

The Arctic as a Food Producing Region

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Iceland

- Marine bioresources play a key role in the bioeconomy of Iceland. Import of food, feed and fertilizers to the region indicates opportunities to increase self-sufficiency, especially with cross sectoral utilisation of side products.
- Export of fish and fish products are by far the most important food export items from Iceland. In 2016 about 596 thousand tons fish products were exported for revenue of about 246,000 million ISK.
- There are about 3,000 small family-owned sheep farms in Iceland. The challenges for sheep farmers are low income and the need for off-farm employment. Innovation, product development and added value products are very much needed in the sheep value chain.
- Geothermal energy makes the production of various vegetables possible in Iceland. This sector can be developed considerably.
- The production of the old Icelandic dairy product skyr has increased greatly in Iceland and abroad. A total volume of about 1,300 tons are exported annually for a value of about 500 million ISK.

Norway

- There is a potential for increased value adding of food produced in the Norwegian Arctic, in both local and national markets.
- In Northern Norway there are a number of local food networks four building competence and provide support to SMEs. These are however fragile and often dependent on individual driving forces.

Canada

- In 2016, Canada exported over 75 million kg of marine foods from the Arctic, with an estimated revenue of nearly \$800 million CAD.
- Between 2005-2014, Canada exported more than \$66.6 million worth of seal products (pelts, meat, oils) to 48 countries.
- Between 1988 to 2017, 3641 tons of roots, tubers, cucumbers, beans, chickpeas and mushrooms were exported from northern Canada to countries around the world.
- Since 2000, the export volume of prepared foods in northern Canada has increased by approximately 18,000 tons per year, or an increase of 384% since the 1990s.
- In a survey of Canadian consumers (n=1602), 76.8% indicated they are willing to try Indigenous-inspired foods, and 85.5% indicated willing buy foods sourced from Canadian Arctic.
- Specific provisions in Canada's Comprehensive Land Claims Agreements have created barriers for Indigenous communities to develop food related industries.

Policy Considerations

- Resources should be made available to support the maintenance and upkeep of the on-line Arctic Export Database. There may be an administrative role for the Arctic Economic Council.
- Iceland and Canada should provide infrastructure to support innovation for regional and rural development. Rural regions should be identified where the bioeconomy is strong and has potential for further growth. Gap analysis within those identified regions should be conducted regarding necessary infrastructure.
- Iceland should focus on the blue bioeconomy with food production as the backbone of the modern bioeconomy. Flagship projects to boost and communicate impact should be established. Strategic bioeconomy innovation can be a major contributor to achieve the Sustainable Development Goals.
- Iceland is developing a national food policy. Certain infrastructure investments are needed regarding food safety, which is the prerequisite for food trade.
- Crop production in the Arctic region could be strengthened by identifying and cultivating the best adapted species. Screening of available genetic resources for crop production in the Arctic is important for selecting well-adapted plant material. Institutional and technical barriers to transfer of genetic resources across borders should be addressed and cooperation encouraged, with the aim of increasing production and preserve biodiversity.
- The SDWG should consider the establishment of an Arctic Foods Innovation Cluster to act on the findings of this study. A cluster-based approach to food innovation would draw together Arctic food producers with governments, Arctic Indigenous communities, universities, research centers, vocational training providers, and industry associations and young people (the next generation). Overall it would seek to respond to global challenges of food production while seeking to define the Arctic's role and contribution to the changing climate and issues of food security locally and around the world. The AFIC could be used to create opportunities for entrepreneurship and innovation in the food and drink industry and supply chain, while strengthening the Arctic's position at the international scale.

Introduction

In 2016, the Sustainable Development Working Group (SDWG) endorsed *The Arctic as a Food Producing Region* research project. Involving research teams from Iceland, Norway, Canada, Greenland and Russia, the objective of the project was to assess the potential for increased production and added value of food from the Arctic, with the overarching aim of improving food security, and enhancing the social and economic conditions of Arctic communities.

The Arctic is already an important food-producing region, but there was a shared sense that the Arctic was not meeting its full potential, either in terms of satisfying local food needs or for maximizing its export potential. By focusing on biological (climate change), commercial (commercial resources, infrastructure and resource and industry policy), cultural (food traditions and organization of food chains) and market conditions (local, national and international), we set out to identify potential pathways for Arctic food production and distribution. The aim was to identify conditions for increased production, both to improve food security in northern regions, and to increase the added value of food originating in the Arctic both for local and southern markets. The aim was therefore twofold: 1) to enhance commercial food production 'in the North and for the North' and 2) to develop North to South food production linkages. We believed, and feel even stronger now, that achieving these two aims will lead to more sustainable food systems in the Arctic.

Much of our focus during this research has been directed to developing detailed descriptions of the main food production systems in Arctic countries. We have assembled national data sets on production (volumes and revenues), products, industry structure, and business conditions (availability of resources, policy, infrastructure, culture etc.) and a general outline of the market for different products – local, national and international. We have also identified the opportunities and challenges for future development of selected food production opportunities. This includes information on the unique biological attributes of Arctic product that can be used for marketing advantage.

Conceptually the project has operated at two levels. At the macro level we have examined the driving forces affecting the food-producing actors and industries (biological, business, cultural and market conditions). At a micro-level we have examined local, regional and national differences, highlighting possibilities and challenges, with a special focus on local consumption and marketing benefits for products with an 'Arctic Origin.'

As identified in our original SDWG proposal, we focused on the primary industries: fisheries/aquaculture, agriculture, herding, hunting, and gathering, which are more or less prominent in different Arctic regions. Our analysis was also directed to primary, secondary and tertiary forms of production.

- Primary production is used to denote fishing, hunting and gathering, as well as agricultural and aquaculture production of raw material, including harvesting, milking and livestock production before slaughter. In this case the original character of the product is not changed.
- Secondary processing includes slaughtering, processing, packing and transport of a product/raw material from primary production. This includes adding some conservatives (salt, sugar), drying, freezing etc., to obtain a more value-added consumer ready product.
- Tertiary production is used to denote processing that significantly changes the product, by adding other ingredients and produce a consumer ready product.

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Each country lead selected a number of products\species and food producers in their respective country to be considered, highlighting the principal value chain characteristic for their respective regions. Food production in and for Indigenous communities was also emphasized in the areas/countries where this was relevant. While some latitude was exercised in each study region, we were all guided by a common set of questions. The questions included:

1. What is the status and what is the potential for various food production opportunities in the Arctic?
2. What are the added value of these products when marketed by their special qualities and unique origin?
3. What conditions are important to the further development of the Arctic as a food producing region?
 - a. How can production be increased and how can new species and products be developed in sustainable ways?
 - b. What are the market conditions for adding value and does an 'Arctic' branding influence consumer preference and competitive advantage at local, national and international levels?
 - c. What role does industry structure, infrastructure and organization of different value chains and industry policy play for the potential development?
 - d. What role do local cultural values have for the development of new food products and new local markets?

Our results indicate that within the Arctic region there are considerable opportunities for commercial food production, both for export and for meeting local food needs. Food industries are producing large volumes of food commodities that are culturally compatible with indigenous\local food preferences and also have high export value. Yet Arctic food industries are also challenged by a plethora of social, economic, climatic and logistical constraints. We believe that the outputs generated from this research will yield benefits for communities and food industries across the Arctic. Knowledge from this study about the effects of climate change, market conditions, industry structure, public policy, and social conditions that affect Arctic food production will be useful for policy making, research and business development alike. Increased harvesting and production of marine, agricultural and wildlife resources that are produced and sold locally have the potential to alleviate northern food insecurity and contribute to the social and economic development of northern communities. This knowledge will be informative to policies supporting sustainable economic growth in Arctic regions.

