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Cereal Products And Markets In The Northern Periphery Region

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Cereal products in the North – A Preparatory Project supported by
The Northern Periphery Program



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<i>Ágríp á íslensku:</i>	<p>Forverkefni um kornmarkaði og kornafurðir úr svæðisbundnu korni var unnið á tímabilinu september 2013 til mars 2014. Verkefnið var styrkt af Norður-slóðaaætlaninni (Northern Periphery Promramme, NPP). Þátttakendur komu frá Íslandi, N-Noregi, Færeyjum, Orkneyjum og Nýfundnalandi. Markmið verkefnisins var að: (1) Byggja upp samstarfsnet um kornrannsóknir. (2) Afla upplýsinga um kornframleiðslu og kornnýtingu á hverju svæði um sig og leita nýrra markaða og samstarfsaðila. (3) Leggja drög að umsókn um stórt kornverkefni. Þátttakendur greindu upplýsingar um kornframleiðslu og korninnflutning. Í ljós komu tækifæri til að láta innlenda framleiðslu koma í stað innflutnings. Kornmarkaðir og þróun markaða var tekin til skoðunar og mat var lagt á stærð markaða. Það ætti að vera mögulegt að auka innlenda framleiðslu á ýmsum kornvörum svo sem bökunarvörum, morgunkorni, pasta og áfengum drykkjum. Þátttökulöndin / svæðin eru á mismunandi stigi með tilliti til kornræktar og því þarf þróun kornvara að taka mið af aðstæðum.</p>		
<i>Lykilorð á íslensku:</i>	<i>Korn, Kornafurðir, Vöruþróun, Kornmarkaðir</i>		
<i>Summary in English:</i>	<p>A preparatory project scoping new markets and products from local cereals in several parts of the Northern Periphery Programme (NPP) area, was implemented between September 2013 and March 2014. The project included partners from the following regions: Iceland, N-Norway, Faroe Islands, Orkney and Newfoundland. The project aim was to: (1) Build up a collaborative R&D network on cereals. (2) Review cereal production and utilization in each partner region and identify potential new markets and collaborators. (3) Develop a proposal for a main project. Partners quantified the domestic cereal production and import of cereals. Opportunities were found where imported cereals might be replaced by local products. Cereal markets and food trends were studied and the size of the market for cereal products was estimated. It is possible to increase the use of local cereals for production of many foods: bakery products, breakfast cereals, pastas and alcoholic beverages. The regions differ with regard to cereal production and development of cereal products should take the situation into account.</p>		
<i>English keywords:</i>	<i>Cereals, Cereal products, Product development, Cereal markets</i>		

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1. EXECUTIVE SUMMARY

1. A preparatory project scoping new markets and products from local cereals in several parts of the Northern Periphery Programme (NPP) area, was implemented between September 2013 and March 2014. The project included partners from the following regions:
 - a. Iceland: Matis (Icelandic Food and Biotech R&D), Agricultural University of Iceland.
 - b. Northern Norway: Bioforsk Nord.
 - c. Orkney, Scotland: Agronomy Institute at Orkney College UHI.
 - d. Faroe Islands: Agricultural Centre.
 - e. Newfoundland, Canada: Agrifoods Development Branch – Forestry Agrifoods Agency, Government of Newfoundland and Labrador.
2. The project aim was to:
 - a. Build up a collaborative R&D network on cereals.
 - b. Review cereal production and utilization in each partner region and identify potential new markets and collaborators.
 - c. Develop a proposal for a main project.
3. The background to the project was a common perception in partner regions that there was major potential for greater local cereal production. The main drivers for this were:
 - a. Increased interest in “local” or traditional food products, partly stimulated by demand from tourists.
 - b. The need to reduce the carbon footprint of agricultural feeds and food and drink products. This is particularly large for peripheral regions like those of the partners.
 - c. The financial benefits and employment opportunities this would create for both growers and a range of end-users.
 - d. The availability of improved varieties of cereals with potential for use across all regions.
 - e. The expectation that climate change will improve growing conditions across the area and the perception that this is already happening in some parts of the region.
4. Where possible, project partners quantified the import of cereals to their regions. Currently these mostly represent an outflow of money from the partner regions, but they also indicate opportunities, where imports might be replaced by local production. Some of the main results from this part of the study were:
 - a. Excluding Northern Norway, for which it was not possible to extract local data from national figures, imports of cereals for the partner regions were estimated at about 156,000 t (compared with local production of 42,000 t, excluding Northern Norway) .

- b. In Iceland, 20,518 t were imported for food production and 51,510 t for feed. In the Faroes and Newfoundland, total imports were 15,658 t and 60,000 t, respectively. Orkney is mostly self-sufficient in feed, and most imports are for food and drink, very little of which is produced from local cereals.
 - c. The above data exclude agricultural seed. With about 9,300 ha of cereals being grown in the partner regions, this requires about 1,900 t of seed annually. Most of this is imported – for example, in Orkney, about 85% of seed used is imported.
 - d. In all partner regions, malt is an important import, used mainly by breweries, but in Orkney also by distilleries. Annual malt imports are estimated at about 3,400 t in Iceland and 6,000-7,000 t in Orkney.
5. Research into the recent production of cereals in each partner region showed the following:
- a. There was a wide range of annual production scenarios, ranging from about 24,000 t for Orkney, 17,000 t for Iceland, 1,500 t for North Norway, and no production in the Faroes and Newfoundland (until 2013).
 - b. Barley was by far the most important cereal grown in all regions and is likely to continue to be so because it is the most suitable cereal for northern areas.
 - c. In partner regions where cereals were grown, the majority of cereals were grown for animal feed, with a maximum of 1% of local production (in Iceland) being used for food and drink products.
6. Market-based research by the partners identified the following major factors:
- a. National food consumption surveys for Iceland, Norway and the UK indicate an average annual intake of 74-91 kg of cereal products per person.
 - b. The total resident population across the partners was about 1.4 million people (325,700 in Iceland, 478,100 in Northern Norway, 48,200 in the Faroes, 21,300 in Orkney and 525,000 in Newfoundland).
 - c. The results from a. and b. indicate a total annual consumption, by residents, across the region of about 112,000 t of cereal-based food products. While recognising that this figure is not the same as the quantity of cereal grains required, the figure is a useful base-line indicator of demand (see also 6d).
 - d. Although difficult to quantify accurately, available data indicated that about 1.6 million visitors come to the region annually (excluding Northern Norway). With many of these visitors keen to try local food and drink products and staying on average for several days, this adds significantly to the potential market for cereals created by the resident population (quantified in c.).
7. The partners combined their knowledge of local market trends with those of global trends in the food and drink market and identified several drivers which suggest strong and continuing demand for food and drink products made from local cereals:
- a. Amongst food products, major trends are for increased demand for local, healthy and convenience foods. There is particular interest in regionally distinct foods made from local ingredients. An added advantage of cereals is that wholemeal products, in

particular, have recently been promoted as healthy foods as a result of their high fibre content while barley also benefits from its high beta-glucan content.

- b. The same strong demand for locally distinct products has been seen in the global drinks market where consumer reaction to a range of similar products from large multi-national companies has resulted in a proliferation of small-scale, innovative producers. This is best seen in the rise of microbreweries, but has also been reflected in microdistilleries. For example, in Britain, 187 new breweries opened in 2013, while in the USA, the sale of craft beers defied the recession and doubled to about \$12 billion (€8.8 billion) from 2007 to 2012.
 - c. Within the spirits market, there is particular strong demand for premium products, either traditional (e.g. single malt whisky) or innovative (e.g. flavoured vodka and gin). Consequently, the sale of premium spirits increased by 10% from 2010 to 2011 compared with 7% for overall spirits sales in the same period. In the premium market, consumers have a particular interest in craft producers and products which demonstrate special provenance. This is especially relevant to the partner regions.
 - d. Apart from their production side, there is also a trend for breweries and distilleries to invest in visitor centres which creates additional employment and helps to attract tourists to a region. In Scotland, for example, about half (52) the distilleries have visitor centres and it is estimated that these employed 460 workers, attracted 1.3 million visitors and had a turnover of £26.9 million (€33.1 million) in 2010.
 - e. A well-established brewing or distilling industry which uses provenance to promote its products must ultimately seek to maximise its use of local ingredients and this can give a major boost to the rural economy. The Scottish whisky industry, for example, spent about £200 million (€247 million) on purchasing Scottish cereals in 2008.
 - f. Although the Scottish whisky industry has developed over hundreds of years, Sweden provides an excellent example of how a new whisky industry (about 11 distilleries) can be established in a much shorter time - only 15 years. Similar progress could be made in some of the partner regions.
 - g. Internet marketing has made it very much easier for small companies in isolated areas to reach large overseas markets.
8. As a result of stakeholder discussions and the study of imports (4. above), partners identified the opportunities for increased cereal production in their own region, especially for food and drink uses. The main opportunities are considered to be the following.
- a. In regions where there is little or no cereal production (especially Newfoundland and The Faroes), the priority is likely to be on developing cereals for feed, although in both regions there is also interest in food and drink uses. Although feed uses are well developed in Orkney, there is potential for growing wheat as the basis for producing specialist feeds.
 - b. Across all regions, there is potential for increasing the use of farm-saved seed, although this is only possible where grain drying facilities are available.
 - c. The main food and drink uses of barley in all partner areas are likely to be flour for bakery products (especially bread and biscuits) and pasta, husked grain for soups,

breakfast cereal and porridge, and grain for malting (for beer or spirit production). All of these uses have already been pioneered on a small scale in Iceland or Orkney.

