compared to 23 residents per km^2 south of the arctic. The total population in the Nordic arctic is approximately 1.2 million.

Table 1. Areas and population in respective countries arctic regions.

	Area, km^2 x 1000			Population x 1000			Density / km^2	
Country	**total**	**arctic**	**%**	**total**	**arctic**	**% arctic**	**total**	**arctic**
Iceland	103	103	100	330	330	100	-	3.2
Norway	386	113	29	5983	480	8.0	20.2	4.2
Sweden	450	100	22	9675	250	2.,6	26.9	2.5
Finland	340	100	29	5440	180	3.,3	21.9	1.8
Total/mean	***1279***	***416***	***33***	***21428***	***1240***	***5.8***	***23.0***	***3.0***

Agricultural land (UAA) as per cent of total area is low in all countries or from 3.3-9.2% south of the arctic and only 0.4-1.2% in the arctic regions (figure 1). It should be noted, however, that naturally vegetated non-forested terrains, that are easily reachable for farms with goats, sheep, horses and cattle are commonly used for grazing, but are not a part of the UAA by definition.

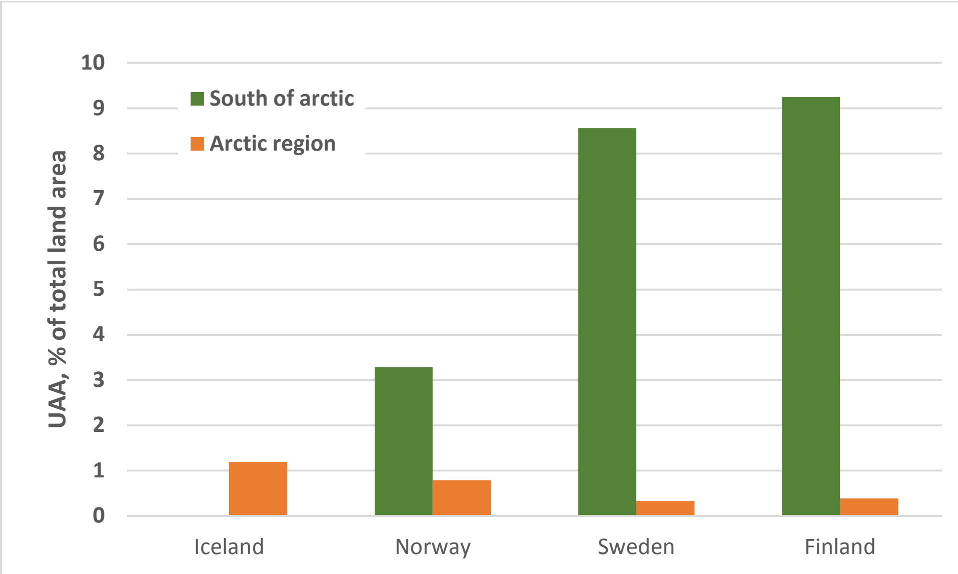


Figure 1. Agricultural area (UAA) as per cent of total land area in the arctic regions and south of the arctic regions in the respective countries. Based on available data from Eurostat and national bureaus of statistics, 2010-2013.

Today's arctic agriculture

Arctic agriculture in all countries is primarily based on family farming with forage cultivation for the farmer's own livestock to produce milk, meat, wool and leisure activities. The grazing season is short, only 3-4 months, and preserved forage is the dominant feed, comprising up to 90% of the annual forage ration. Cereal production is limited in the arctic and starchy rich feed mixtures to boost livestock production are mostly imported to these regions. Sweden is an exception, since approximately 12% of the UAA in the arctic region is used for grain production, mostly spring barley for feed. On conventional farms, mineral fertilizers are used sparingly with animal manure on crops to give optimum yields. Herbicides and pesticides can be used, but other measures to fight weeds and pests are preferred by most farmers.

The share of organic farming in the arctic varies between countries (figure 2). In arctic Scandinavia 3.4 to 4.6% of all farms (holdings) are organic, but this figure is much lower in Iceland where only 1.1% of holdings are organic, with 65% horticultural farmers. On the other hand, organic horticultural farmers hardly exist in arctic Scandinavia. Organic farming in Iceland and Norway has stagnated in recent years, unlike in Sweden and particularly in Finland where organic farming has been on the rise after a recession in the first decade of this century. This has probably been due to more favorable current subsidy programs than in Iceland and Norway.