In this report we provide summary descriptions of food production in three regions of the Arctic. These regions include: 1. the entirety of Iceland, 2. Norway's three northernmost counties - Nordland, Troms and Finnmark, and 3. northern Canada, including Yukon, Northwest Territories, Nunavut, Nunavik and Labrador. More detailed and country-specific reports have been prepared for our respective SDWG Delegates.

This report is organized as follows:

- **Section II** provides production summaries for marine and aquatic resources. Due to the availability of public data, we also provide commercial data for Alaska, Denmark, Finland and Sweden.
- **Section III** describes the Online Mapping Interface that was developed for organizing export volumes, values and destinations from Iceland, Norway, Canada, Alaska, Denmark, Finland and

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Sweden. Steps are being taken to ensure this on-line system is maintained with regular annual updates. We are also looking for opportunities to include Russia and Greenland data and we will reach out to those SDWG Delegates for direction.

- **Section IV** describes the production systems for meat (e.g., reindeer, sheep, muskox). Volumes, consumer demand and potential markets are described, as are the challenges associated with increased production.
- **Section V** provides a summary of agricultural production, including field and greenhouse production.
- **Section VI** summarizes the results from our consumer preference surveys (Canada and Norway). This section includes information on food values and attitudes as identified through neophobia scaling and food choice experiments.
- **Section VII** present our main findings and identifies some of the constraints and opportunities associated with the sustainable development of the Arctic's commercial food systems.
- **Section VIII** concludes with a brief discussion of policy considerations that will need to be addressed for the Arctic to grow as a sustainable food producing region in the future.



Figure 1 Fisheries and Agricultural Village in Lofoten, Norway (Photo Credit Nofima)

A Summary of Arctic Commercial Food Production

2.0 (Fish and Aquatic Food Resources)¹

2.1 Iceland

Export of fish and fish products are by far the most important export items from Iceland and are a considerable part of the economy. Cod is the most important species. Total cod catch in 2016 was 264 154 tons, thereof 70 000 tons (26.5%) were caught by small vessels. A number of Arctic char farming operations



Figure 2 Icelandic Small Vessel Landings

are situated at different locations around Iceland. All operations are land-based and use water that, according to EU's water framework, is classified as being of unique quality extracted from springs, boreholes and wells. In 2016, 669 tons of lumpfish caviar, 731 tons salted lumpfish roes and 2 700 tons frozen lumpfish blocks were exported from Iceland, worth an estimated 2 084 million ISK. Fish products are exported from Iceland to more than 90 countries, with the EU, USA and Nigeria markets of most importance. The value of Icelandic fish export has fluctuated due to variable exchange rates and proportions of fish species landed.

2.2 Northern Norway

From 2012 to 2016, Norway exported fish products worth 339,207,335,000 Norwegian krone (NOK)². Norway's biggest market for fish products was Poland, which imported a value of 32,449,669,000 NOK in the same period. Other notable countries included France, Denmark, the United Kingdom, Russia, Sweden, Japan, the Netherlands, Spain, Germany, China, the United States, Portugal, and Italy, who together imported over 10 billion NOK, which accounted for 78% of all Norway fish exports from 2012 to 2016. The fish export value in Norway increased from 50.8 billion NOK in 2012 to 89.2 billion NOK in 2016, demonstrating an annual percentage increase of 8.8% in 2013, 11.5% in 2014, 7.3% in 2015, and 23.9% in 2016. Over this period the value of fish exports from Norway increased by 75.6%. Only a small amount of the Norwegian seafood goes to domestic consumption. It is estimated that 95% of Norwegian seafood is consumed abroad. In 2017, Norwegian seafood was exported to 140 markets around the globe.



Figure 3 Norwegian Salmon Packed for EU Export (Photo Credit Nofima)

¹ The availability of public fisheries data allowed for the inclusion of Alaska, Denmark, Finland and Sweden in this section.

² Statistics Norway (2018). External Economy: External Trade. Retrieved from: <https://www.ssb.no/en/utenriksokonomi?de=External+trade+>.

2.3 Canada

From 1988 to 2017, 3,470,745 tonnes of fish and aquatic products—the largest fraction (43%) being crustaceans—were exported from the Canadian Arctic, adding more than \$18 billion CAD, or approximately \$600 million CAD per year, to the Canadian Arctic economy. From 2012-2016, the total value of aquatic products exported by the Canadian Arctic was 4.1 billion CAD. Among 133 export destinations, the United States, China, Japan, Denmark, and Russia were the leading importers of Canadian Arctic seafood. The value of Canadian Arctic aquatic exports has increased slightly in recent years, from 709 million CAD in 2010 to 798 million CAD in 2017. The major commercial fisheries in the Canadian Arctic are Greenland halibut, shrimp (*Pandalus borealis* or northern shrimp), *Pandalus montagui* (striped shrimp), and Arctic char. In the Northwest Territories (NWT), the major species harvested are lake whitefish, lake trout, northern pike, and inconnu. Offshore, Canadian Greenland halibut enters the EU through the EU Border Inspection Posts in either Sisimiut or Nuuk, Greenland. Container ships transport fish products (Greenland halibut and northern shrimp) from Greenland to Aalborg, Denmark. Northern shrimp from Nunavut are landed in Greenland to facilitate transportation to other international ports. In addition to fisheries, Canada has exported (2005 and 2014) more than \$66.6 million worth of seal products (pelts, meat, oils) to 48 countries.