- d. Across the project partnership, local companies have been identified which are keen to participate in developing most of the products identified in 6c.
 - e. The markets identified in 6c will, however, require grain of a suitable quality and also access to appropriate equipment or facilities for additional processing (e.g. for milling, husking or malting). New alternatives to traditional methods may sometimes be appropriate – for example, Iceland has experimented with making beer from unmalted grain and enzymes.
9. Apart from Iceland, there had been few studies on the economics of cereal production in the partner regions. Nevertheless, the potential profitability of the enterprise is indicated by the significant areas already grown in Orkney and Iceland. In these regions, some of the most important factors affecting profitability are the following:
- a. Yields are strongly influenced by the right choice of location, soil and appropriate agricultural practices. There are, however, few opportunities for growers to reduce fixed costs of production, except by using farm saved seed. Care is needed with this, however, to ensure good quality seed is produced which will give a good crop.
 - b. For cereals to be sold for food and drink uses, their moisture content needs to be reduced immediately after harvest to about 14%. While grain drying is more expensive than processing grain for animal feed, and requires an investment in appropriate machinery, it provides growers with access to higher value markets. The use of early maturing varieties can reduce drying costs because they are likely to be harvested with a lower grain moisture.
 - c. Straw is a valuable by-product from cereal crops throughout the region and will either be used on-farm or sold. It can contribute up to 25% of the production costs.
 - d. In most of the partner regions, the majority of farms with cereals will be likely to include livestock. This will allow organic manures to be used which will mean that cereal production will not be totally dependent on imported mineral fertiliser.
 - e. Apart from the advantage of income generation, cereal cultivation can have wider benefits within the farming system. For example, the introduction of cereal cropping allows a crop rotation and hence the renovation of grass fields, making them more productive.
10. Partners identified a number of research initiatives which have generated information of considerable value to any future NPA cereal project, especially:
- a. Research on barley bread at Nofima (Norwegian Food Research Institute).
 - b. The BARLEYboost project which is investigating the use of barley for making healthy foods.
 - c. The NORSKOL project which is being carried out by Bioforsk in Norway which will focus on gathering traditional and new information about Norwegian brewing.
 - d. MATIS and The Agricultural University of Iceland have been collaborating in projects aimed at increasing the value of Icelandic barley since 2006.

- e. In Scotland, the Agronomy Institute has been collaborating with the Rowett Institute of Nutrition and Health to investigate the nutritional properties of Orkney-grown barley and oats since 2011. It has also been involved in projects with distilleries, breweries and mills which have resulted in the release of new products.
- f. In parallel with the current project, the same partners are also involved in a NORA funded project (Northern Cereals – New Opportunities) which is addressing a number of issues related to the commercial growing of cereals in the partner areas. The support to the growing side provided by the NORA project will therefore provide a sound basis for a future Northern Periphery & Arctic (NPA) project concentrating on the end user side of the supply chain. The NORA project has also helped to consolidate the collaborative network between the partners.

2. INTRODUCTION

The demand for cereal products is great. Cereals are among the most important food groups with many different products that vary in importance from one country to another. The northern periphery areas have been underdeveloped with regard to utilization of regional cereals. Cereals for food production have mostly been imported. However successful production of cereals in some northern areas have opened new possibilities for regional utilization for food. Cereals are also important feed for cattle and pigs.

In recent times, northern cereals have almost exclusively been used for animal feed. It is a new approach in the northern areas to use the cereals as a major source for the food and drink industries. Also, increasing tourism opens up the possibility of regional food production for this growing market. Regional products are of special interest to tourists which means that local farmers and companies have opportunities to increase production with wide benefits for the economy. Regional use of local cereals for food, drinks and feed will reduce carbon footprint.

Tourism is increasing sharply in various northern areas. For example, about 807,000 travellers visited Iceland in 2013, more than double the population of the country. More food is needed in regions visited by tourists and here regional products are of special interest. This opens up new opportunities for local farmers and companies to increase their production with benefits for the regional economy.

There are strong indications that climate change will increase the potential for food production in the Nordic countries and also increase the pressure to expand food production at higher latitudes (Nordic Bioeconomy Initiative, 2013). Small temperature changes can have major effects on agricultural production and influence the choice of species and varieties. Cereals are now successfully grown in some Northern Periphery Areas (Iceland, Orkney) because of progress in breeding and increased experience and know-how among farmers. Other areas (Faroe Islands, N-Norway) have not yet fully employed the developments elsewhere. Northern areas require different cereal varieties to warmer regions so the cooperation between the Northern Periphery Areas is very useful.

Growing cereals in the cool climate of northern areas has both advantages and disadvantages. Among the advantages are the generally low levels of contaminants in the harvest and the products are therefore expected to be wholesome. Insects and other pests are relatively few and use of pesticides is limited. The relatively low temperature means that some of the mycotoxin producing moulds do not survive. It is a disadvantage that cereals in most northern areas are usually harvested before they are fully mature and consequently the grain contains too much water for storage. It is therefore necessary to dry the grain after harvest for proper storage and high quality.

Barley is the cereal best suited for cultivation at high latitudes. Although the cultivation of wheat, oats and rye has been successful in some northern areas, it is expected that barley will continue to be the main cereal crop in northern areas in the future.

Barley and other cereals have great potential for the production of a variety of foods (Baik and Ullrich, 2008). Icelandic barley has been used for production of bakery products, breakfast cereals and beer. Barley contains less gluten (which builds structure in leavened bread) than wheat so barley is mixed with wheat for production of leavened bread. In a R&D project, barley from Icelandic farmers was used successfully to produce leavened bread from 40% barley and 60% wheat flour

(Reykdal et al., 2008)). However unleavened bakery products can be made from 100% barley. Experimental production of barley malt was successful in Iceland.

An indication of the potential for increasing the production of local cereals for food in northern areas is given by data from Iceland where the total use of cereals is about 90,000 tons per year for the food and feed sectors. The production of cereals (mostly barley) in the country is about 15,000 tons per year and mostly used for feed. In 2011 only about 120 tons of barley were used for food in Iceland. It is possible to increase the production of cereals (mainly barley) in Iceland 5-fold since plenty of land is available.

Whole grain is rich in fibre and a diet with a high proportion of whole grains therefore helps to meet the recommendations of nutritionists for increased intake of fibre. The manufacture of whole grain products is increasing. Barley and oats are rich in the water soluble fibres beta-glucans which lower glycemic index and blood cholesterol. A recent EU regulation No 432/2012 permits health claims for beta-glucans (contribute to normal blood cholesterol levels; as part of a meal they contribute to reduction of blood glucose), and for barley/oats (contribute to increase in faecal bulk). Barley and oats might in the future be used in functional foods which have health benefits. The health potential and image of barley is particularly important for development in the North since barley can be cultivated at higher latitudes than other cereals.

A NPP PREPARATORY PROJECT ON CEREALS

The Northern Periphery Program (NPP) supported a preparatory project on northern cereals in the period September 2013 to March 2014. The main focus of the preparatory project was the development of cereal products (food and drink products) from northern cereals. Work was carried out on the following topics:

- Building a network to transfer knowledge on cereals between partner areas.
- Review of cereal production and utilization in each partner region. Special emphasis was put on cereal processing and possibilities to increase value of products.
- Emphasis was put on a study of cereal markets following recommendations from NPP staff.
- Cooperation was started with companies producing or processing cereals.
- Participation in two training seminars organized by NPP.
- Development of ideas and a proposal for a main project on cereal products.

This report reviews the work in the preparatory project.

Partners were from 5 countries: Iceland, North Norway, Faroe Islands, Orkney and Newfoundland. The following partners participated in the preparatory project:

- Matis – Icelandic Food and Biotech R&D (<http://www.matis.is>) is a non-profit institute under the Ministry of Industries and Innovation. Headquarters of Matis are located in Reykjavik Iceland. Matis was the lead partner in the project.
- Agricultural University of Iceland (AUI, <http://www.lbhi.is>) is an educational and research institution in the field of agriculture, land resources and environmental sciences under the Ministry of Education, Science and Culture.

- Bioforsk Nord, Norway, <http://www.bioforsk.no>, is an institute under the Ministry of Agriculture and Food. Bioforsk Nord is representing the three northernmost counties in Norway; Nordland, Troms and Finnmark, stretching from latitude 65°N to 71°N.
- Agronomy Institute (AI), <http://www.agronomy.uhi.ac.uk>, Orkney College (University of the Highlands & Islands) is a research centre of the University of the Highlands and Islands (UHI) and is based at Orkney College, one of the academic partners in UHI.
- Agricultural Centre (AC), <http://www.bst.fo>, Faroe Islands, is an institution belonging to Ministry of Fisheries and Agriculture.
- Agrifoods Development Branch -Forestry & Agrifoods Agency (Government of Newfoundland and Labrador), Canada (AFF, <http://www.nr.gov.nl.ca/nr/agrifoods>). The Agrifoods Development Branch of the Forestry and Agrifoods Agency, is responsible for promoting the continued development, expansion and diversification of competitive and sustainable primary and value-added agriculture and agrifoods businesses.

3. REGIONS AND POPULATIONS

The regions studied in this report are four regions within the Northern Periphery Area and additionally Newfoundland. The regions are defined as follows:

- Iceland, the whole country.
- North Norway: the counties of Nordland, Troms and Finnmark.
- Faroe Islands, all islands.
- Orkney, all islands.
- Newfoundland, the island which is a part of the Canadian district Newfoundland & Labrador.

Table 1. Populations in different regions.

Region	Date	Populations
Iceland - Capital area	1.1.2014	208,531
Iceland - Countryside	1.1.2014	117,140
Iceland - Total	1.1.2014	325,671
Norway - Nordland	1.1.2014	240,877
Norway - Troms	1.1.2014	162,050
Norway - Finnmark	1.1.2014	75,207
Norway - Total	1.1.2014	478,134
Faroe Islands - Capital area	1.1.2013	19,829
Faroe Islands - Countryside	1.1.2013	28,375
Faroe Islands - Total	1.1.2013	48,204
Orkney – Urban	1.1.2011	7,815
Orkney – Rural	1.1.2011	13,534
Orkney - Total	1.1.2011	21,349
Newfoundland - Urban	2011	305,566
Newfoundland - Rural	2011	208,970
Newfoundland - Total	2011	513,546
Total population		1,386,904

Sources: Iceland: Statistics Iceland, <http://www.statice.is>. North Norway: Statistics Norway, Population and population changes, Q1 2014, <http://www.ssb.no>. Faroe Islands: Statistics Faroe, <http://www.hagstova.fo>. Orkney: Scotland's Census 2011, <http://www.scotlandscensus.gov.uk/census-results>. Newfoundland: Statistics Canada, <http://www.statcan.gc.ca>.