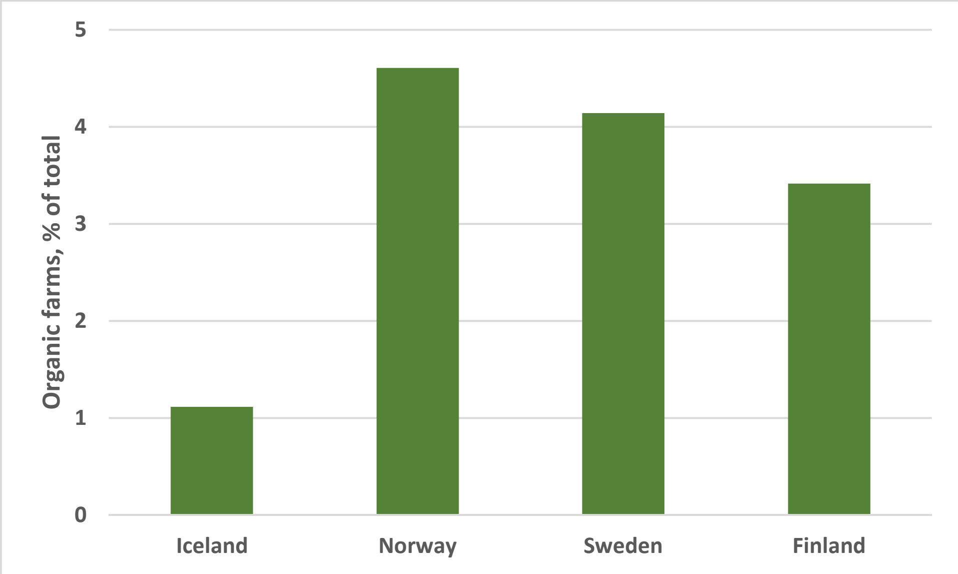


Figure 2. The share of certified organic farms in the arctic regions of the respective countries. Based on available data from Eurostat and national bureaus of statistics, 2015.

The share of organic retail sales in these countries ranges from less than 1% in Iceland and up to 6% in Sweden (Figure 3). Statistics on the share of organic retail sales in Scandinavian arctic regions are not available. The retail sales value of organic food is notably much lower than would be assumed from the share of organic farmland in all countries. This is in part because of lower productivity (per acreage or holding) in the organic systems than in conventional systems, and also that higher shares of the production are comprised of animal products which have higher land requirements.

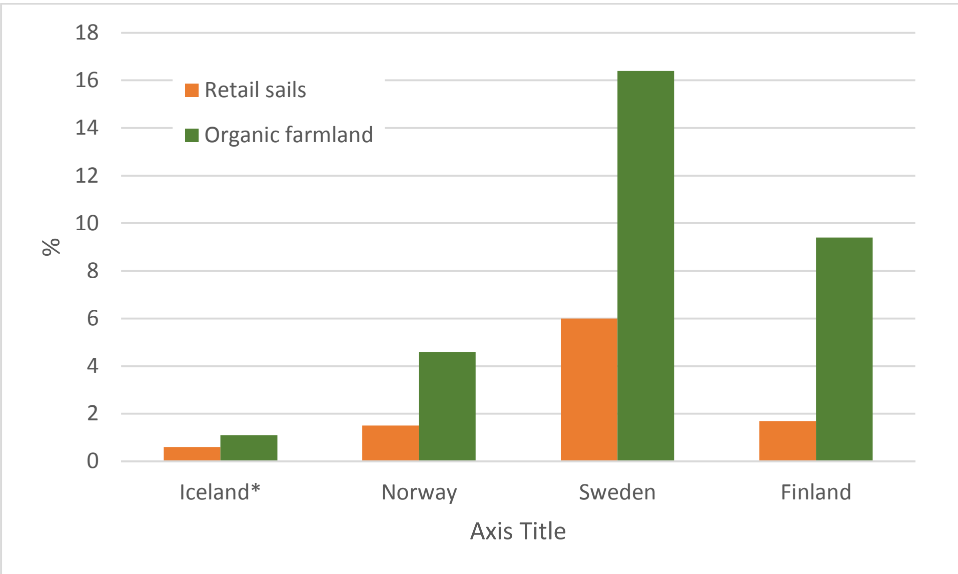


Figure 3. Farmland and market share of organic retail sales in the respective countries, 2014. Source: IFOAM EU Group except for Iceland. *estimate made by the authors of this report.

The average acreage per farm (holding) varies also between countries, regions and production systems (Figure 4). In Iceland, organic farms are much smaller than conventional farms. This is partly because 65% of the organic holdings are based on horticultural production. If these holdings are excluded, the average acreage of organic farms is estimated at approximately 30 ha, which is still substantially lower than for traditional farms in Iceland. Acreage per farm is lowest in all systems and regions in Norway, with organic farms being the smallest. The organic farms in Sweden and Finland are substantially bigger than other farms in the arctic.