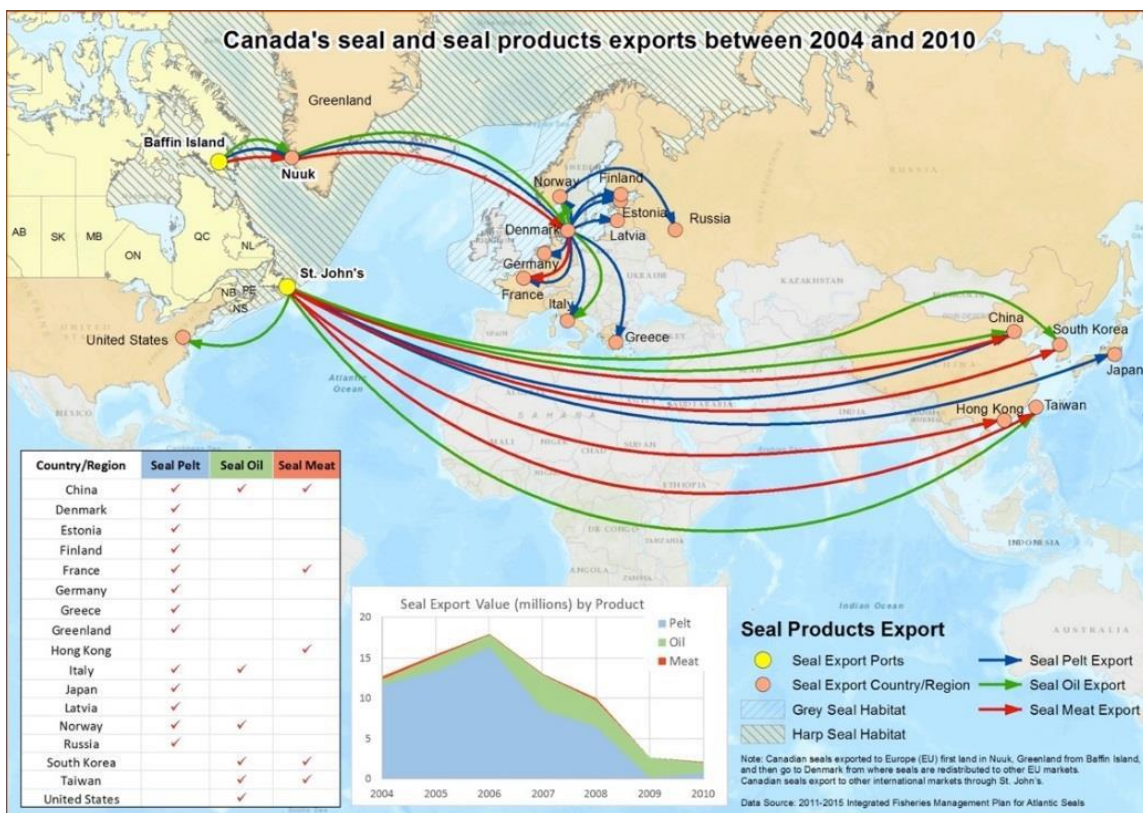


Figure 4 Canadian Seal and Seal Products Export

2.4 Alaska

Alaska has a prominent fishing industry. According to the 2018 U.S. census³, Alaska exported value of fish, exceeded 11 billion USD from 2012-2016. Of the 65 countries that imported Alaska's fish products, the top five were China, Japan, South Korea, Germany, and the Netherlands. The approximately 3,133 tons of fish

³ U.S. Census Bureau. (2018). U.S. Import and Export Merchandise Trade Statistics. Retrieved from: <https://www.census.gov/foreign-trade/reference/products/catalog/orderform.html>.

exported to these five countries was 76% of the total fish exports from Alaska during this period. From 2012-2015, the value of Alaska's aquatic exports increased gradually, rising 0.45% in 2013, 1.8% in 2014, and 4.0% in 2015. However, the aquatic export value dropped from 2.3 billion USD in 2015 to 2.1 billion USD in 2016 (a decrease of 10.2%). Overall, Alaska's fish export value fell 4.5% from 2012 to 2016.

2.5 Denmark (excluding Greenland and Faroe Islands)

Denmark had 133 trading partners for its fish products from 2012 to 2016. Germany was the top importer of Danish fish products, importing a value of 19,258,702,000 Danish krone (DKK)⁴ in this period. The value of Danish fish product exports from 2012 to 2016 was 94,327,255,000 DKK. The annual value of fish exported from Denmark increased from 16.3 billion DKK in 2012 to 21.9 billion DKK in 2016. The annual growth rate was 9.2% in 2013, 3.4% in 2014, 7.6% in 2015, and 10.6% in 2016. Overall, Denmark has become an important fish exporter in the Arctic region, with a growth rate of 34.4% from 2012 to 2016.

2.6 Finland

Finland has 60 national trading partners for its fish products from 2012 to 2016⁵; with Estonia being the top export destination, importing 93,642,955 euros (EUR) worth of Finnish fish products. The Finnish fishing industry exported a value of 209,211,636 EUR during this five-year period. The top five importers of Finland's fish products (Estonia, Russia, Sweden, Denmark, and Latvia) imported 88% of Finnish fish exports from 2012 to 2016. The fish export value increased remarkably in 2016, marking the highest export value in the period. The annual change in fish exports decreased 1.9% in 2013, 7.8% in 2014, and 17.4% in 2015, and increased 63.4% in 2016. The Finnish fish industry experienced an overall increase of 22% in the five-year period from 2012-2016.

2.7 Sweden

Sweden has 80 national trading partners for its fish products. Poland was the largest importer of Swedish fish products with a value of 28,606,568,000 SEK⁶. Other Swedish export destinations included France, the United Kingdom, Spain, Portugal, Italy, Lithuania, Denmark, Germany, and the Netherlands. From 2012 to 2016, Sweden exported 137,695,616,000 SEK worth of fish products. Ten traders imported 88% of all exported Swedish fish products. Between 2012-2016, the Swedish fish export value almost doubled over five years, from approximately 20 million SEK in 2012 to 37 million SEK in 2016. The Swedish fish export value grew by approximately 20% each year, or 94.8% over the four-year period.

⁴ Statistics Denmark (2018). Imports and Exports (SITC). Retrieved from: <http://www.statbank.dk/10029>.

⁵ Uljas. (2018). ULJAS - Foreign Trade Statistics. Retrieved from: <http://uljas.tulli.fi/>.

⁶ Statistics Sweden (2018). Statistical Database - Trade in Goods and Services. Retrieved from: http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__HA__HA0201/?rxid=80008446-02b6-4408-8376-e1f6f80e35d6.

3.0 Online Map Interface

Information about export values and export destinations from seven Arctic Nations regions can be accessed from an online map at <http://webgis.usask.ca/ArcticFood/>. The interactive map allows users to visualize the value and quantity of exports (via text) and the trading partners of each country (via geographical information) for each product in each year. Figure 5 shows the interface of the online map of the Canadian Arctic in 2017. Eight different seafood categories exported from the Canadian Arctic from 1988 to 2017, and fish export values from 2012 to 2016 can be displayed.

The online map can be accessed from a standard web browser, such as Chrome, IE, Safari. Export information for a country in a specific year can be obtained in four steps:

1. Select *Trader* from the dropdown list. This defines the place of origin (e.g., Canada) that exports a product around the world
 - a. After you have defined *Trader*, the *Product* tab will update automatically based on available product categories for this country.
2. Select the desired *Product* from the dropdown list.
 - a. After you have defined the desired *Product*, the *Year* will update automatically based on export years available in the database.
3. Select *Year* from the dropdown list.
4. Press the *Map* button to produce a map with the customized parameters above.



Figure 5 An example of the online map with information on Alaska’s fish exports in 2016.

Users can hover over any destination country to show the specific export information, as in Figure 5 (Alaska). The default bright theme can be switched to a dark theme by clicking on the map style button on the top right corner. The displayed map can be printed on both soft and hard copy. A user’s guide is available; select “help” at the bottom of the screen.

4.0 Meat Production

4.1 Iceland

There are well over 3 000 sheep farms in Iceland. These farms tend to be small and family-owned. The sheep farming is as old as the human settlement of Iceland. Still sheep farming is based on traditions which include various foods made from the animals. Iceland is very well suited for sheep farming with plentiful grasslands and highland pastures. Lambs graze in the highlands until slaughtered in the autumn. The grazing areas are comprised of native vegetation, which enhances the quality and reputation of Iceland's lamb industry.

There are 10 slaughterhouses for sheep in Iceland. During the 2017 slaughter season, 560 500 lambs were slaughtered. The average carcass weight was 16.5 kg and total production 9 200 tons lamb meat (carcasses). The value was 6 200 million ISK for lamb meat sold at the domestic market.



Figure 6 Photo Credit Farmers Association of Iceland

The volume of exported lamb and sheep meat was 4 100 tons.

The challenges for sheep farmers are low income and the need for off-farm employment

The slaughterhouse industry has a strong position on the market and needs a considerable share of the market value. Sheep farming constantly faces the competition from other more profitable meat sectors.