Populations in the regions are reported in Table 1. The total population is about 1.4 million, most people live in Newfoundland and North Norway, about 0.5 million in each region. The population of Orkney is only 21,349.

According to Table 2, the estimated number of tourists visiting all regions, except Norway, is about 1.6 million per year, although it is often difficult to get accurate numbers for tourists. For Orkney 142,000 visitors were estimated in 2009, with an additional 45,000 visiting on cruise liners. The number of ships has increased in recent years, however, and now averages about 75 cruise liners carrying 60,000 passengers and 20,000 crew. Good data for tourists visiting Faroe Islands are not available, but it is thought that about 60,000 visitors come to Faroe Islands each year in addition to about 60 cruise liners with about 50.000 passengers.

Table 2. Number of tourists visiting different regions per year.

Region	Date	Number of tourists per year
Iceland	2013	807,349
North Norway		
Faroe Islands	2012	110,000
Orkney	2009	187,000
Newfoundland	2012	504,400
All regions, excluding Norway		1,608,749

Sources: Iceland: Icelandic Tourist Board (2014). Faroe Islands: Estimation. Orkney: Orkney Visitor Survey 2008/9. Newfoundland: Newfoundland and Labrador Department of Tourism, Culture and Recreation, 2013.

Data for North Norway is lacking in Table 2 as there are no good estimates of the total number of tourists visiting North Norway every year. The trend is however that this number is increasing, especially for winter tourism. The value of the tourism industry in North Norway is estimated at 16.7 Billion NOK (€ 2.02 Billion), and it employs 15,454 persons. In 2012, the number of visitor nights at hotels, camping places and hostels was 3,122,000. From 2008-2012 this number has increased by 10.3 % and it is estimated that foreign tourists contributed nearly one million of these visitor nights. However, since many tourists stay more than one night in Northern Norway it is difficult to calculate the exact number of tourists. In addition there are caravan and cruise boat visitors (Nordnorsk Reiselivsstatistikk 2012).

Food consumption surveys reveal the quantity of cereal products people consume. Comparison of cereal food consumption between regions might indicate opportunities for increased production. The consumption of cereal foods in Iceland, Norway and the UK is presented in Table 3.

For Iceland, data from the Icelandic national nutrition survey 2010-2011 are used. The survey included 1,312 individuals 18-80 year old selected randomly from the national register. All regions of the country were included.

The Norwegian survey was based on personal interviews and detailed accounting in a representative sample of private households based on persons from 0 to 79 years of age (0-84 years in 2012). In

2012 the sample was 7,000 households. Earlier the sample was annually 2,200 persons. Institutional households such as hospitals, boarding houses etc. were not included.

Table 3. Consumption of cereal foods in Iceland, Norway and the UK.

Food	Region	Consumption kg per person and year
Bread	Iceland	34.7
Biscuit and cakes	Iceland	17.2
Breakfast cereals	Iceland	5.1
Porridge	Iceland	10.6
Pizza	Iceland	9.9
Pasta	Iceland	6.9
Rice	Iceland	6.9
Cereal products, total	Iceland	91.3
Bread	Norway	40.5
Cakes	Norway	5.7
Crispbread, biscuits etc.	Norway	2.9
Macaroni and cornflakes	Norway	3.4
Flour and meal	Norway	21.8
Flour, meal, bakery products	Norway	74.3
Bread, white	UK	18.6
Bread, wholemeal	UK	6.6
Bread, brown	UK	5.1
Bread, other	UK	1.1
Bread, total	UK	31.4
Biscuit	UK	4.7
Cakes	UK	6.6
Breakfast cereals, high fibre	UK	6.6
Breakfast cereals, other	UK	2.2
Pizza, rice and pasta	UK	31.0
Cereal products, total	UK	82.5

Sources: Iceland: Thorgeirsdottir et al (2011). Norway: Statistics Norway (2013). UK: Department of Health UK (2012).

Specific consumption data for Orkney are not available. Therefore Table 3 presents average figures for adults in the UK (Average for male and female 19-64 year olds) from the National Diet and Nutrition Survey, Rolling Programme 2008/09 – 2010/11.

Food consumption data is not officially collected in Newfoundland and therefore cannot be provided. From Statistics Canada and the Canadian Council and Food and Nutrition (CCFN) we see there has been an overall decline in the consumption of grain products and few people make whole grain choices. Much of this is due to the bad press grains have received in North America in recent years

with publications such as “Wheat Belly” and other anti-grain/anti-gluten self-help books. This trend is not as pronounced in Newfoundland and consumption and demand of grain products still appears to be high based on observations.

It is not possible to compare the consumption data from the three countries in detail. However we might use these data for rough estimations. If consumption of cereal products is around 80 kg per person and year, the population of the partner regions (1.4 million) would need 112,000 tons of cereal-based food per year. This is of course not the same as cereals needed but gives us some indication. Tourists will add to the cereal products needed.

4. CEREAL HARVEST AND IMPORTS

An estimate of cereals harvested and imported (as whole grains, but excluding agricultural seed) by the partner regions is reported in Table 4. According to Statistics Iceland (n.d.) 72,028 tons cereals (rice excluded) were imported in 2012; 17,117 tons for food production, 3,401 tons malt and 51,510 tons for feed. The cereals were imported for 3,479 CIF¹ million ISK (about 22 million EUR). Cereal foods were imported in 2012 for 4,258 CIF million ISK (9,276 tons). These data were collected by using classification from the Directorate of Customs. The classification is complicated and a more detailed study is needed. However, some results are reported in Table 5. The annual barley harvest in Iceland has varied from 10,000 to 17,000 tons during the last 10 years. About 120 tons of domestic cereals are used for food production annually (about 1% of the harvest). This is mostly barley but small amounts of wheat are included (5-10 tons annually).

In Faroe Islands, the amounts of imported cereals per year are as follows: Barley 3,634 tons, wheat 8,192 tons, rye 2,381 tons, oats 1,451 tons (Statistics Faroe, n.d.). No cereals were harvested in Faroe Islands in 2012.

Table 4. Cereal harvest and import in different regions. Cereal seed is excluded.

Region	Date	Cereal harvest tons	Cereal import tons	Cereal, total tons
Iceland	2012	16,800 ¹	72,028	88,828
North Norway	2012	1,526		
Faroe Islands	2012	0	15,658	15,658
Orkney	2012	24,138 ²	8,500	25,088
Newfoundland	2012	0	60,000	60,000
Total		42,464	156,186 ³	197,124 ³

¹ Calculated for crop areas of 4,500 ha (determined by The Farmers Association of Iceland) and estimated yield of 3.75 t/ha. Estimated for grain at 85% dry matter.

² The cereal harvest for Orkney was estimated using crop areas from the Scottish Government's 2013 Report on Scottish Agriculture and multiplying the areas for barley, wheat and oats by average yield figures of 5.5 t/ha, 5.0 t/ha and 5.0 t/ha, respectively. These average yields are typical to those achieved in trials and are for grain at 85% dry matter.

³ North Norway is excluded. See table 5 for whole Norway.

Sources: Iceland: Statistics Iceland. Newfoundland: Department of Natural Resources, Agrifoods.

About 1,000 tons of barley were imported to Orkney for malting in 2012, an additional 6,000-7,000 t of malt are used by the islands' two distilleries and two breweries and it is estimated that about 1,000 t of flour are imported by bakery and biscuit companies. The sale of imported flour through supermarkets is not known. Small quantities of wheat were imported for specialist feed (e.g. for chickens and pigs), but more will be imported as chicken feed once a new egg production facility is fully operational. Hardly any rye, oats and rapeseed were imported as grain. It is estimated that

¹ CIF (Cost, Insurance, Freight) value means the FOB value plus costs incurred until the item is unloaded in the country of import. This chiefly involves freight rates and insurance costs.

about 15% of the cereal seed used in Orkney is “farm saved”, suggesting that about 680 tons of cereal seed is imported per year (there are 3 main companies importing cereal seeds).

Table 5. Cereal imports in Iceland in 2012.

	Cereals tons	Value million ISK	Value million EUR
Cereals for feed	51,510	2,175	14.0
Cereals for food, excluding rice	17,117	1,031	6.7
Rice	1,303	300	1.9
Malt	3,401	273	1.8
Breakfast cereals	2,076	1,387	8.9
Biscuits and cakes	4,740	2,255	14.5
Pasta	1,147	328	2.1
Other cereal products	1,313	288	1.9
Cereals and cereal products, total	82,607	8,037	51.9
Beer and pilsner	4,370	621	4.0
Whisky	101	143	0.9

Source: Statistics Iceland.

About 60,000 tons are imported each year to Newfoundland for the livestock industry. This does not include rapeseed although there are several farmers bringing it in for feed. The first harvest of barley was in 2013 and totalled 122 tons.

Since data for cereal imports to North-Norway are not available, the imports of cereals to the whole of Norway are reported in Table 6. All of the barley grown today in North Norway is used for fodder, but in other parts of the country the use of barley for human food has increased in recent years. In 2012, barley was cultivated on 339 hectares in North Norway. In the last decade some organic farmers used the barley in silage with molasses. For this, the barley is only grown to the yellow-stage, when it has a water content of about 35-50%. The yield was on average 4.6 tons/hectare (Røthe, 2006).