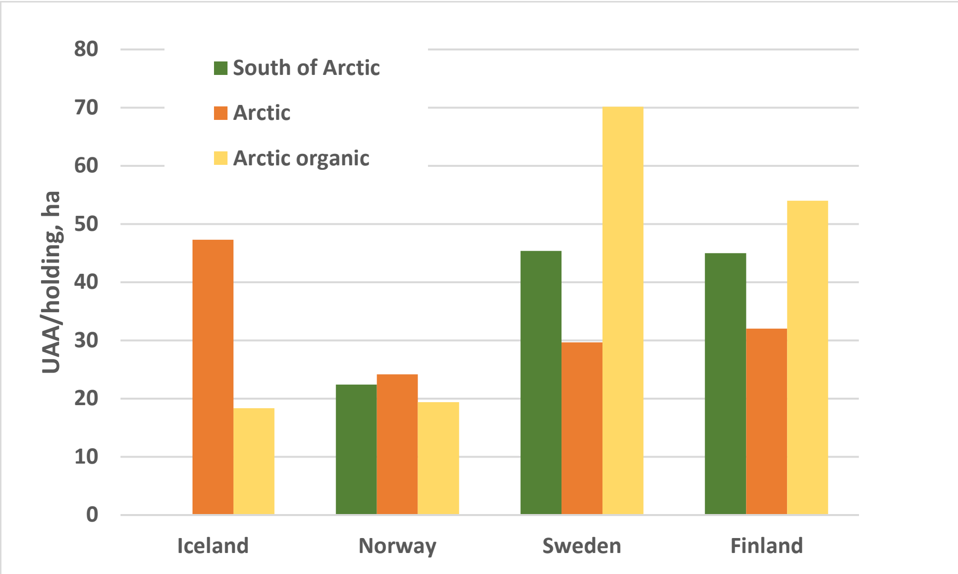


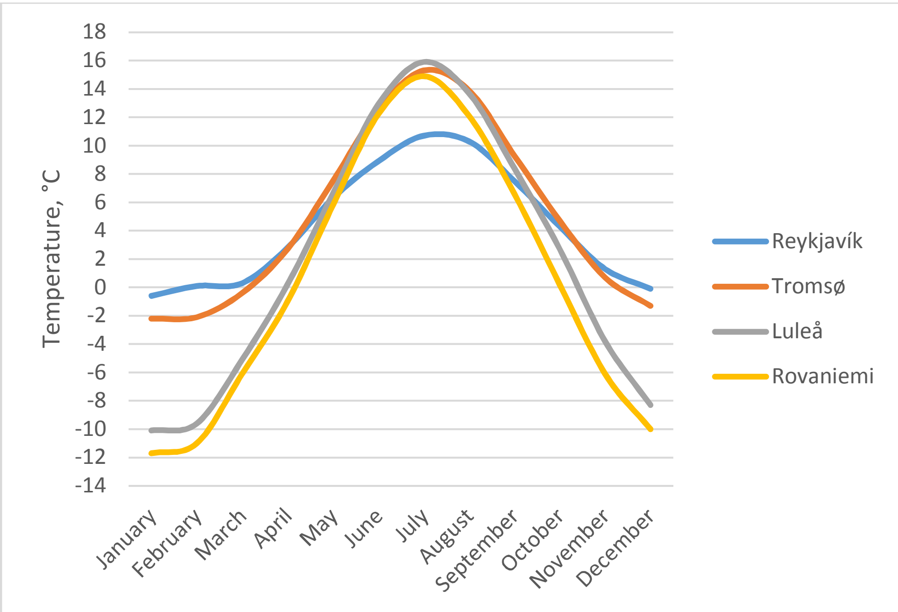
Figure 4. Average acreage per holding in respective countries. Based on available data from Eurostat and national bureaus of statistics, 2015.

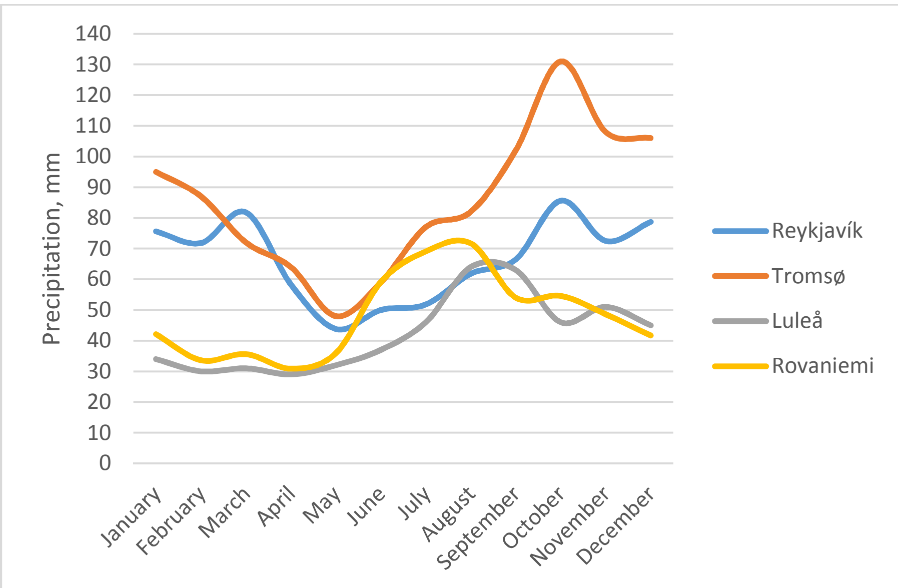
The climate

The arctic in the four countries share many common climatic features but are distinct in others (Table 2). Iceland and coastal Norway have a maritime North Atlantic climate with mild winters compared to the continental cold winters of arctic Sweden and Finland. The maritime areas of Iceland and Norway have much higher precipitation during winter months, falling as either snow or rain, compared to arctic Sweden and Finland that have much less precipitation and which mostly falls as snow (Figures 5). The special climatic feature of Iceland is the distinctively colder growing season than in the other three countries. However, there is a huge temperature and precipitation variation within each country as well (Table 2). This is due to mountainous terrains in all countries which create windward and leeward effects on the local climate. The main agricultural areas and holdings are at low altitudes close to sea level, whereas livestock grazing in natural areas is common at higher altitudes on mountain slopes. The growth period varies within each country depending on location, but also between countries. The growth period is longest in the maritime regions and shortest in the continental regions. Iceland has in general much fewer growing degree days than the other countries in spite of the relatively long growth period. Due to the very high latitude, all countries have extremely long diurnal photoperiods during the growing season, which favor plant growth and counteract low air temperatures in the arctic.

Table 2. Approximate low altitude precipitation, temperatures and growth period ranges in the respective arctic countries.