4.2 Northern Norway

The largest agricultural production systems in Northern Norway are based on meat production. Abundant high-quality grazing areas are an important resource for this production, but with a long winter season good grass feed production and sufficient barn capacities are also an important prerequisite for this production. In the primary production, there are 1 312 producers of cattle (mainly dairy farmers), 1 608 sheep producers as well as 115 pig producers (2017). In addition, about 30 dairy goat farmers are producing goat meat. The total primary production is 186 462 sheep, 28 061 cattle and 103

Box 1. Reindeer Industry in Norway

Reindeer meat has been consumed for several thousand years in Norway. Today, approximately 80 000 animals are slaughtered each year, which gives roughly 1 800 tons of meat and 1 500 tons by-products. It is mainly consumed in Northern Norway and is an important part of the sami diet. Feed supply (and predators) limits the total number of animals. Reindeer meat is sold at approximately twice the price of beef.

Estimated market value for meat and by-products is roughly 500 million NOK. Among the by-products are fur and skin, which represents the highest commercial value. Almost all meat is consumed in Norway while the by-products are mainly sold abroad. Food trade regulations limits the options for selling meat outside Norway, which also influences the retail price in the domestic market. There are 4 medium sized and 3 small slaughter plants for reindeer in Norway. In total, these plants have roughly 350 employees. In addition to the slaughter plants there are 15 companies that process carcasses into meat products. In total these companies have more than 1 000 employees, but most of them process other types of meat as well.



Figure 7 Photo Credit Opplysningskontoret for kjott

600 pigs slaughtered in 2016. In 2016 there were approximately 1000 employees in secondary and tertiary industry in Northern Norway. The meat products are sold locally, regionally and nationally. The industry is characterized of high level of products processing. There are possibilities for increased meat production in the north, both by utilizing the total potential in the outfield grazing fields for increased primary production and by increasing the value added by producing local specialty products.⁷

The reindeer industry in Norway is closely connected to the Sami-culture and heritage. Only persons of Sami descent can be owner of reindeers, a right protected by law. In 2017, 3 233 persons were registered as owner of reindeer in Norway. However, slaughtering and processing of the animal products is open for everyone that is qualified. The majority of reindeers are found in Finnmark (75%), while Troms and Nordland have approximately 6% and Trønderlag has 14%. The reindeer are semi-domesticated, which means they roam freely in nature where they consume grass during summer and lichen during winter.

Box 2. Muskox Harvest in Canada

In the Northwest Territories (NWT), the Inuvialuit Regional Corporation helps Sachs Harbour residents hold a community muskox hunt on Banks Island. The muskox population on the island fluctuates between 80,000 and 120,000 animals (McKeon 2009). At present, the community harvests a few hundred muskoxen (roughly 4% of the total estimated population). In 2008, the hunt brought \$70,000 worth of wages to Sachs Harbour and employed more than 20 community members. In 2006, 300 quotas were allocated by the Nunavut Development Corporation (NDC) for hunters that accounted for 30 to 35 jobs. To harvest muskoxen, local hunter and trapper organizations (HTOs) partner with Kitikmeot Foods in Cambridge Bay, Nunavut (Ryan 2006).

McKeon, L. (2009). Commercial Fishing. News North. URL <http://www.nnsl.com/business/pdfs/commercial-fishing.pdf> (Last Accessed May 2017).
 Ryan R., (2006). Summary of Proceedings: Building a kitikmeot economic development strategy. Proceedings Report KEDC Regional Planning Meeting.

4.3 Canada

The value of live animals and animal products exported from the Canadian Arctic has increased steadily over the last 30 years. During the 1990s, the average revenue from sales was roughly \$858,814 CAD per year. However, by 2000, annual sales increased to \$2.5 million CAD, or an increase 300%. Overseas exports fluctuated from 2000 to 2017, with the highest values being \$3.5 million in 2003 and \$4 million in 2011.

The western Arctic area near Sachs Harbour and Holman is known for its large-scale commercial harvest of Muskoxen. Usable parts from a muskox include meat, hide, wool (Qiviut), and horns. Northern communities export these items to markets in southern Canada. In addition to hunting for subsistence and marketing purposes, guided sport hunting-and-outfitting based tourism connected to muskoxen provides a source of food and income for northern communities.

Although caribou hunting in Canada supports household subsistence and inter-settlement trade, the feasibility of commercial hunts first needs to be assessed on animal supply. As supplies from wild harvests are intermittent, this influences the exports of caribou meat or any other types of sales of caribou in southern markets. The uncertainty of supply makes buyers from outside Canada hesitant to

⁷ Sources: Landbruksdirektoratet, statistics: <https://www.landbruksdirektoratet.no/filserver/prodrapp.htm>
 Animalia, slaughtering statistics: <http://statistikk.animalia.no/statistikk/>
 Statistics Norway, statistics meat production/slaughtering: <https://www.ssb.no/statbank/list/slakt?rxid=2c9310c4-9a42-4bf9-ae33-94ebde71e54a>
 Mat og Industri, www.matogindustri.no
 Matmerk, increased sales for local food; <https://www.matmerk.no/no/matmerk/aktuelt/lokalmatsalget-vokser-mest>
 The business finder; www.proff.no

enter into contracts with northern producers, reducing the viability and commercial value of the caribou harvest.

5.0 Agricultural Production

5.1 Iceland

Geothermal energy for heating and electricity produced by hydroelectric power stations for illumination are the basis of vegetable production in greenhouses in Iceland. A few vegetables are grown in greenhouses all year round, including tomatoes, cucumbers, bell pepper and lettuce. Additionally, a few vegetables are grown more irregularly: spinach, Chinese cabbage, kale and herbs. Even the greenhouse production of strawberries has been successful, but the produce has had a hard time competing with the prices of imported strawberries. Several greenhouses are operated through dark winters by using electrical illumination. Products are marketed on the domestic markets. Most of the greenhouses are located in clusters where geothermal energy is available. The greenhouse production of cucumbers, tomatoes and bell pepper was 3 500 tons in 2016. The total value of greenhouse and out-door vegetable production in Iceland was 3 800 million ISK 2016. The value of greenhouse products is a considerable part of this, estimated to be about 1 500 million ISK. The number of employees in vegetable production was 237 (year 2008) and for related services 107 employees were involved (outdoor production included). The greenhouse vegetable production in Iceland meets only a part of the domestic demand, however, export has been investigated. The market share for domestic tomatoes and cucumbers is the highest (70-90%) but lowest for lettuce and bell pepper (about 10%). The import of vegetables is therefore considerable.

5.2 Northern Norway

The agricultural production in Northern Norway is the northernmost active agriculture in the world. It is only possible because of the warm carried by the North-Atlantic current and because of the latitudinal

Box 3. Skyr Production in Iceland

Skyr has been a part of the Icelandic cuisine since settlement. The industrialization of skyr production started in the 1930s. Gradually domestic production of skyr decreased and by 2010 only a few farms were reported as skyr producers. In the last few years several farms have started to produce skyr according to the traditional methods and the products have been sold to customers.

Skyr has in the past been sold mainly within Iceland but in recent years skyr has been exported from Iceland. About 4 500 tons are produced annually. Of those, a total volume of about 1 300 tons are exported for a value of about 500 million ISK. The remaining 3 200 tons are sold on the domestic market.

MS exports or has sold production licence to several countries, including the United States of America, Denmark, Greenland, Norway, Finland, Sweden, Switzerland, United Kingdom, Ireland and Malta. In 2016, MS and its cooperating companies sold about 13 thousand tons of skyr in Europe, 800 tons more than in 2015.