In the county south of Nordland, Trøndelag, barley is grown to full maturity. In a trial (Bergjord & Weiseth, 2011) with four different varieties the water content was between 18 and 26% and the yield between 4.7 and 5.6 tons/hectare. If we assume a yield of 4.5 tons/hectare the total production (at about 20% moisture content) in North-Norway is about 1,526 tons barley (4.50 tons/hectare × 339 hectare).

In the period 1961-1974, most of the cereals used for food in Norway were imported. After this the proportion of Norwegian produced cereals increased steadily and was about 70% of food cereals in 2007. About 3,000 tons of barley have been used for food in Norway in recent years (Norwegian Agricultural Authority, 2013).

It is important to know the number of farms and producers of cereals to evaluate the possible production of cereal products. The number of farms is shown in table 7. It can be seen that the proportion of farms producing cereals is relatively low. For the Faroe Islands the number of farms is reported as 380 although many of these are very small and run by part-time farmers; there are about 40 full-time farmers and 28 dairy farms. The 500 farms in Newfoundland include many small farms.

Table 6. Cereal harvest and imports for all Norway. Cereal seed is excluded.

Grain	Year	Cereal harvest tons	Cereal import tons	Cereal, total tons
<u>For food</u>				
Wheat	2012	52,882	222,545	275,427
Rye	2012	5,433	19,836	25,269
Barley	2012	2,757	0	2,757
Oat	2012	24,157	0	24,157
Total	2012	85,229	242,381	327,610
<u>For feed</u>				
Wheat	2012	177,768	104,939	282,707
Rye	2012	5,293	0	5,293
Barley	2012	457,134	104,938	562,072
Oat	2012	242,182	12,120	254,302
Total	2012	882,377	221,997	1,104,374
Total for food and feed		967,606	464,378	1,431,984

Source: Norwegian Agricultural Authority (2013).

Table 7. Number of farms in different regions.

Region	Year	Total number of farms	Farms producing cereals
Iceland	2010	2,592	444
Norway - Nordland	2012	2,387	35
Norway - Troms	2012	1,037	2
Norway - Finnmark	2012	336	1
Norway - Total	2012	3,760	38
Faroe Islands	2013	380	0
Orkney	2012	2,032	468
Newfoundland	2011	510	0
All regions		9,274	950

Sources: Iceland: Statistics Iceland and The Farmers Association of Iceland. North Norway: Norwegian Agricultural Authority. Faroe Islands: Statistics Faroe. Orkney: Economic Report on Scottish Agriculture 2013. Newfoundland: 2011 Census of Agriculture – StatsCan.

5. ECONOMICS OF CEREAL PRODUCTION

FEASIBILITY OF CEREAL CULTIVATION – THE SITUATION IN ICELAND

Since cereal cultivation is at very different stages of development within the partner regions, it seemed most useful to consider the feasibility of cereal cultivation using Iceland as an example. Here, there has been an active cereal research programme for many years.

The feasibility of cereal cultivation in Iceland is governed by two primary factors, the cost of production and the value of the products. In Iceland barley is the only cereal species, which is grown with acceptable safety, thus cereal in the present context refers solely to barley.

A. Production cost of unit weight of cereal is determined primarily by four factors:

1. Fixed cultivation costs. This includes the cost of land, such as land rental, fences, etc., the cost of machinery, i.e. tillage, seeding and threshing, the cost of fertilizer and seed costs. There are not many opportunities to influence this cost component, except by careful selection of land, choice of tillage method and the use of homegrown seed.
2. Usable yield per unit area. High yield is, of course, important as it reduces the fixed cost per unit weight. Various factors can affect yield such as the correct choice of fertilizer, proper choice of variety and also of course breeding gains for cereals. Selection of suitable location for cereal cultivation is also important as the whole country is not fit for barley cultivation.
3. Processing costs. Here we have costs that are dependent on harvest quantity. Three processing methods are available that differ both with respect to costs and safety; firstly, anaerobic ensiling without additives, secondly ensiling with additives, which makes it possible to keep the cereal in open storage, and thirdly drying. The last method can be costly if the cereal is harvested with high moisture content, but on the other hand the grain can be used in various different ways, creating opportunities for high added-value. The costs of drying are significantly higher in Iceland than in more continental climates, where the seed is threshed more or less fully dry. Processing costs can also be reduced by choosing early maturing varieties which deliver seeds with as little moisture content as possible.
4. Official support which the individual grower cannot influence.

B. The value of the product determines income. It is influenced by four factors.

1. The cost of the imported product. The value of the Icelandic cereal production will de facto be determined by the market price abroad plus transportation costs to the country. Price abroad is determined by many factors, including official cultivation support, which is decided differently than in Iceland and, in some cases at least, gives better support to cereal production. There have been considerable fluctuations in the market price in recent years.
2. The value of straw. Straw is a by-product, which is important in Iceland. It is unknown for straw to be imported to the country and the price of straw is entirely determined locally. It can fluctuate considerably depending on harvest and demand. Preliminary observation suggests that straw sales could amount to 25-50 % of fixed cultivation costs and can reduce considerably the income needed for the grain itself. Also, it is worth mentioning, that the straw yield is not nearly as sensitive to the weather as the grain yield.

3. The value of the harvest can be increased by processing it for human consumption. Malted barley is imported for beer production, but not for human consumption otherwise. In Iceland there is some production of cereals for human consumption, such as flour for bread making, breakfast cereal or barley (bankabygg) for food. These products are not in competition with imported barley, but should rather be compared to wheat, corn or rice. The same applies to the Icelandic barley, which is used in small quantities along with foreign malt in brewing beer. Therefore, it is possible to protect the Icelandic production in this area, which is determined by the fact that producers are willing to offer locally produced goods and consumers are willing to pay for the image.
4. Possibilities of added value in Icelandic cereal production at present appear to be associated with tourism. There seems to be considerable demand for food and drink products using local ingredients and made locally. This applies to flour in bread, breakfast cereal and ingredients in beer making. More examples could be mentioned. Knowing that a product is made with local ingredients is a big attraction and the market is willing to pay a premium for this.

C. The link of the cereal production to an emerging cultivation culture is an added value.

Cereal cultivation will encourage the renovation of grass fields through crop rotation resulting in higher quality roughage for livestock. This factor has probably been underestimated in recent years, as it is difficult to convert it to monetary value.

Recently we have witnessed a downturn in cereal production in the rural areas where farmers have had to lease land for their cereal cultivation, such as in Skagafjordur North Iceland. Those farmers have not benefitted from the positive influence of the leys.

Considering the current import of cereals and plans for the use of homegrown cereal for feed, it is clear that the market share of locally produced cereals can be expanded up to four times the production. What limits the growth of cereal cultivation now seems to be that organized processing and cereal sales are lacking. Cereal cultivation is now in the same position as milk production was in the years around 1930.

DOMESTIC MARKETS FOR CEREAL GRAINS

In Iceland, cereal farmers sell barley flour/whole barley directly to supermarkets, bakeries, breweries or food industry. One farmer sells barley flour to the company Kornax which sells the flour to bakeries together with imported cereals and other supplies for the baking industry. A market for cereal feed in Iceland has not been developed since most farmers use their cereal production on their farm.

In Norway the grain is delivered to Fellskjøpet (a farmer owned cooperative) or to various private mills. There is only one such mill/marked in Northern Norway, in Sømna, Sømna Mølle.

In Faro Islands there is no market for trade with grain.

In Orkney grain can be sold locally, but there is not usually a large market as most farmers aim to be self-sufficient in animal feed. The current feed price is about £140/t (€170/t). The price of straw is about £14 (€17) per round bale (1.2 × 1.2 m, approx. 200 kg straw/bale (fresh weight)); straw is commonly sold between farmers as large amounts are required for winter bedding.

There is some export of grain and straw to Shetland. This is estimated at about 160 t of grain (barley and oats) and 50 t of straw (straw is just used to top-up the load). This trade benefits from the lower cost of ferry transport from Orkney to Shetland compared with from Aberdeen to Shetland. A small amount of malting barley (about 50 t) is grown annually on contract for Highland Park Distillery and a similar amount of the Scottish barley landrace, Bere, is grown for Bruichladdich distillery. About 3 t of oats are sold to Barony Mill for milling.

Newfoundland farmers need all the grain that can be produced and therefore other markets for trading or selling are not required at the moment.

STATE SUPPORT

State support differs between countries but is not available in Faroe Islands since the domestic production of cereals has not started.

Cereal farmers in Iceland receive state support based on the size of cereal fields. Farmers only receive payment if the fields have been harvested, which can depend on the weather. The total support is a pre-determined amount and the support can be lower, if the cultivation exceeds the expected size (The Icelandic Agricultural Advisory Centre, 2014). The support in the year 2013 for a common/ traditional farmer was:

- 1-30 ha 17,000 ISK (about 110 EUR) per ha – minimum size 2 ha.
- 30-60 ha 12,000 ISK (about 77 EUR) per ha.
- Above 60 ha No additional payments.

The support for cereal cultivation on pig farms was:

- 1-75 ha 17,000 ISK (about 110 EUR) per ha – minimum size 2 ha.
- 75-150 ha 12,000 ISK (about 77 EUR) per ha.
- Above 60 ha No additional payments.

The Norwegian Agricultural Authority administers Income and Welfare Schemes which provide an income for primary producers. The main subsidies in agriculture are the schemes directed toward Incentive Programs related to land use and animal husbandry. For farms taking cereals to full maturity the support in North-Norway is 2,210 NOK per hectare (€ 268). If the production is organic the rate is somewhat higher.

In Orkney farmers are subsidised through the EU's single farm payment scheme, but this does not specifically subsidise cereal farmers.