	Iceland	Norway	Sweden	Finland
Latitude arctic area (°)	63-66	66-70	64-69	65-70
Altitude (m.a.s.)	0-2000	0-1900	0-2000	0-1200
Precipitation (mm)	400-1100	300-2000	600-800	450-700
Mean annual temperature (°C)	2 - 4	1-3	0-2	-2 - +3
Mean temperature in July (°C)	9 - 11	13-10	14-15	13 - 16
Mean temperature in January (°C)	-2 - 0	-4 - - 7	-10 - -14	-9 - -14
Growth period (T>5°C) days	120-160	120-180	120-150	105-140
Growing degree days (GDD, T>5°C)	500-700	600-1100	600-1000	600-1000





Figures 5. Monthly mean temperature and precipitation in the most populated arctic cities in the respective countries, 30-year average (1961-1990).

The climate in the arctic puts more strain on organic farming compared to conventional farming. It is important for crops to initiate growth early in the spring to secure fast growth and good yield because of the short growing season. Mineralization from the soil pool and organic fertilizers (manure/compost) occurs in all seasons but the rate is temperature controlled. This process in the arctic is both slow (due to low temperatures) and harmonizes poorly with the crops' need for nutrients during the growing season. Mineralized nutrients from the soil pool are in too short supply for fast crop growth in the spring. The same applies for N-fixing crops like clovers; the fixation is slow in the spring. Mineral fertilizers applied in the spring can secure fast crop growth in conventional farming systems. Organic systems, on the other hand, are not allowed to use mineral fertilizers and there is no organic certified fertilizer as efficient as mineral fertilizer in that respect. Therefore, the yield levels are substantially lower in the organic system compared to the conventional system. It should also be noted that organic systems are vulnerable to high nutrient losses (leachates and volatiles) from organic and green manure because of misplaced mineralization.

The arctic soils

The arctic soils are post-glacial formations from after the last Ice Age approximately 10000 years ago (Table 3). Large areas of Sweden and Finland are covered by a continuous layer of glacial till dominated by podzols. In Norway the glacial till is thin and discontinuous. Northern Swedish soils developed on parent materials derived from marine and, lake deposits as well as glaciofluvial deposits. In the low-lying coastal areas along the Gulf of Bothnia silty and clayey deposits are common. Smaller areas of sandy glaciofluvial deposits can be found in all three Scandinavian countries.

Parent materials in Icelandic soils are much different than in Scandinavian soils, which gives them unique properties. They are dominated by recent volcanic material, usually consisting of basaltic tephra (andosol). Active eolian processes, frequent tephra depositions, and a sub-arctic maritime climate with frequent freeze-thaw cycles during long winters greatly modify the soils. These soils generally contain a range of pore and particle sizes that can retain large amounts of water but are also very erodible. They are high in organic C and N, and have a strong tendency to fix phosphorus.

Natural arctic soils are important carbon sinks because of restricted mineralization caused by low temperatures and/or anaerobic conditions in wetland areas. These soils are therefore carbon rich and more organic than most other soils at warmer latitudes. Peat covers around 15% of the area in Finland and Sweden and a substantial part in North Norway. In Iceland up to 50% of the agricultural soils are drained histosols or more commonly histic andosols. These usually fertile organic soils are the backbone in many agricultural regions in the arctic. In some smaller areas in Iceland mineral rich geothermal soils are cultivated for outdoor vegetables. Marine and river deposits in fjords and valley bottoms are also important agricultural soils in all countries. A vast part of arctic soils is too rocky or shallow for cultivation in many other inhabited low altitude areas.

Table 3. The arctic soils in the respective countries.

	Iceland	Norway	Sweden	Finland
Soil age, years	<10,000	<10,000	<10,000	<10,000
Geological origin	volcanic, tephra and morainic deposits	marine, glaciofluvial and morainic deposits	marine, lake and glaciofluvial deposits	marine, glaciofluvial and morainic deposits
Dominating texture	sand, silt, clay, organic	sand, organic	sand, clay, organic	sand and organic
Soil types (FAO)	andosols, histic and vitric andosols, histosols	podzols, cambisols, histosols	podzols, cambisols, histosols	podzols, cambisols, histosols
pH (0-20 cm)	4.5-6.5	5.5-6.0	5.5-6.0	5.5-6.0

Organic systems are more sensitive to soil fertility (quality) than conventional systems. Organic farming needs natural nutrient rich and fertile soils, like drained organic wetlands and flood plains in delta areas, to obtain adequate and successive yields. Conventional systems have more options when it comes to improving and maintaining soil fertility for good crop growth and limiting nutrient losses.

Arctic crops

There is no need to differentiate between organic and conventional farmers when it comes to selection of crops for livestock or human consumption. Relatively few crops can be grown in the arctic due to climatic restrictions. Commercial organic greenhouse and outdoor horticulture is limited because of the short growing seasons. In Iceland however, available abundant geothermal and hydro power makes it possible to sustain viable horticultural production all year round for domestic markets. There is also potato farming in the arctic for the domestic market. Grain production in the arctic is very limited but notable in Sweden and Iceland. The grain is primarily barley for feed but also to a lesser extent for human consumption. Wheat, rye, peas and rape are sporadically cultivated in most favorable areas in the arctic for grain, whole crop, green fodder or oil production.