Figure 8. Skyr Production. (Photo Credit Matis - Kristin Edda Gylfadottir)

placement of the region, the growing conditions are characterized by short growing season and 24 hour day length in mid-summer.

The agricultural food processing industry in Northern Norway is dominated by large cooperatives owned by the farmers, like TINE (dairy) and Nortura (meat). In addition there are about 500 local food producers.⁸ Agriculture production in Northern Norway is mainly grass-based animal husbandry (dairy cattle, sheep, pig, laying hen and goat). Northern Norway also includes horticultural production, mainly potatoes, but also some vegetables and berries. In addition, a few farmers grow cereals (mainly barley) in the north. Horticultural production is low in Northern Norway. The main horticultural production is potatoes that are grown on about 460 hectare. Vegetables and berries are grown on about 65 hectare with about equal distribution in Troms and Nordland counties. Key strengths for horticultural production in Northern Norway are the natural growing conditions with cool summers and long days. These conditions imply little problems with pests and diseases and require low use of pesticides and herbicides.



Figure 9 Currants production in Troms
Photo Credit Finn Måge, Nibio

At the same time there are indications of specific quality attributes of horticultural products produced under these growing conditions.⁹ It has been documented in several horticultural products grown in Northern Norway that the low temperature, in combination with 24 hour light and longer photosynthetic activity, causes more crispy and juicy products with sweeter taste compared to the same product produced further south. It is usually not a result of increased amount of sugars, but rather less production of different kind of bitter tasting substances. Several food producers in Northern Norway are using these particular biological attributes together with the product origin, for marketing products with “Arctic quality”. This is e.g. used in successful marketing of a locally produced potato variety “gulløye”, as “the potato of the midnight sun” and lam meet producers in Lofoten and Lyngen market the Arctic quality of the meet based on the lam grazing in wild nature from the coast up to the mountains. Consumers generally prefer food that is healthy, with good taste and produced in a sustainable manner, and increasingly they prefer food with a unique story. Food from the Arctic may score high on all these properties, especially with marketing based on properties highlighting the characteristics of Arctic food. There are great opportunities for developing high value niche “Arctic products” for tourist markets and other selected regional and national markets, as well as for local markets

5.3 Canada

From 1988 to 2017, 3641 tonnes of roots, tubers, cucumbers, beans, chickpeas and mushrooms were harvested in the Canadian Arctic and exported (mostly frozen) to countries around the world. The

⁸ Numbers from The Centre of Expertise for local food production North (Kompetansenettverket for lokal mat Nord)

⁹ Johansen, T. J., A. L., Hykkerud, E. Uleberg & J. Mølmann (2018). Arktisk kvalitet – En beskrivelse av nordlige natur- og klimaforhold og virkning på egenskaper hos nordnorske matprodukter. NIBIO Rapport nr. 40.

highest volume was in peas, with 492 tons exported to China in 2006, and potatoes, with 275 tons (\$107,621) exported to Russia in 2014. During that same period Blueberries, cranberries, bilberries, raspberries, blackberries, and apples accounted for 3377 tonnes in export. The Netherlands and other European Union countries were the major markets for fruit and nut products from the Canadian Arctic. From 1988 to 2017, the total weight of oil seeds, oleaginous fruits, medical plants, straw, and fodder exported from the Canadian Arctic reached 1202 tons (\$1,689,154) and contributed 13% to the total weight of farm exports. Other farm products including live trees, teas, cereals, malts, starches, resins, and vegetable saps were also exported from the Canadian Arctic with a weight of 964 tonnes (\$1,346,561). Unlike the large commercial farms in the Canadian prairies, agricultural production in the Canadian north is conducted small-scale farms, community gardens, and greenhouses. The 2016 Census of Agriculture indicated that there were 142 farms operating in Yukon, encompassing a total farm area of 10,330 hectares, with 6,801 ha involved in pasture and the production of crops. The number of farms operating in Yukon has fluctuated since the 2001 Census of Agriculture, from a high of 170 (2001) to a low of 136 (2006), though the total area in production has not changed as notably.

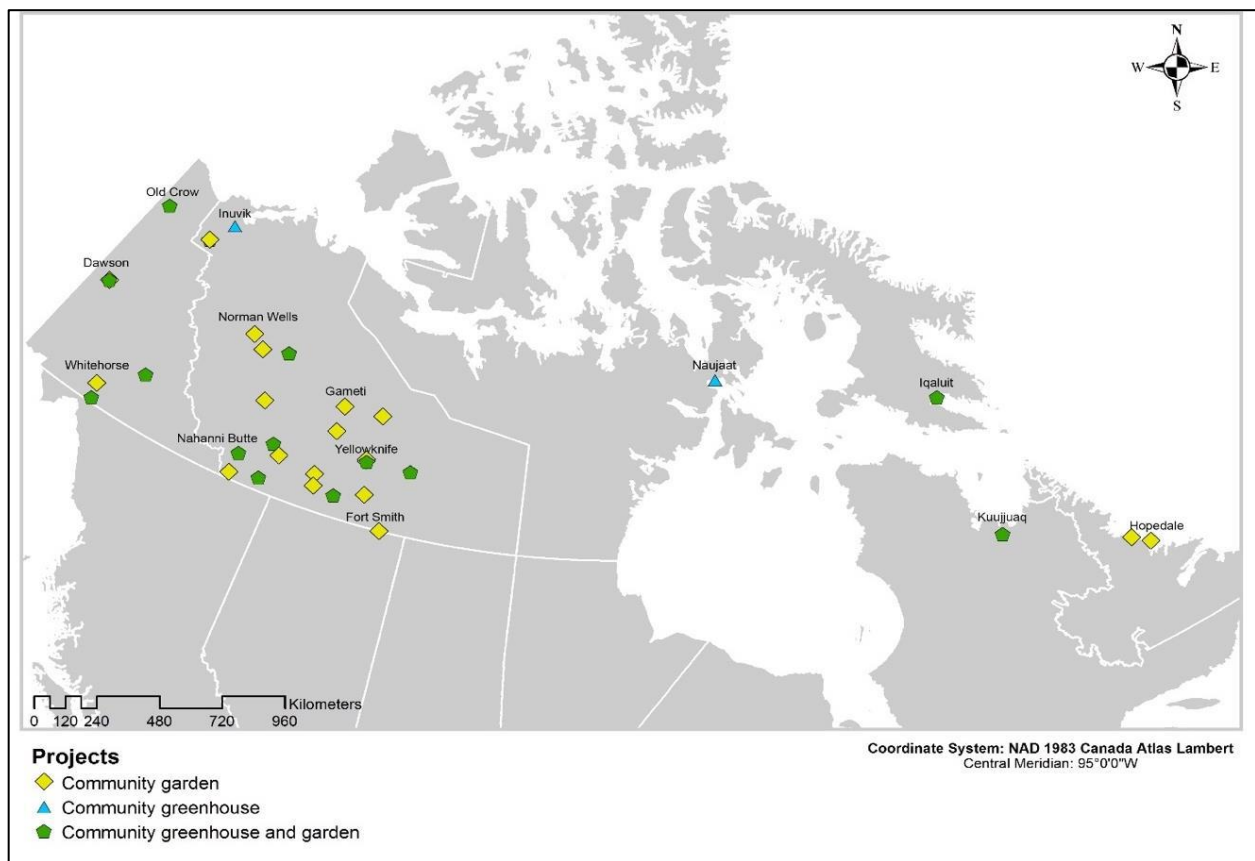


Figure 10 Locations of Community Gardens and Greenhouses in northern Canada

6.0 Competitive Advantage

6.1 Canada

An online Arctic Food Survey was conducted in Canada between August and September 2018. Only buyers of fish, seafood, or meat products were allowed to participate. Sample (N=1602 Canadian adults) is fairly

representative of the Canadian population in terms of gender, age and geographic distribution, except the levels of education and income which are higher than the Canadian average.