The Newfoundland and Labrador Government is leading the current cereal crop expansion and research. The Forestry & Agrifoods Agency purchased the required equipment (combine, seeders, etc.) and brought equipment to each farm as necessary. The Agency is also supplying the seed and inputs for the crop during this experimental stage. Our goal is to assist farmers in creating the industry and then have them purchase their own equipment (with Government assistance) after the best management practices and suitable species and varieties are determined.

MARKET PRICES

Table 8 reports market prices for cereals sold as feed and for baked bread. Information on prices was collected by partners through different channels but Norwegian information was mostly collected from the Norwegian Agricultural Authority. Companies might get discounts from market prices, e.g. most bakeries in North Norway get discounts of about 20-30 %. No market prices exist for Icelandic wheat since production is little and quality differs between years.

Table 8. Market prices for cereal feed and food in different regions.

Item	Region	Date	Unit	Price, own currency	Own currency	Price EUR
Dried barley for feed (85% DM)	Iceland	Nov. 2013	ton	39,000	ISK	252
Milled barley for baking industry	Iceland	Nov. 2013	ton	50,000	ISK	323
Icelandic barley flour (supermarket)	Iceland	Nov. 2013	kg	575	ISK	4
Imported wheat flour (supermarket)	Iceland	Nov. 2013	kg	115	ISK	1
Whole wheat bread	Iceland	Nov. 2013	kg	300	ISK	2
Dried barley for feed	N-Norway	2012-2013	ton	2,320	NOK	285
Dried barley (whole) for baking industry	N-Norway	2014	ton	8,710	NOK	1,071
Milled barley for baking industry	N-Norway	2014	ton	8,730	NOK	1,074
Milled whole barley for baking industry	N-Norway	2014	ton	9,070	NOK	1,116
Whole wheat bread	N-Norway	2014	loaf	35	NOK	4
Whole wheat bread	Faroe Islands		kg	40	DKK	5
Dried barley for feed	Orkney	2013	ton	140	GBP	173
Straw	Orkney	2013	ton	75	GBP	93
Milled barley for baking industry	Orkney	2013	kg	1.26	GBP	1.5
Whole wheat bread	Orkney	2013	kg	1.87	GBP	2
Dried barley for feed	Newfoundland	Feb. 2013	ton	460	CAD	309
Dried wheat for feed	Newfoundland	Feb. 2013	ton	478	CAD	321
Dried oats for feed	Newfoundland	Feb. 2013	ton	383	CAD	257
Whole wheat bread	Newfoundland	Oct. 2013	kg	6.15	CAD	4

ECONOMICS OF REGIONAL MARKETS

The economics of cereal production in Iceland was analysed by the Intellecta consultancy company (Intellecta, 2009). They concluded that the cereal markets in Iceland would make it possible to increase the cereal production two-fold in 2-3 years after 2009 and increase the production three-fold in the next 5-7 years. To make this possible some government support would be needed.

The running of cereal farms can be profitable if certain conditions are fulfilled. The profitability was calculated for different sizes of cereal fields, equipment costs and type of farms. In almost all farms in Iceland, cereal cultivation is only a part of the activities on the farms.

It is important that the drying process for cereals is as economical as possible. Drying method, energy price and cost for buildings and equipment are the most important parameters. It is not likely that drying of less than 300 tons per year will be profitable.

The most important factors determining the profitability of cereal production in Iceland are market prices for cereals, climate change and membership of the European Union. It is expected in the future, that prices for cereals will increase and temperature will increase. Both factors will favour cereal production in Iceland. The general conclusion is that the outlook for cereal production in Iceland is positive.

From section 4 it can be seen that cereals are used for many products and the value for imported cereals are much higher than for the domestic production. It would be favourable for the economy of the country to increase the proportion of domestic cereals.

No economic research results are available for cereal production in Faroe Islands. The farmers that are ready to start with cereal production are dairy farmers and so they already have equipment for ploughing, cultivating, sowing, herbicide/fungicide spraying, mowing and baling. The inputs they need are machinery for threshing, and due to the poor carrying capacity of the fields, it is important to use machines with big and wide wheels, preferably twin wheels. Other inputs are fertilizer that will partly be imported NPK fertilizer and partly slurry from the dairy cows.

Norwegian Institute for Agricultural Research investigates the economic situation yearly for the different production enterprises. In 2012 farms with more than 10 hectares (97 farms) of barley had an average of 17 hectare barley and the average yield was 4.12 tons/hectare. The farmer got 2,200 NOK/tons (€ 266) and the income from the production alone was 153,000 NOK (€ 18,521), the margin was 10,000 NOK/hectare (€ 1,211).

The price of barley grain has gone up since 2012, and for 2013-2014 the price is 2,500 NOK/tons (€ 303) (Norwegian Agricultural Authority, 2013).

Bioforsk Økologisk (Bioforsk, 2006) produced a report on the economics of organic cereal production. It found that the yield is 40-50 % lower in organic farming compared to conventional farming. However due to increased governmental support and higher prices for organic grain the income is, on average, 35,634 NOK higher per hectare in organic cereal production compared to conventional.

In Helgeland most barley (from 170 hectare) is harvested by combine harvester. Farmers in the area deliver the mature barley (80-81% dry matter) to a common facility at Berg in Sømna where the barley is dried at 15-20°C air temperature (grain temperature is similar). Only a small amount of barley (from about 5 hectare) is used for silage. In Finnmark, the barley is harvested at about 60% dry matter and is solely used for silage and fed to cattle and sheep.

There have been some calculations in North Norway on the profitability on the production of barley for silage with molasses (Røthe, 2006). The results are positive compared to the use of alternative fodder. The investments in machinery are however relatively high.

Orkney. No published studies have been carried out on the economics of cereal production in Orkney.

The following inputs are normally used for cereal production:

- Fertiliser – most farmers will apply organic manure as slurry or farm yard manure to their cereal fields before ploughing, followed by mineral fertiliser at planting (N, P and K; typically about 50-60 kg/ha of each of N, P₂O₅ and K₂O)

- Herbicide
- Fungicide

Current, approximate costs of inputs and operations (costed at contractor rates) for growing malted barley are provided below, but returns are very variable and depend on the terms of the contract between the grower and distillery (see table 9 and notes below). Many growers would also perform some of the operations themselves which would reduce costs.

In comparison to a grain price of about £200/t (€246/t) for malting barley, feed barley is sold occasionally for a price of about £140/t (€172/t). Although feed barley would have a similar cost of production, it would not require drying (but would still incur a cost for any preservative used) and would have a slightly higher yield. In spite of this, the returns from malting barley are currently higher and have the attraction of providing a new source of income to growers.

If farmers have access to grain drying and cleaning facilities, they also have the possibility of using their own grain as seed (farm-saved seed) which can reduce production costs. For example in Orkney, farm saved seed has a production cost of about £300-400/t (€246-492/t) compared with a purchase price of about £540/t (€664/t) for commercial seed.

Table 9. Cost and income for growing of barley for malt production in Orkney.

	Cost/ha GBP (£)	Cost/ha (EUR)
Spreading farmyard manure	20	24
Ploughing	42.50	50
Seed ¹	(108.00)	(127)
Fertiliser	167.00	197
Single Pass Drilling	82.50	97
Rolling	17.29	20
Herbicide (spraying + chemical)	33.00	39
Fungicide (spraying + chemical)	45.00	53
Combining	100.00	118
Baling (14 bales @ £12/bale) ²	168.00	198
Grain Drying (5.8 t from 22% to 13% moisture content) ³	(230.00)	(271)
Total Cost⁴	1013.29	1196
Grain Value (5.2 t at 14% moisture content and £200/t) ³	1040.00	1227
Straw value (14 bales @ £12/bale)	168.00	198
Total Income	1208.00	1425

^{1, 3} Important cost variables are seed and grain drying – in some cases these may be provided free by the distillery – this makes a big difference to the profitability of the enterprise.

² This is based on round straw bales about 1.2 m in diameter and 1.2 m long.

³ £200/t is an indicative basic price for dried grain; the actual price can differ from this depending on deductions and premiums for quality and the general market situation.

⁴ Some farmers carry out some of the operations themselves in which case the costs are likely to be less.

Newfoundland. The cost of production has not been determined as Newfoundland is in the initial cereal production stages. We are working with private farmers that incurred labour costs that have not yet been shared; however we have assembled a general cost structure from our (government) end for the first experimental wheat crop. The cost of materials per hectare including seed, fertilizer, herbicide, combine fuel, Ag bag and preservative was €279. The per hectare value of harvest ranged from €910 on a field that was newly cleared of conifers (the previous year) and had acidic soil, to €2095 per hectare on a field that previously was planted with potatoes and was intensely managed. A barley cost/value analysis will be possible in fall 2014.

Newfoundland has a marine climate which is characterized by a cooler and wetter growing season than mainland Canada. Fungal diseases such as *Fusarium* Head Blight were detected and fungicides must be incorporated into our future trials.

6. CEREAL PRODUCTS AND LOCAL PRODUCTION

Cereal foods are a very important part of the diet in many northern periphery regions. This is indicated in Table 3 for Iceland, Norway and the UK. Cereal feed plays a major role in agriculture for the production of milk and meat. On the world scale maize and wheat are produced in greatest quantities but barley ranks fifth among the crops. Barley is the cereal best suited for cultivation in the northern periphery region and will be important for domestic foods and fodder. There is great potential to utilise barley in a large number of cereal-based food products as a substitute, partially or wholly, for wheat, oat, rice and maize (Baik and Ullrich, 2008). The following food uses of barley were reported:

- Barley flour for incorporation into wheat based products.
- Pearled barley used as a rice substitute
- Barley flakes
- Breakfast cereals
- Soups
- Porridges
- Bread, cakes, cookies, e.g. muffins and flat bread
- Noodles
- Extruded snack foods
- Tortillas
- Baby foods

In Iceland there is considerable production of cereal-based foods (mainly from imported cereals), but many finished products are also imported:

- Bread is mostly produced in the country from imported cereals. Barley bread is available in some bakeries but the use of barley could be increased. Cakes are mostly domestic products but barley has hardly been tested in these products.
- Most of the biscuits are imported. There are however traditional biscuits produced in the country and barley biscuits have been produced.
- Breakfast cereals are imported in great quantities but one Icelandic company has produced extruded barley breakfast cereal for a few years.
- Beer is produced in the country from imported malt and unmalted Icelandic barley. Beer is also imported.
- Whiskey and similar drinks are imported. Production of whiskey is being developed in the country.
- Pasta is imported but the production of experimental Icelandic barley pasta has been successful.