The main crops in the arctic are perennial forages for the domestic livestock like cattle, sheep and horses. The most important and dominating forage species is timothy (*Phleum pratense*), but it is usually seeded in mixtures with other grasses and/or clovers. These species are meadow fescue (*Festuca pratensis*), perennial ryegrass (*Lolium perenne*), smooth meadow grass (*Poa pratensis*), red clover (*Trifolium pratense*) and white clover (*Trifolium repens*). The proportion of clovers in organic forage fields is typically higher than in conventional systems in arctic Sweden due to lower fertilization rates for organic farming.

Perennial forage legumes (clovers) are of interest for both organic and conventional farmers in the arctic. This is not only because of their ability to fix nitrogen from the atmosphere, but also because of their nutritional value. Forage legumes have a higher content of proteins, minerals and more rapidly digested fibers than grasses, giving rise to higher feed intake and production levels. In recent decades, extensive experiments with grass-legume mixtures have been carried out in the Nordic countries. One of the outcomes of these experiments is that the main limitation to the use of forage legumes in arctic areas is the availability of adapted cultivars. Breeding efforts of both white and red clover have led to considerable progress in this respect, making the cultivation of these species more secure. Recent studies have shown that grass-legume mixtures are more stable and more productive than their individual components in monoculture.

Crop yield in organic systems is lower than in comparable conventional systems. In two recently published meta-analyses on organic yield gaps in comparison to conventional yields, organic yields were on average either 19% or 34% lower (Ponosio et al 2014, Seufert et al 2012, respectively). A recent study in Iceland showed that converting conventional grass fields to organic grass fields resulted in substantial lower nutrient use efficiency and nutrient yields (Sveinsson 2017). The nutrient use efficiency and dry matter yield was 33% and 25% higher, respectively, in the conventional system compared to the organic system. Farms converting to organic farming frequently experience substantially lower DM yields and deterioration in their grass fields because of changes in vegetation and reducing feeding values. In a Swedish study south of the arctic, on nitrogen flow and farm-gate balances with dairy farms, the nitrogen efficiency was similar in organic and conventional systems (Wivstad 2009).

The main cause for reduced organic yields is low access to organic manure or other organic fertilizers. Manure, which is the main organic fertilizer, is a limiting resource for most farms in arctic regions, which results in low nutrient availability for organic crops. The situation is different between countries, however, since organic farmers in Sweden are allowed to use (buy) manure from conventional farms, which is prohibited in other countries.

Additionally, most bovine organic farms in the arctic import high proportions of concentrates, cereals and protein feed, that results in surpluses in the farm-gate nutrient balances. Consequently, the nutrient supply to feed crops in organic rotations, together with input through nitrogen fixation (clovers), can support both high yields and high feed qualities. However, this is not an economical option for organic sheep farmers in the arctic.

Still, many farms converting to organic farming will experience substantially lower DM yields, and there is a need to manage appropriate crop rotation, including with forage crops containing adequate clover proportions. Furthermore, careful manure management is of utmost importance to conserve nutrients in the farming system and to reach high nutrient use efficiency in the crops.

Availability of adapted cultivars for arctic conditions is limited in all crops for both conventional and arctic farmers. This is, however, more problematic for arctic organic farmers since organic certified seed is much harder to obtain on the market.

Weed infestation is generally more pronounced in organic farming because of limited options and manpower. Weed control in organic systems is more difficult than in conventional systems, due to the prohibition of synthetic herbicides. Well-planned crop rotations, adjusted tillage and mechanical weed control are the main weed control measures in organic production. Weeds are, however, usually a smaller barrier for organic farming in the arctic than for organic farming in the south. Most weed species, both annual and perennials weeds, are easier to control in crop rotations with perennial lays than in rotations with annual crops (cereals, pulse crops, oil seed crops). Hence, the existing crop rotations in the arctic region with high lay proportions, both in organic and conventional agriculture, counteract heavy weed problems.

Even though the number of weed species is lower in the arctic compared to more southern areas, weed density and weed biomass in the crop fields can be high. The reason for this is that problematic weeds prefer moist, coarse mineral and organic soils and relatively low soil pH, which are typical in many arctic fields. Weed species which thrive well in arctic fields are species of the genus

Chenopodium, *Spergula*, *Galeopsis*, *Cirsium, Stellaria*, *Rumex*, *Taraxacum*, *Ranunculus*, *Sonchus, Elymus, Poa* and *Alopecurus*.

The arctic has the advantage of cold winters and many pests and diseases therefore have difficulty surviving. This is however not always the case in coastal areas, where winter temperatures are relatively mild. A number of fungal forage and cereal diseases are known in the arctic, like scald, powdery mildew, blotch and rust, but they can be controlled efficiently with crop rotation. Crops of the genus *Brassica* are often severely damaged in some areas by flea beetles or pollen beetles in the arctic. This may limit their use, but in most cases these pests can be controlled by proper management and without the use of pesticides.

Arctic livestock

The main organic arctic livestock are either sheep or cattle. There are no barriers so far on what livestock breeds organic farmers can use for their production compared to conventional farmers for each country. There are many native breeds of sheep and cattle listed in Scandinavia and most of them are close to extinction as purebreds because they are not used in any substantial production.