This project aims to explore how consumers in markets outside of the Arctic perceive foods originating in the Arctic, whether there are competitive advantages for marketing Arctic foods based on unique origin and sustainable harvest certifications, and whether consumers would be willing to pay a premium for Arctic foods. The 20-minute survey consists of five main sections.



Survey starts with a list of 17 **food values**¹⁰. Respondents selected the most and least important values to their food purchase. Price, taste, safety and nutrition are rated as the most important values; while convenience, tradition, novelty are the least important. Overall, a majority of sampled Canadians (~80%) indicated they are willing to try new or unfamiliar foods in general.

For the **Arctic foods** in particular, 76.8% indicated they are willing to try Indigenous-inspired foods, and 85.5% indicated willing buy foods sourced from Canadian Arctic if available. Over half of respondents had experience eating Arctic foods such as Arctic char, moose, and halibut, but very few (less than 10%) had ever eaten seal, muskox, walrus, and whale. Overall, sampled Canadians held a favourable attitude towards Arctic foods. For example, a majority of respondents believed that Arctic foods allow them to experience Indigenous cultures and tradition, support local Indigenous communities, impose less risks to human health, are more natural and from a pristine environment. Most respondents also indicated *unwilling* to buy seal, walrus, and whale when they become available in grocery stores or restaurants.

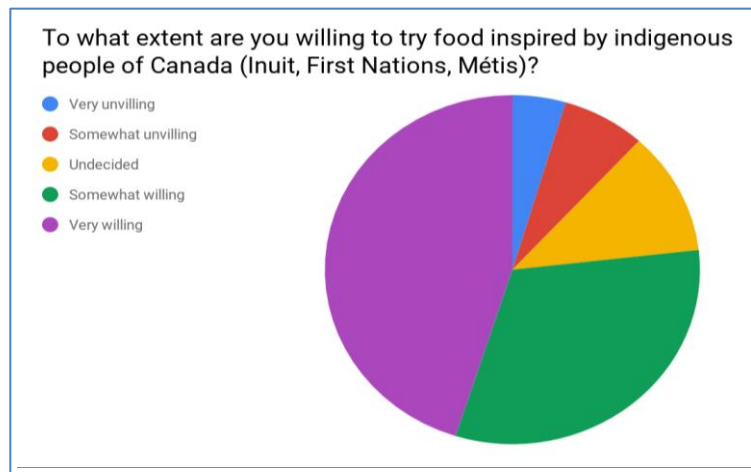


Figure 11 Willingness to Purchase Arctic Foods

In the **choice experiment**, respondents were asked to choose between alternative packages of one-pound Arctic char fillets that vary in five features: (1) *geographic origin*, fillets are produced in Canadian Arctic, B.C., Canada, or Alaska, U.S.; (2) *production method*, wild-caught or farmed Arctic char; (3) *producer*, fillets are produced by Indigenous fishers or non-indigenous fishers; (4) *certification*, fillets are certified for their geographic origin, sustainability, authenticity; and (5) *price*. Preliminary results indicate that people value (prefer) the features of Arctic origin, wild-caught, Indigenous fishers, and certification for sustainability and authenticity.

¹⁰ Lusk, J. L., & Briggeman, B. C. (2009). Food values. *American Journal of Agricultural Economics*, 91(1), 184-196.

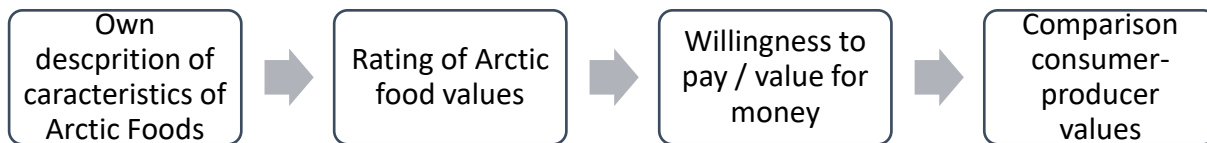
This survey also assesses respondents' awareness of ten **sustainable food labels**, such as Animal Welfare Approved, Certified Sustainable Seafood, and SeaChoice. A majority of respondents indicated they have never seen these labels before, except the "Canadian Organic" and "Fairtrade". Respondents who have seen these labels before also indicated knowing "nothing at all" or "just a little" about their meanings. Most respondents only "sometimes (37%)" or "rarely (27.3%)" take these labels into account when purchasing foods. Interestingly, respondents showed low confidence in seafood labelling, believing 46% of the time seafood labelling is misleading or fraudulent in Canada.

6.2 Norway

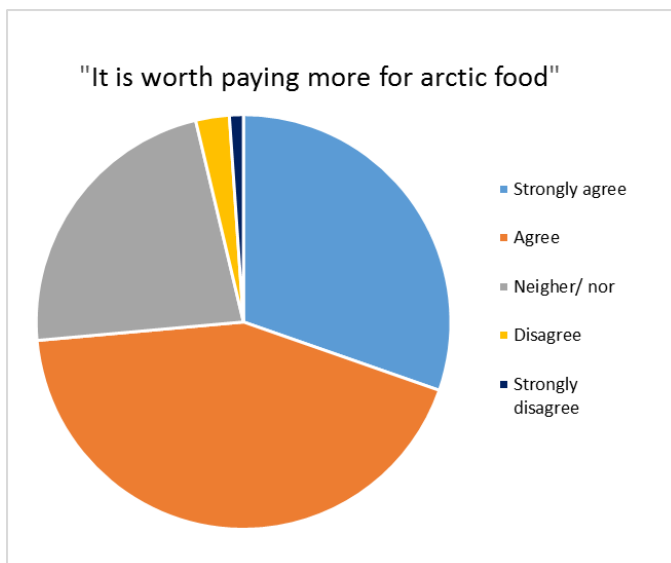
Two online surveys were carried out in Norway in late 2018. The first "Arctic Food consumers" (AFC) collects data on consumers' perception of arctic food (N=458). It also has a regional- national perspective separating responses from the arctic region (N=232) and central areas in the south (N=226). The sample is focused on the target groups for Arctic Food products; above 30 years of age with an average to high income. The second survey, "Arctic food producers" (AFP) focuses on SME's experiences, marketing practices and use of the national and regional system for supporting SME's and entrepreneurs (N=29).

AFC explore how consumers at the local, regional and national level perceive foods originating in the Arctic part of Norway. What is arctic food in their minds and do they express a willingness to pay a premium for these features. AFC and AFP also aim to measure if the producers are marketing their products in a way that resonates with their consumers. A failure to take the full advantage of customers' perceptions and preferences can identify a potential unrealized profit.

The surveys were analyzed aiming for four different aspects



The consumers were asked to state what were the three first **own words** that came to mind when thinking about Arctic Foods. Type of products were first to mind, and different types of seafood was highly representative (cod, traditional cod products and king crab). Then came reindeer, whale and by a few agricultural products like potatoes and finally different types of berries. Some mentioned features like fresh, tasty, wild and locally produced. This is somewhat different from what they rate as most important **arctic food values**. Here healthy, fresh, pure and environmental,- and animal friendly get the highest scores.