The domestic production of cereals is mostly used for dairy cows and pigs. Seed is mostly imported. Icelandic varieties are grown in Sweden for seed production.

Bakeries and breweries in North Norway import all their cereals as either flour or malt from southern Norway or abroad.

If new methods, varieties or climatic changes make it possible to produce dry grain with good quality, there is potential in the market for the production of barley flour for breads or traditional bakery goods. Barley grains can also be used as a substitute for rice. Barley grains are healthier compared to rice. Pre-cooked barley-grains have a possible potential in the market as a product in itself or in pre-cooked meal/dessert-products (sous-vide).

Local breweries are interested in local malt. However, malt production facilities do not exist in the whole of Norway. For malting on a larger scale a big investment in infrastructure and equipment is needed.

There is currently no cereal production in Faroe Islands. Local bread, cakes and beer are made from imported cereals, while products that require higher processing, like breakfast cereals, are imported.

Newfoundland and Labrador produces bakery products and alcoholic beverages. Products that require higher processing (i.e. breakfast cereals) are produced off-Island in mainland Canada or in many cases the USA. Also, bakery products produced in Newfoundland utilize grain imported from elsewhere.

The following cereal products are produced in Orkney:

- Seed. About 30 t of certified seed of Golden Promise (a variety from the 1960s which is still liked in Orkney because of its earliness). It is estimated that about 15% of the seed used in Orkney is “farm-saved” – approximately 120 t.
- Malting barley for whisky production – about 50 t is produced locally for Highland Park distillery and 50 t of Bere is grown and sent to Inverness to be malted for Bruichladdich distillery.
- Malt – about 1000 t of malt is produced locally by Highland Park distillery using mainly imported (about 950 t) grain.
- Bere (barley) – about 15 t is produced locally for milling by Barony Mill into Beremeal.
- Wheat – ca. 8 t is produced locally for milling by Barony Mill into flour used by a local bakery.
- Oats – ca. 3 t is produced locally for milling by Barony Mill.
- Flours – the annual production by Barony Mill varies, but is about 10 t of Beremeal, 1-5 t of wheat flour (brown) and 1.5 t of oatmeal.

The following cereal foods are produced in Orkney:

- Flours - see above for quantities produced by Barony Mill.
- Bakery products – There is one major bakery and 3 smaller bakeries. These mainly produce breads but also biscuits and cakes. All use small amounts of Bere meal but only one uses local wheat flour.
- Malt – about 1000 t is produced by Highland Park Distillery for its own use.
- Whisky – is produced by Highland Park and Scapa distilleries.
- Beer – is produced by The Orkney Brewery and The Highland Brewing Company.

The following cereal products/foods are imported to Orkney:

- Seed - estimated at about 680 t annually.

- Barley (grain) – about 1000 t by one distillery for malting.
- Barley (malt) – about 6000-7000 t are imported by distilleries and breweries.
- Flours – A wide range of flours, including oatmeal, is imported by local bakery companies, biscuit manufacturers (probably about 1,000 t) and butchers (for haggis and white pudding). There are 3 main supermarkets in Orkney and these all import significant quantities of flour.
- Bakery products, breakfast cereals (all), beers and grain-based spirits – large quantities of all these products are imported by supermarkets and wholesalers.

7. TRENDS IN CEREAL FOOD MARKETS

REGIONAL TRENDS

A recent survey of the top 10 world food trends (General Mills, 2014) identified several which are very relevant to any future NPP cereals, in particular:

- Local food, based on greater transparency and more sustainability initiatives
- Wellness foods as a source of health and often using traditional grains
- More wheat-free products
- Snack options which are convenient and easy-to-eat

Similar trends were found by most project partners in their own areas. These trends are very relevant to tasks dealing with development of cereal products. The health benefits of barley as a food are considered further in section 8.

The trend for increasing consumption of local food is demonstrated by a study from Norway which found that over the last four years the growths of local food sales in grocery stores has been twice or thrice that for the food and drink sector as a whole. The data are shown in Table 10 and are based on AC Nielsen ScanTrack (Nielsen, 2013). For this, certain criteria are used to define products as *local food*. Then, since all products in the grocery stores carry a barcode all products sold are registered and their values can be summed to find values for the different categories. It is thus possible to buy values for certain regions, certain products or certain categories, but this information is expensive.

Table 10. Comparison of the turnover of local food and all food and drink in the Norwegian market from 2010 to 2013.

	2010	2011	2012	2013
Total turnover for local food	€ 280 million	€ 320 million	€ 340 million	€ 360 million
Growth of local food turnover in the last year	7.3 %	13.0 %	6.7 %	8.4 %
Growth of total category food and drink turnover in the last year.	3.5 %	4.0 %	5.0 %	3.6 %

In Iceland, food trends have not been studied. However, there is a general opinion that interest in local products and organic products has increased. Many small companies and initiators are trying to start small-scale production of foods.

Partly out of recognition of the importance of the market for local food and drink products, several of the partner countries have initiatives aimed at promoting their food and drink sectors. For example, in Scotland, “Scotland, A Land Of Food And Drink” (Scotland of Food & Drink, 2014) is an initiative aimed at growing the sector to £16.5 billion (€20 billion) by 2017.

REVIEW OF TRENDS IN WORLD SPIRITS AND CRAFT BREWING

Since there is considerable interest from project stakeholders in most partner countries in the potential for using local cereals to produce spirits or beer, this section reviews information about the current state and anticipated trends in the world spirits and craft brewing markets. It also briefly identifies potential areas of collaborations between the partners and local stakeholders.

World Spirits

This section describes recent developments in the world spirits market. It then describes the recent development of a new whisky industry in Sweden to demonstrate that considerable progress is possible in a short time. Finally, aspects of the Scotch whisky industry are described to show some of the benefits this brings to Scotland. Within Scotch whisky, single malt whisky is of greatest relevance to NPP project partners as this is mostly produced by smaller scale distilleries in the remoter parts of the country.

The World Spirits Market

Global spirits consumption is expected to reach a value of US\$230.3 billion (€168 billion) by 2014 (Winchester Capital Research, 2012). The global spirits market is currently very buoyant and grew by 7% in volume from 2010 to 2011 (Ipsos, 2013). However, as a result of a trend towards premiumisation (growth in the more expensive spirit categories like single malt whisky and cognac), the value of sales increased even more, by 10% over the same period (Ipsos, 2013). Growth of sales has been highest in China and India and, together with Russia, these are the largest markets for spirits in the world. Within the spirits sector, there has been an expansion in sales of both traditional products (single malt whisky, rye whiskey, vodka and cognac) and also many innovative products (e.g. flavoured vodkas and gin) which are generating considerable consumer interest and redefining and creating new categories of spirit.

The demand for premium and super-premium products has created new markets for craft-producers and products which can demonstrate a special provenance. In the USA, for example, sales of flavoured vodka expanded by 25% between 2010 and 2011 (Ipsos, 2013) and there is growing interest in innovative brandies, gins and infused vodkas (Wright, 2011). This has resulted in a huge resurgence of interest in craft distilling in the USA where the number of licensed craft distilleries grew from 69 to 240 between 2003 and 2011 and it is projected that there may be 450 in the USA and Canada by 2015 (Wright, 2011). Marketing of new products which may have limited distribution channels has been greatly assisted by the internet and this is also helping to add to the exclusivity of products (Dow and Jung, 2011).

Some of the major product trends which are predicted (Wright, 2011) include:

- Increased consumer demand for more choice amongst distilled spirits
- Opportunities for strong growth of non-Scotch whiskies
- Strong consumer interest in spirits for mixing in cocktails
- Increasing sales of convenient, ready to drink (RTD) products
- Continued new product development of flavoured vodkas and rums

The world market for spirits is expected to continue to expand (Wright, 2011; Ipsos 2013) because it has remained resilient in spite of the recent economic recession in many Western countries and

particularly because its expansion is driven by increasing demand in the world's developing economies (India, China and South America).

Swedish Whisky Industry

Although whisky is often associated with Scotland (Scotch whisky), it is a global product which has many national variants. For example, there are strong whisky industries in Ireland, USA, Canada and Japan and each of these industries has its own characteristics and its own enthusiastic clientele. The development of a Swedish whisky industry within the relatively short timescale of 15 years provides a good example of the potential identified above (Wright, 2013) for the growth of markets for non-Scotch whiskies.

Construction of the first Swedish distillery, Mackmyra, started in 2002 and since then another 7 already have stills in place and 3 have started distilling (www.swedishwhisky.se/english/). Mackmyra released its first whisky in 2006 and is now well established as an international whisky producer. Using Swedish raw materials and developing its own approach to the whisky making process, it is likely that a distinctive Swedish style product is developing (Roskrow, 2013).

Scotch Whisky Industry

Exports of Scotch whisky reached a record £4.3 billion (€5.3 billion) in 2012, an increase of 87% over the previous 10 years (Scotch Whisky Association, 2013) and Scotland now earns more from whisky exports than from any other class of exports. With exports having increased for eight years in succession, demand is expected to continue to rise in the future in both mature (e.g. USA) and emerging markets (e.g. China, Brazil and India). A reflection of the Scotch whisky industry's confidence in the future is recent large investments in expansion of existing facilities and the opening and planning of new distilleries. Recently, for example, at least six new distilleries of varying scale have opened, several more are planned and Diageo has committed to investing £1 billion (€ 1.2 billion) in its Scotch whisky business while the Edrington Group is investing £100 million (€123 million) in facilities at its Macallan distillery (www.scotsman.com/lifestyle/the-new-whisky-distilleries-being-built-in-scotland-1-3223616).