Types of productive breeds in the arctic countries vary a great deal horizontally (between countries from west to east) but not so much vertically, within countries (from north to south). Breeds can be freely crossed between countries in Scandinavia but not in Iceland when it comes to goats, sheep, dairy cattle and horses. Breeds in Iceland of these species are native and importation of other breeds is not permitted. Breeds of beef cattle (Galloway, Angus and Limousin) have, however, been sparingly imported to cross with the Icelandic dairy cattle to improve meat quality. The Icelandic cattle has poor production efficiency for both conventional and organic systems alike. Hence, importation of new genetic material would favor both systems. The Icelandic sheep, on the other hand, is well adapted and productive for both conventional and organic systems.

There are small differences between organic and conventional farmers when it comes to breeding methods and breeding goals for their livestock. The breeding goals for both systems are to improve animal productivity (yield), fertility, longevity and health. In a Swedish study about preferences for breeding traits, both conventional and organic dairy farmers ranked the trait longevity first (Ahlman et al. 2014). But organic dairy farmers ranked mastitis and parasite resistance higher than conventional ones. Opposite rankings were true for high milk production. However, as the traits most important for producers with organic herds are already considered in the current Nordic breeding goal, most agree that it is not necessary to breed different lines of ruminant livestock for organic farmers.

There were 160 organic livestock farmers in the arctic in 2014-2105, 92 sheep farmers and 66 bovine farmers (Figure 6). A total of 70% of the organic farms are in Norway, but they are also smaller than in the other countries.

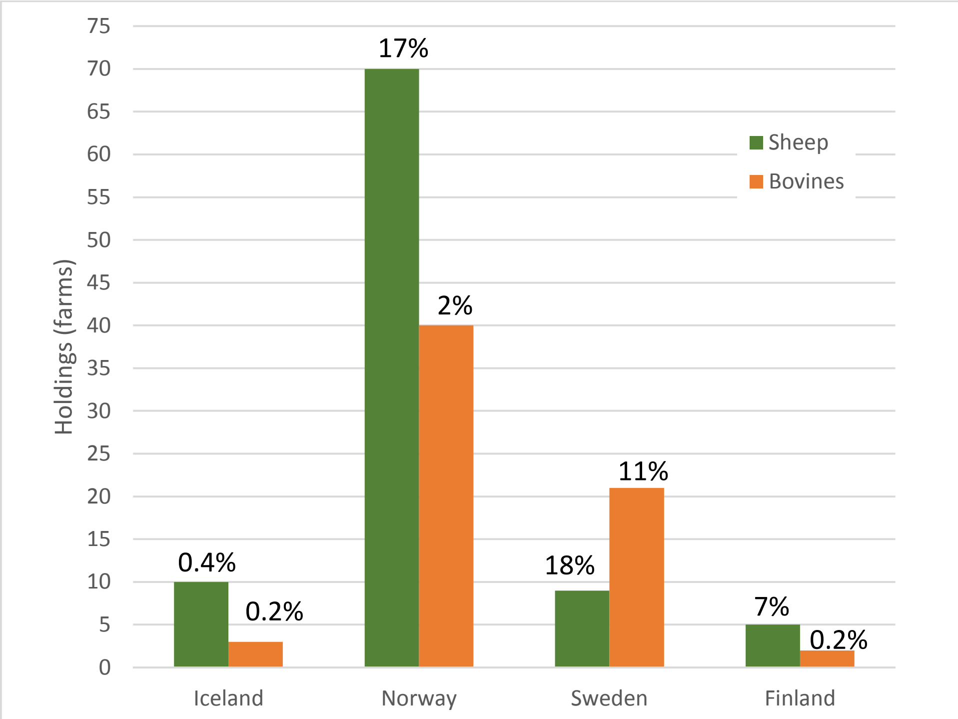


Figure 6. Number of organic livestock holdings (farms) in the arctic in the respective countries. Numbers on the top of the columns show the share (%) of organic livestock of the total number of livestock in the arctic. Based on available data from Eurostat and national bureaus of statistics, 2014 or 2015.

There were a total 10,118 head of cattle and 3,408 organic sheep in the arctic in 2014-2015 divided over these holdings (Figure 7). The figure reveals differences in size of the organic farms in the arctic. A total of 66% of the organic arctic livestock is in Norway.