Consumer and producer's opinion differ slightly when **comparing values**. *Healthy* and *natural* are most considered as arctic characteristic by consumers. While *locally produced food*, *natural* and *traditional* food are the characteristics producers use mostly in their communication around arctic

products. The characteristic *natural* is the only one that is significantly more cited in both surveys. According to consumers, *locally produced* food is also another important property of arctic food but only for the consumers in Northern Norway. The term *locally produced food* should therefore only be used as a selling argument for products that are sold in Northern Norway. We noticed that there might be a small gap between producers' communication arguments and consumer's perception of Arctic food characteristics.

Consumers (62%) are stating a **willingness to** pay more for Arctic food products (figure X It is worth paying more for arctic food) although fewer agree that these products give value for money (31%). Producers (41%) do believe climate change is going to challenge their production in the future. Sami food is perceived as unique and exciting and is considered an important part of Arctic foods (29% totally agree). Finally, respondents largely agreed (30% totally agree) that Sami food traditions are linked to more environmentally friendly way of life.

7 Summary

The objective of this project was to identify new food production opportunities that could lead to sustainable economic development for Arctic communities. Preliminary results show that within the Arctic region there are considerable opportunities for commercial food production, both for export and for meeting local food needs. Food industries are producing large volumes of food commodities that are culturally compatible with indigenous\local food preferences and also have high export value.

There are however, large variations in actual and potential production and harvesting volumes, both between Arctic Nations, species, and product groups. The volume variations at a national level can, for instance, be seen in the export statistics for seafood products (see <http://webgis.usask.ca/ArcticFood/>). These differences will have a large effect on product development and marketing strategies chosen by producers as a whole. Whereas challenges with infrastructure and food security are important issues in Iceland and Canada, marketing access, lack of available raw material, and skilled workforce, and environmental issues are some of the main challenges shared by all.

Food production is of great importance for the economy of Iceland. Fisheries based on large vessels are well established and fish are exported to many countries. A considerable part of the population and economic activities are located in the southern part of the island. The northern part faces the Arctic Ocean and this part of the island is sparsely populated. However, the northern region is well suited for sheep farming and geothermal energy and tourist attractions are found in this region. Infrastructure is less developed than in South Iceland, e.g. regarding roads and transport systems. The population in Northern Iceland has been shrinking over the last few decades and this could develop to a critical point where residence cannot be maintained. Increased food production in the northern regions might be a key factor to preserve the inhabited regions. It is costly to invest in new land based production facilities. Qualified human resources are important to allow for the production of high quality fresh and frozen fillets, portions and whole fish products that meet the highest standards of the market. Accessing new markets will require additional resources.

Iceland has a variety of biological resources available for sustainable and responsible utilisation, some of which are underutilized. The major underutilized resources include side streams, such as those found in the marine and agricultural industries. However, data on these resources are sparse, resulting in ineffective

decision making. Iceland, except for the capital area, is sparsely populated with changing demographics impacting regional innovation capacity. Developing human capacity enables adaptive solutions to climate change and global challenges described in the Sustainable Development Goals by the United Nations.

Iceland is mostly self-sufficient with dairy products and meat. However, the increasing number of tourists increases the demand for food. To satisfy this demand, Iceland must import food products. The tourism industry provides an opportunity for food producers to increase production and develop new products. Regional products are of particular interest to tourists and also help to increase sustainability and support local farmers. Vegetable production could be increased considerably, however there is import competition. Barley production in the country is 10–16 thousand tons per year. Only about 2% of the barley is used for food but this proportion could be increased.

Agriculture production in Northern Norway is mainly grass-based animal husbandry (dairy cattle, sheep, and goat), but some farms also include horticultural production (potatoes, vegetables and berries). The national objective is to cover about half of national demand. As good as all production is for the national market. As much as 95% of the fishery and aquaculture products are, on the other hand, being exported to other markets. The most important species in terms of volume are salmon, trout, cod, mackerel, herring and saithe. Despite different market situations of agriculture and aquaculture products, some challenges are general. First, all industries experiences production or harvesting limitations, due to either national regulations (e.g. quotas, health and safety legislations) or natural circumstances (e.g. climate, availability of food sources, resource availability). Production is therefore often seasonal. Second, high labor costs, transport costs and export tariffs on high-value food products, affect the profitability of food producing companies, for example contributing to less processing of seafood within the Norwegian borders. Third, similarly to Iceland and Canada, there is also a shortage of skilled labour. Since food harvesting and/or production in most instances are located in districts with low population density, acquiring knowledgeable and flexible employees can be an issue.



Figure 12 Competence building: small scale producers are taught meat processing techniques in Tromsø 2018. Photo credit Hilde Halland, Nibio

Local food in Northern-Norway, a success through cooperation and competence building. About 500 local food producers can be found in Northern Norway today¹¹. The agricultural food processing industry in Northern Norway is dominated by large cooperatives owned by the farmers, like TINE (dairy) and Nortura (meat). In addition, there has been a focus on building various types of network cooperation between the local food companies. These networks are often partly funded through Innovation Norway. Most networks are geographically linked like *Nordlandsmat* or *Vesterålsmat*, but some are also linked to a product type like *Lofotlam* (sheep meat) and *Arktisk kje* (goat meat). These networks often focus on overcoming the challenges of being a small producer in the north by achieving large-scale advantages and being stronger together in areas such as distribution, sales and marketing. Evaluations of the Company network program from Innovation Norway points to criteria for success to be that the purpose of the project must be clearly defined and beneficial for all parties involved. A general lesson is that it takes time to build trust between the

¹¹ Numbers from The Centre of Expertise for local food production North (Kompetansenettverket for lokal mat Nord)

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companies, especially if they see themselves as competitors¹². However, some of the networks in Northern Norway is still active after 12-13 years like *LofotenMat* (founded in 2007) and *Fjellfolket* (funded in 2006). Competence is the key to success. Governmental support to build up the local food sector in Norway started in 2002 including starting the Centre of Expertise for local food production where the northern hub is located at Nibio in Tromsø. The target group is small and medium sized local food producers where the goal is to increase the value of arctic food through increased competence. The means for doing this is courses and direct help in the business.

In Canada a national Nutrition North Program subsidizes the transportation costs for selected foods shipped from the south to northern communities. Eligible foods include meats, vegetables, grains and dairy products. The objective of the NNP is help make healthy foods more affordable and accessible to northern communities. On average the NNP provides annual subsidy of \$65 million, nearly half of which subsidizes the transport of meat, fish and vegetables. As of 2018, 121 northern communities were eligible for subsidized food rates. While well intentioned, the NNP has in some cases caused economic disincentives for local food producers, as the subsidized costs of imported foods are often lower than actual costs of food grown or harvested in the North, for instances potatoes grown in the Northwest Territories.