Within the Scotch whisky industry, single malt whisky has shown particularly high growth in recent years with exports having risen over the last 10 years by 190% from £268 million to £778 million (€330 million to €957 million) (Scotch Whisky Association, 2013). Single malt Scotch whisky is very much at the premium end of the spirits market and most originates from smaller scale, individual distilleries, many of which are located in the remoter parts of Scotland's Highlands and Islands. Apart from producing high-value products, many of these distilleries make an important contribution to the local economy through the employment they provide, through local purchases and by the tourists which they attract (Scotch Whisky Association, 2011).

About half (52, in 2011) of Scottish distilleries have dedicated visitor centres and some of the more popular have resulted in the development of tourism and cultural clusters around the distilleries. In 2010, it was estimated that Scottish distillery visitor centres (52) employed 460 workers, attracted 1.3 million visitors and had a turnover of £26.9 million (€33.1 million) (Scotch Whisky Association, 2011). Another very important boost to the rural economy comes from purchases of cereals and in 2008 about £201 million (€247 million) was spent by the industry on Scottish cereals (Scotch Whisky Association, 2010). With an increasing need for product differentiation in a competitive market, an interesting trend is that some distilleries, especially on islands (for example, Bruichladdich on Islay and Highland Park on Orkney), are investing in developing local barley supply chains so that their whiskies can claim 100% local provenance (Martin, 2012). As a result, malting barley is being grown

in new areas and the most northerly malting barley in Britain is now grown in Orkney by Highland Park's supply chain.

The Craft Brewing Market

In both the USA and Britain, there has been a major increase in craft brewing and the opening of numerous microbreweries in recent years. For example, by December 2013, 187 new breweries had opened in the UK in the previous 12 months (Burn-Callander, 2013) while 409 opened in the USA (including 310 microbreweries) in 2012 (Brewers Association 2013). Mintel (2013) has reported that in the USA sales of craft and craft-style beers defied the recession and almost doubled between 2007 and 2012 – increasing from \$5.7 billion (€4.3 billion) in 2007 to \$12 billion (€8.8 billion) in 2012. It forecast that the sector would grow to \$18 billion (€13.1 billion) by 2017. In the UK, it is estimated that craft beer represents about 1.9% of total beer volumes, but with year-on-year sales increasing 84% for draught and 40% for packaged products (Nicholls, 2013).

The rise of the sector is attributed to a desire for discovery of new and unique products (Nicholls, 2013) which use new and esoteric ingredients (McFarland, 2013). As a result, breweries are taking ideas from distillers and winemakers, producing blended beers and beers which have been aged in whisky and brandy casks. Some beers have also been developed to be served with specific food dishes. Many of the drivers behind the development of craft beers are the same as those which resulted in major changes in appreciation of food in Britain - localism, natural ingredients, bolder flavours and artisanal methods (Brown, 2013).

The emergence of craft beers has also stimulated changes in outlets so that a number of specialist craft beer bars are emerging which stock a much wider range of beers than usual (Nicholls, 2013). Sales of craft beers has also been helped by online outlets – some of these sell directly to consumers while others process the orders but leave the breweries to despatch the beers (Burn-Callander, 2013). This has the advantage of allowing beers to be kept under optimum conditions until the time of sale.

Conclusions on spirits and craft brewing

The above review of markets and trends in both the spirits and craft brewing sector support the project idea that local breweries and distilleries, especially on a small scale, would be appropriate markets for locally grown cereals. Furthermore, where these are already established, the availability of local cereals could benefit them by providing raw material for new product development. The key reasons for this conclusion are:

- Recent market trends show that both sectors are buoyant and have expanded considerably in recent years, in spite of recession in many western countries.
- It is expected that these sectors will continue to expand for several years into the future.
- The market interest in unique, local, craft products using local ingredients (e.g locally grown cereals) will fit exactly with the aims of the main project which the partners are developing.
- Although the domestic market of most of the project partners is quite small, most receive large and increasing numbers of tourists annually. Many of these tourists are relatively affluent and consider the consumption of local food and drink products an essential part of the visitor experience.
- Spirit, in particular, is a versatile, high value product and therefore offers many opportunities for adding considerable value to local cereals.

- Development of local beer and spirit products in the partner countries by small scale producers has the potential to deliver widespread benefits – to cereal and spirit producers, bottlers and marketing companies and a wide range of retailers and outlets.
- With the rise of internet marketing and with the interest in many countries in novel products, it is also not unreasonable to expect that some of these products will eventually be exported and could become popular international products.

8. CEREAL PROCESSING AND FUTURE POSSIBILITIES

COMPANIES PRODUCING CEREAL PRODUCTS

Several different companies in Iceland, Norway and Orkney produce foods and beverages from domestic cereals. However, in Faroe Islands and Newfoundland and Labrador there are no companies producing foods or beverages from domestic cereals.

Four farms in Iceland supply the food industry and consumer markets with cereals which are mainly barley but small quantities of wheat have been available in some years.

- Mother Earth farm, <http://www.vallanes.is/> (Móðir Jörð): Barley flour. Whole barley. Selection of barley products.
- Thorvaldseyri farm, <http://www.thorvaldseyri.is/> (Eyrarbúið ehf. Þorvaldseyri): Barley flour for baking industry.
- Brautarholt farm (http://www.foldvegur.is/iskorn/um_iskorn/): Barley flour.
- Belgsholt farm (<http://belgsholt.is/>): Barley for breweries.

The first three farms are also food processors with a licence for food production. These farms have equipment for small scale cereal processing, e.g. mills.

The company Lífland imports most of the cereals used for food and feed in Iceland. A subunit of this company, Kornax, runs a mill for imported wheat and sells flour to the baking industry. Kornax also sells barley flour from Thorvaldseyri farm to the baking industry. All barley for food is milled at the farms since the Kornax wheat mill is not suitable for barley. Barley flour from Mother Earth farm is sold directly from the farm which also carries out product development.

The bakery industry in Iceland is well established. The number of bakeries has decreased over the last two decades and now one bakery (Myllan) holds a considerable part of the market. The Association of Bakeries (is. Landsamband bakameistara) promotes innovation in the baking industry. The food scientist at the Association has been active in promoting barley for bread. In 2009 the Association started a campaign to increase the use of barley in bakeries. During this campaign about 40 bakeries offered breads made from barley and wheat. Myllan bakery developed a barley bread named after the origin of barley at the Thorvaldseyri farm. Since then, the use of barley by bakeries has decreased. A few bakeries still sell barley bread all year round:

- Grimsbær bakery (is. Bakaríð Grímsbæ)
- Reynir bakery (is. Reynir bakari)

In 2013 the Association of Bakeries held a bread baking competition. Among the requirements was that barley flour should be at least 20% of total flour. Barley is now used at low levels in several breads as a result of the competition.

The company Árla ehf. is producing barley breakfast cereals made by extrusion. The product is called Byggi and is made from domestic barley. An initiator has founded the company Matgerðirn (e. Malt

production) to produce malted barley in cooperation with Scottish experts and companies. Experimental malting has been successful.

Icelandic breweries supply a considerable part of the beer consumed in the country. The beer is produced mostly from imported malt although the use of Icelandic unmalted barley is increasing. Two breweries supply the major part of beer produced in the country: Egill Skallagrímsson brewery and Vífilfell brewery. About 6 microbreweries are operated in the country. The following breweries use barley:

- Egill Skallagrímsson Brewery, <http://www.olgerdin.is/> (is. Ölgerðin Egill Skallagrímsson)
- Borg Microbrewery
- El Grillo Microbrewery (is. Ölgerð El Grillo ehf)

Iceland has no tradition in the production of whiskey. However Eimverk Distillery (<http://www.flokiwhisky.is/>) has started whiskey production and Thoran Distillery (www.thoran.is) is developing whiskey production.

The situation in Norway is as follows:

Bakeries: In the whole of North Norway there are approximately 100 bakeries. In addition there are even more small hobby-based bakeries producing *lefse* (a traditional flatbread).

Sous-vide: In North Norway there are some companies that produce their products with the sous-vide method. There is one company that produces pre-cooked dinners under their own label.

Breweries: In the whole of North Norway there is only one large brewery left, Mack Brewery AS, in Tromsø. In addition, interest in hobby-brewing has exploded. The rules and regulations concerning brewing and selling beer have been simplified over the last years, and some smaller breweries are today selling their own beer in their own restaurants and some (2-3) also sell beer in bottles.

Investment in new equipment is a challenge for companies today. Especially for small companies, these necessary investments create a considerable economic risk for the companies since there is little financial support from the government for such expenses (up to 25% support is possible). New investments necessary for utilizing locally produced barley would include the purchase of equipment for sowing, harvesting, drying, malting etc.

Faroe Islands. The Faroese have grown barley for centuries. It is most likely that the first settlers brought this tradition with them from the home-land they left – Ireland and Norway, and according to Faroese cultural history, the growing of barley continued unbroken for centuries until it stopped in the middle of the 20th century.

The grain was used only for food. As far as history tells, the Faroese have never been self-sufficient in grain, but to a certain degree domestic production of barley allowed islanders to be self-sufficient for long periods when merchant ships from the mainland were behind schedule or even needed to cancel trips due to bad weather.

After harvesting, the grain was dried in specially equipped houses with open fire and smoke. Before use it was milled in either small water mills or indoor in small stone grinding mills powered by hand.

The history of local grain production is still in people's mind in Faroe Islands, and now when the prevailing trend in food is heading towards local and traditional food, we feel that there is an interest to restart the tradition of grain production. Some farmers have taken an interest in it both for feed

production and to provide barley for the food and beverage industry. One brewery and a couple of restaurants are also interested in locally produced barley if or when it will be on market.