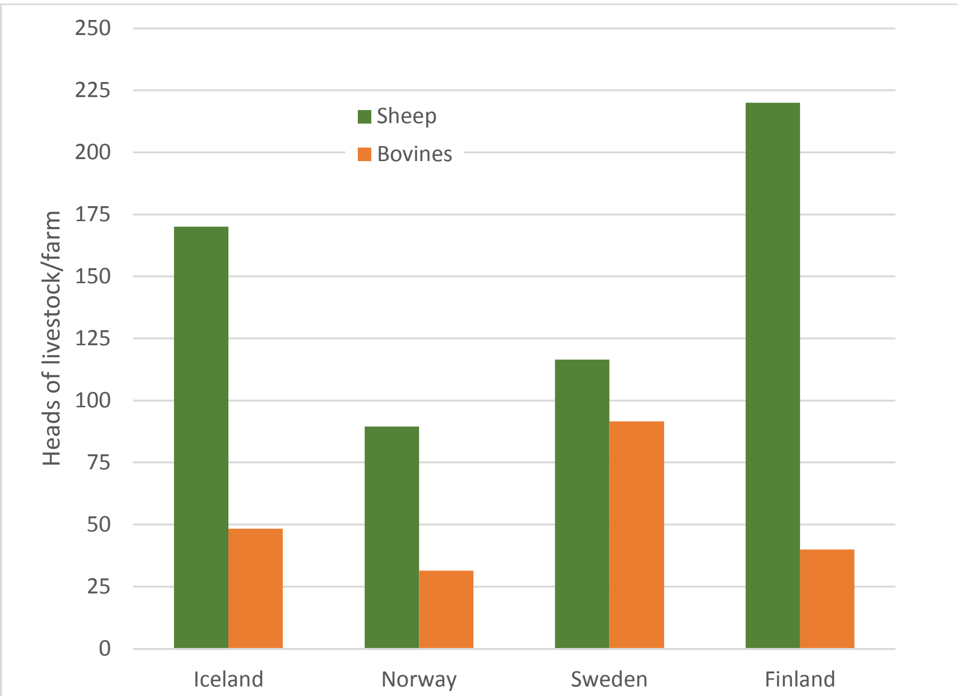


Figure 7. Average number of head of livestock per organic farm in the arctic in the respective countries. Based on available data from Eurostat and national bureaus of statistics, 2014 or 2015.

The dominating competitive dairy cattle breeds in Scandinavia are Norwegian Red (NRF) in Norway, Swedish Red and Swedish Holstein in Sweden, and Ayrshire in Finland. These breeds are interrelated and have also been crossed with other breeds like Holstein. Other noteworthy introduced breeds in Scandinavia are Holstein and Jersey, and some farmers use their own crosses between these breeds.

There is a slight but no distinct difference when it comes to selection of breeds, milk quality (solids or somatic cell counts) or animal health between organic and conventional dairy farmers. There is, however, a large variation in these parameters between farmers within each system. The milk yield per cow is lower in the organic system compared to the conventional system (Figure 8). This is believed to be related to lower utilizable energy in organic feed which results in lower productivity. To boost milk yield, concentrates (digestible starch, proteins and essential minerals) make up a large part (up to 40% on a dry matter basis) of the total feed ration for dairy cows in both systems. Most of these concentrates are imported into the arctic regions. The availability of organic concentrates is limited and also costlier for organic farmers compared to the concentrates available for conventional farmers. The growing season in the arctic is short and grazed feed is not a big part of the total annual feed ration for dairy cows. Grazed feed is a much bigger part of the total annual ration for suckle cows and their calves during weaning. However, preserved feed is the main feed for all cattle in the arctic.

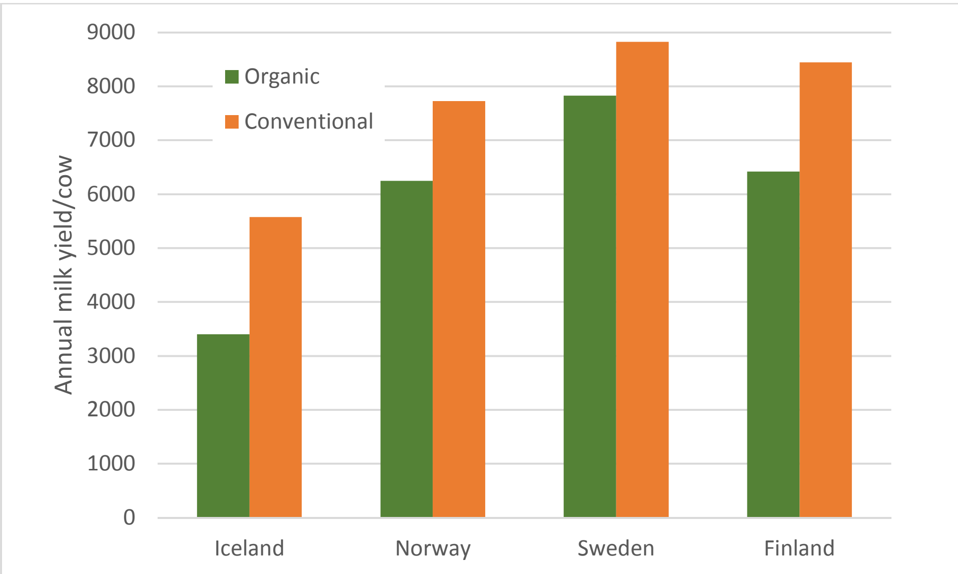


Figure 8. Annual milk yield delivered per cow in organic and conventional systems for each entire country. Source: Course in Uppsala: Organic milk production in the Nordic countries (2016), except for Iceland.

The sheep are mainly raised for meat and specialized wool production for home industry in each country. There are numerous native breeds in Scandinavia, many of which have been crossed with introduced breeds but an accessible up-to-date overview of these breeds and crosses could not be found for this report. Two unique but related breeds of sheep are recognized in Iceland: the Icelandic sheep and the Icelandic leader sheep. Sheep production is more widespread in Iceland than in other Nordic countries because of its traditional large share in the domestic meat market. However, lamb meat consumption is on a steady decline at the cost of cheaper meat from other species of livestock, mainly pork and chickens. There is no known qualitative difference between sheep products made organically or conventionally. Organic lamb meat production was compared with conventional lamb meat production with available data in Iceland for this report (Table 4). The conclusion was that there are no substantial qualitative differences between these systems.

Table 4. Ewes and lamb meat production in Iceland in 2013.