Adding further challenges to local food production in northern Canada are the Comprehensive Land Claims (CLC). The settlement of Comprehensive Land Claims (CLC) recognizes Indigenous ownership of over 600,000 km² of land, protection of traditional ways of life, confers exclusive and preferential harvesting rights, and provides for Indigenous participation in land and resource management decisions. CLC have the potential to facilitate entitlement and access to food as they contain specific provisions that protect Indigenous hunting, harvesting and fishing rights. While the settlement of CLC has in many ways empowered Indigenous peoples in Canada, the specific provisions found in these agreements have also created barriers to the development of food related industries. While the provisions vary from one CLC to another, most contain explicit language that prohibit the commercial sale of traditional foods. The only exception being the Nunavut Land Claims Settlement (1993) (see Table 1)

Table 1 Land Claims Provisions Relevant to the Commercialization of Traditional Foods

Land Claims Provisions Relevant to the Commercialization of Traditional Foods	
Agreement	Provision
Labrador Inuit Land Claims Agreement 2005	12.3.9 No Person may sell Wildlife or Plants under section 12.3.17 except as provided in sections 12.3.11 and 12.3.12 and under Laws of General Application.
	12.3.12 Inuit have the right to sell to any Person: (a) any non-edible product of Wildlife Harvested and (b) any craft, tool, artwork or other cultural artefact that they produce from Plants.
Nunavut Land Claims Agreement 1993	5.7.30 - Subject to Sections 5.6.26 to 5.6.30 and 5.7.31 to 5.7.33 , an Inuk shall have the right to dispose freely to any person any wildlife lawfully harvested. The right to dispose shall include the right to sell, barter, exchange and give, either inside or outside the Nunavut Settlement Area.
	5.7.33- Inuit are subject to laws of general application regarding the sale or offer for sale of any migratory bird, migratory bird's egg, or parts thereof.
Gwich'in Comprehensive Land	12.3.4 The Tetlit Gwich'in shall have the right to trade among themselves and with Yukon Indian people all edible fish and wildlife products harvested by them pursuant to 12.3.1

¹² Evaluering av Bedriftsnettverks-tjenesten til Innovasjon Norge, Oxford Research, 2018.

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Claims Agreement 1992	in order to maintain traditional sharing among aboriginal people in the Yukon and Northwest Territories for domestic purposes but not for commercial purposes.
Yukon Umbrella Final Agreement 1990	16.4.5 Yukon Indian People shall have the right to give, trade, barter or sell to any person any Non-Edible By-Product of Fish and Wildlife that is obtained from the Harvesting of Furbearers or incidental to Harvesting pursuant to 16.4.2, or limited pursuant to a Basic Needs Level allocation or pursuant to a basic needs allocation of Salmon.
Western Arctic Claim - Inuvialuit (1985)	14.(24) The Inuvialuit may, without restriction, sell, trade or barter fish and marine mammal products acquired in subsistence fisheries to other Inuvialuit , regardless of residence, subject only to regulations to protect public health, to prevent sale, trade or barter to persons who do not qualify and to permit the acquisition of information necessary for the management of the fishery.
	14.(27) Subject to the Fisheries Act and any regulations thereunder, the right to harvest fish and marine mammals includes the right to sell the non-edible products of legally harvested fish and marine mammals.
James Bay Northern Quebec Agreement 1975	24.3.11c. Community use shall include the gift, exchange and sale of all products of harvesting consistent with present practice between Native communities and/or members of the Native community or communities. For greater clarity, community use shall not exclude the gift, exchange and sale of all products of harvesting between Native communities and members of the Native community or communities not presently conducting such activity. Community use shall not include the exchange or sale of fish and meat to non-Natives except in the case of commercial fisheries.
	24.3.16 The Native people shall have the right to trade in and conduct commerce in all the by-products of their lawful harvesting activities.

Notwithstanding these challenges, there are opportunities for increased production in the Northern Regions since there is increased demand for high quality food. Local niche products are needed for specialized markets. New opportunities might include domestic food production in farms and villages to meet local needs while reducing carbon footprint. This might interest tourists who are visiting northern regions and may be receptive to local foods. The continued growth of the tourist industry could become important for the food related economy of the northern regions. Iceland, Norway and Canada each have the advantages of adding value to the products by further processing and product development or identifying the local value by historic background or Arctic quality for increasingly growing consumer market. Iceland and Norway are already identifying special chemical attributes within the raw material produced in the Arctic climate and using this for marketing or as extractions of valuable compounds used within the industry. For these reasons some of main opportunities for increased food production and value adding revolves around niche products and storytelling, better use of surplus biomasses, improving product quality, and increasing food tourism and local markets. This has been the case in northern Canada where the production of prepared or value-added foods has been steadily increasing since 1990s. Since 2000, the export volume of prepared foods has increased by approximately 18,000 tons per year, or an increase of 384% since the 1990s. These exports consist mainly of value-added fisheries products (e.g., farmed char), but also includes agricultural products (berries, teas, beverages) that are contributing to local economies and food security of the region.

New opportunities within the Arctic region may also arise from global warming, especially within land-based production. As the growing season is being prolonged, it opens up for new and more productive species, especially annual species. An ongoing North-Atlantic collaboration has identified a possible northward expansion of barley cultivation because of temperature increase. With a changing diet preference, the market demands more vegetable-based products which can increase production of berries and vegetables in the Arctic. Agriculture in the Arctic region is considered marginal, characterized by a short

growing season with low growth temperatures and long days. The increase in temperature due to global warming is predicted to be greater in the Arctic region than the global average. This opens new possibilities for increased plant production further north, especially annual plants. Land based plant production in the Arctic has not received much attention over the years, although it may be of global importance to utilize the production capacities of the northern regions. Global warming can give new opportunities for growing new crops and cultivars with a higher yield potential within a prolonged growing season. The unique light conditions in the Arctic will not change, and in interaction with the increasing temperatures this is creating new environmental conditions and with new challenges that are not comparable to any other plant-producing areas. Warmer autumns in combination with short days in the Arctic can e.g. result in less winter hardiness and increase winterkill of crops.¹³ To identify the capacity for increasing plant production and agriculture in Arctic areas, it is of major importance to understand the mechanisms behind the effects of climate change on plant production and plant persistence. Screening of available genetic resources in the Arctic is important for selecting well-adapted plant material both for crop production and for preservation of biodiversity. Implementing technological solutions into production systems will further increase the production potential. For a successful development of rural plant production, knowledge transfer is crucial. This can be achieved by strengthening and enlarging the R&D network to support collaboration across national borders in the Arctic. Engaging stakeholders from producers to consumers should promote innovation opportunities in agriculture, and create new markets and jobs. A better insight into the effective use of available plant genetic resources will give social and economic advantages for the future rural population in the Arctic area. Future opportunities also lie in new and better storage methods for seasonal raw material and full utilization of the raw material.

8 Policy Considerations

The SDWG should consider the establishment of an Arctic Foods Innovation Cluster. Icelandic Food and Biotech R & D (Matis), has established several food innovation centres at various locations in the country. Support from regional innovation centres has been a successful strategy for small-scale product development. The intention is to improve regional food production further and the Icelandic government is expected to increase funding for local and regional innovation all around Iceland. This is important, as small scale local and regional food producers and entrepreneurs need financial assistance in the early stages of food innovation. With the establishment of national ‘hubs’, a cluster-based approach to food innovation could draw together Arctic food producers with governments, Arctic Indigenous communities, universities, research centers, vocational training providers, and industry associations and young people (the next generation). An Arctic Foods Innovation Cluster (AFIC) would be well positioned to act on the findings of this study and serve as an institutional body capable of responding to global challenges of food production while seeking to define the Arctic’s role and contribution to the changing climate and issues of food security locally and around the world.

¹³ Dalmannsdottir, S., Jørgensen M., Rapacz, M., Østrem, L., Larsen, A., Rødven, R. and Rognli, O.A. 2017. Cold acclimation in warmer extended autumns impairs freezing tolerance of perennial ryegrass (*Lolium perenne* L.) and timothy (*Phleum pratense* L.). *Physiologia Plantarum*, 160:266-281.