System	Ewes	Lambs/ewe	Lambs n	Carcass kg/lamb	Carcass scores muscle	fat
Organic	1,700	1.56	2,000	15.4	8.2	6.3
Conventional	440,000	1.61	518,000	16.0	8.6	6.4
Total	441,700		520,000			

Sheep production is not dependent on concentrated feed as milk production is and most of the feed is produced on the farms. Grazed feed is also a substantial part of the annual feed ration, even though preserved feed is usually the main feed. The winter feed is mostly baled wilted silage or hay obtained from mowed permanent or semi-permanent grass fields. The organic sheep farmer can only use organic fertilizer on the mowed grass fields, mainly the farm's own sheep manure and certified compost. These fertilizers do not support high grass yields and the organic sheep farmer needs therefore bigger areas to mow and costlier management methods to secure winter feed for the herd than does the conventional sheep farmer. It is more important for the organic sheep farmer than the conventional farmer to incorporate clovers effectively in the grass fields and possibly to systematically rotate the fields between mowing, grazing and fallowing to maintain successive and acceptable yields on the farm.

Administrative and marketing barriers of organic agriculture in the arctic

A survey was made for this project of all certified organic sheep and dairy farmers in Iceland. They were asked what the main barriers to organic production were.

The organic sheep farmers replied:

- No demand for this product.
- Failures in marketing.
- Lack of subsidies and higher premiums.
- Prejudice against organic farming in the society.
- The certification system is too expensive and too strict.
- More research and professional help needed.
- Too low yields from the fields – needs lot of space.

The organic dairy farmers replied:

- Lack of certified fertilizers (mostly phosphorus but also nitrogen).
- Too strict legislation and expensive certification system.

In a recent similar survey among organic horticultural farmers in Iceland the reply was:

- Lack of interest in the community.
- Lack of financial support.
- Negative debate.
- Academic hostility.

Surveys among organic farmers in Scandinavia have shown similar concerns.

In a report published by the IFOAM EU Group in 2016 the following concerns were stated for European organic farming in general:
"Supply chains suffer from gaps between supply and demand, logistic failures and/or other inefficiencies that do not allow supply and demand to be matched. Most studies on organic supply chains report a number of issues concerning their structure and performance:

- *high operating costs*
- *lack of alignment between supply and demand*
- *poor reliability of supply*
- *lack of collaboration among chain members*
- *different values and motivation among different actors in the chain*
- *lack of information flow"*

These points apply even more heavily for organic arctic farmers than organic farmers further south. There is limited flexibility in the organic directives and rules that take into consideration regional variation like the cold climate and short growing season. The standardized EU legislation for its inner markets does not seem to include scope for any meaningful allowance for deviation from general production rules. The standard argument is continually repeated that a country granted exceptions from the rules, even in minor aspects, such as taking into account the need for the use of slatted floors in livestock buildings in non-cereal producing arctic regions, would create a competitive advantage. However, there are still national differences when it comes to organic directives and rules. For instance, Sweden allows up to a certain extent co-operation and interactions between organic and conventional farms which are prohibited in other arctic countries.

Conclusions and suggested alternatives for arctic agriculture

The main barriers for organic agriculture in the arctic are:

- Comparable larger yield gap vs. conventional production caused by slow and restricted release of nutrients from organic fertilizers as a result of the cold climate and short growing season.
- Lack of organic certified raw material, mainly fertilizers, but also seeds.
- Lack of domestic markets, i.e. the willingness of the consumer to buy organic products.
- Too expensive and strict certification system, not adjusted to arctic agricultural conditions.

There are indications that organic farming is easier in the arctic than in other parts of the developed world in some respects, e.g. less problems with diseases and pests. But this also applies to conventional farming in the arctic. Therefore, use of pesticides and herbicides on conventional arctic farms is very limited and is by many not considered a threat for human health or the environment in the arctic.

There are limited studies available on water eutrophication caused my mineral fertilization in the arctic. An Icelandic study on nutrient leaching from mostly forage fields (on drained peat) could not correlate time of nutrient leaching with time of mineral fertilizer or manure application.

Both organic and conventional farming systems would benefit from higher proportions of N-fixing clovers in their perennial forage fields, but availability of well adapted cultivars for the arctic is lacking.

Willingness of common consumers in the arctic to pay more (or enough) for organic certified products is limited in spite of promotional efforts by the organic sector and most governments. This may be due to the fact that conventional farming in the arctic is not as distinctively different from the organic farming in southern regions.

Arctic agriculture, whether it is conventional or organic, is costlier and markets are smaller than in more populous regions south of the arctic. Therefore, it can be justifiable to subsidize arctic agriculture more than agriculture south of the arctic to sustain viable food production for domestic markets. Financial instruments need to be developed to generally support agriculture in this region, not only organic farming.

Arctic agriculture is without doubt unique in many ways that are not emphasized with organic labeling. The organic label is global and does not make distinctions between regions. The uniqueness of arctic farming may therefore be better served in another system than organic.

Governments of arctic regions should look for new schemes or systems that can promote arctic agricultural products. A promising scheme to consider comes from EU, the Protected Designation of Origin (PDO):

PDO *"…is a name which identifies a product originating in a specific place, region or, in exceptional cases, a country, whose quality or characteristics are essentially or exclusively due to a particular geographical environment with its inherent natural and human factors and which is produced, processed and prepared in that defined geographical area"*
https://ec.europa.eu/agriculture/sites/agriculture/files/glossary/pdf/index_en.pdf

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