- Føroya Bjór, Klaksvík. The largest brewery in Faroe Islands brews a range of different types of beer as well as soda. They are working with the development of a special Faroese brew based on the Faroese barley cultivars Sigur and Tampar.
- Koks, restaurant Tórshavn
- Hotel Hafnia, restaurant Tórshavn
- Áarstova, restaurant Tórshavn

The three restaurants, Koks, Hotel Hafnia and Áarstova, have specialized in courses based on local products. According to the chefs, locally produced agricultural food is in great demand, and they would appreciate very much if local barley would be available.

But there is a long way to go in Faroe Islands. For commercial growth there are some basic needs like drying facilities and stores and they also need to invest in a mill. However, if they start with a small scale niche production some of the old mills could be renovated and started up again. They could be made to work again, even though they have not been operating for 60 years or more.

In Orkney there are several companies that produce cereal foods and beverages:

- Barony Mill – a 19th century water mill produces stoneground flours, especially Bere meal and oatmeal. Constraints are storage capacity for flour and access to markets outside Orkney.
- Bakeries: there are three bakeries and the largest, Argos, already uses local wheat flour. All bakeries use some local beremeal.
- Biscuit manufacturers: most bakeries also produce biscuits, some of which are exported. Stockans Oatcakes Ltd is a large producer of oatcakes.
- Distilleries: there are two distilleries, Highland Park and Scapa
- Breweries: there are two breweries, The Orkney Brewery and The Highland Brewing Company

POSSIBILITIES TO INCREASE CEREAL UTILIZATION

Iceland. The possible use of barley is well known within the food industry. Generally people in the food industry express interest in testing barley. Therefore it is concluded that people in the food industry will be willing to cooperate in a project on cereal product development.

A stakeholder meeting on cereal utilization was held in Reykjavik in October 2013. There were 23 participants from the baking industry, breweries, distilleries, wholesalers, cereal farms and research & development institutions. The conclusions of the meeting were as follows:

- Cooperation is needed between people that represent the cereal supply chain.
- Market analysis should be emphasised in all projects on cereal product development.
- Developments in cereal drying are needed. Drying capacity will limit the supply of barley for the consumer market if the demand increases sharply.
- Innovation in the baking industry is needed. New products are needed.

- Unique positions should be emphasised in the beverage industry.
- The safety of domestic cereals is very important. Research on the formation of mycotoxins under Icelandic conditions should be increased.
- Continuous promotion of domestic cereals is needed.

In North Norway there is considerable interest in increasing the use of barley for food. The following companies have expressed interest in product development.

- Mack Brewery AS. A large brewery in Tromsø, including a microbrewery with the possibility of producing batches of 200 l.
- Hemnes mikrobryggeri AS. A microbrewery situated in the area with the best growing conditions for grain (Helgeland) in Northern Norway.
- Tromsø bakeri AS. A medium sized bakery in Tromsø which used considerable amounts of barley in 2013.
- Eldhusbakeriet. A small bakery in Sortland which did not use barley in 2013 but has baked with whole barley grains earlier.
- Art Nor AS. A processing company producing precooked dinners and did not use barley grains in 2013.

Since barley is the only cereal that can be grown to full maturity in the north it is assumed that bakeries will not have a great interest in locally produced cereals. Barley seldom constitutes a big percentage in the recipes of baked goods. However, barley flours could be interesting for some bakeries producing other baked goods (other than bread). Sous-vide, pre-cooked dinner producers might be interested in using barley.

Interest in the utilization of domestic cereals is increasing in Faroe Islands. At the brewery Føroya Bjór, the production of beer from local barley was started in 2013, and there are plans for whisky production in 2014 based on locally grown barley. Gourmet restaurants are interested in using local cereals as ingredients in their menu.

Since 2010, Highland Park distillery in Orkney has been supporting a local supply chain producing about 50 t of local barley per year which is used by the distillery for making malt which will be used to produce an all-Orkney whisky (after several years of maturation). Although the supply chain is successful, there are challenges in producing the quantity and quality which is required at a reasonable price. In order to ensure the long-term sustainability of the supply chain and possibly to allow increased production in the future, a number of issues need to be addressed. Some of the most important are: i) achieving reasonable yields without excessively high grain nitrogen; ii) maintaining a suitable barley variety when it is only available as local farm-saved seed.

Barony Mill would like to double the amount of Bere meal and oat meal it produces annually, but needs help to access markets beyond Orkney.

The farmer who supplies wheat to Argos bakery is interested in continuing with this but has had difficulties accessing early varieties. Access to seed supplies might be improved if others were also growing wheat – this could be the case when a new egg production facility becomes fully established. The owners of this enterprise are interested in exploring the feasibility of this.

The Agronomy Institute has collaborative links with three malt whisky distilleries (Isle of Arran Distillers, Bruichladdich Distillery and Highland Park Distillery) and manages barley supply chains based in Orkney for two of them. Since these have only recently been established and cultivation of

malting barley is new to Orkney, the long-term sustainability of these supply chains depends upon on-going research to ensure that the desired quantity and quality of grain is delivered annually. There is also potential for collaboration with other distilleries close to Orkney which have recently opened (Wolfburn Distillery in Thurso) or are in the planning stage (Longship Distillery, Orkney; Shetland Distillery Company).

Orkney has two breweries and the Agronomy Institute already has good links with one of them (The Highland Brewing Company). It is anticipated that collaboration will develop further in the main project and will include the use of local cereals for brewing and adding value to products by special cask finishing. This will be helped by the links with distilleries. Most commercial malting companies in Scotland have a minimum batch size of about 50 t of grain. For specialist batches of beer, small breweries would not require more than about 1 ton of malt and so the lack of malting facilities able to produce small, specialist batches of malt (using local grain) is a major constraint. Possible solutions to this problem will be addressed in the main project. The Institute also has links with a brewery in Shetland which is interested in the possibility of local sourcing of barley.

In Newfoundland the interest in use of domestic cereals is increasing. Yellow Belly Breweries in St. John's Newfoundland and another local brewer is very interested in using local grains for their beer products. We are currently working on a strategy to test some local grain in the upcoming seasons. There may be other interested stakeholders, however first we have to overcome the perception that grain cannot be grown in Newfoundland. As awareness of the cereal growing capacity increases, more inquiries and interest from the public can be expected. At the annual agricultural fair, locals often ask where they may purchase the grain to make their own baked goods.

9. RESEARCH AND DEVELOPMENT OF CEREAL PRODUCTS

It is important that any future Northern Periphery & Arctic (NPA) cereal project builds on existing research knowledge and does not duplicate previous activities. The partners have therefore reviewed recent research on barley and some of the most relevant recent research, which will assist a future project, is summarised below.

Research on barley properties and utilization has been carried out in South Norway. A European project on Barley bread was carried out in the period 2006-2011 at Nofima (The Norwegian Food Research Institute) in collaboration with several partners (Nofima, 2014). The aim of the project was to develop barley flour with at least 75% health promoting components and up to 60% barley in the finished products. The salt content in bread was reduced, down to 0.4% in the finished product. There was also a strong focus on ensuring that the products developed will be liked by the end users.

Barley contains fibre, proteins and antioxidants that have a documented health promoting effect. Barley has a preventive effect on cardiovascular diseases, diabetes, obesity and other conditions. In the old days, barley was a grain that was frequently used in food, in bread and soups for example. However, nowadays most of the barley produced in Europe goes for animal feed or malting.

To achieve the aims of the Barley bread project, a number of factors were tested. Some of the most vital factors were development of flour that has good baking properties and the development of bread with relatively similar properties to wheat based breads and which does not have an unfamiliar taste or colour compared with normal bread. Barley can have an undesirable side taste, which is important to avoid, and the research concentrated on identifying the right varieties of barley, with health promoting components and good baking properties. Consumer surveys have been carried out to see how the new products are received. Several such surveys were carried out in various parts of Europe.

The European project BARLEYboost started in 2013 (BARLEYboost, 2014). It is coordinated by Nofima (Norway) and has two other research partners (VTT and INRA). The objective is to use new technology and innovation to increase the availability of healthy foods made of barley. The three main tasks of the project are: (1) The milling industry needs to develop new ways of enriching beta-glucan from barley. (2) Equipment suppliers need to develop and calibrate new measuring instruments to measure the beta-glucan content from barley samples. (3) The bakeries and ingredient suppliers need to start using a new, rapid-learning product development process, to develop innovative products.

The basis of the project is as follows: 52 million tons of barley is produced in the EU every year, but only 0.6 per cent is used for food. Most is used for animal feeds and for producing alcohol. Barley is a good source of fiber. The European Food Safety Authority (EFSA) has recognized the claimed health benefits of the barley fibre, especially beta-glucan. A daily intake of 3-4 g of beta-glucan can help to reduce cholesterol in the blood and the rise in blood sugar after meal. It has also been found in many studies that increasing daily consumption of barley fiber can reduce the risks of cardiovascular disease, diabetes, obesity, high blood pressure and certain types of cancer. In addition, fibre from barley is good for constipation. Even though barley contains considerable amount of beta-glucans, it can be difficult to enrich beta-glucan in conventional milling processes. That means that, at the

moment, a large portion of barley must be eaten to obtain the desired health effects related to beta-glucan.

In Scotland, the Agronomy Institute is involved in a Scottish Government funded project investigating nutritional aspects of barley and oats grown in the north of Scotland. The project involves major research organisations like The James Hutton Institute and the Rowett Institute for Nutritional Health and will generate nutritional information about barley of considerable relevance to the NPA partnership. The Agronomy Institute has also managed a Scottish Government funded Orkney Flours project, promoting local flours from locally milled cereals and has collaborated with distilleries and breweries in using Orkney-grown grains.

The project NORSKOL on beer production is carried out at Bioforsk (Sundgren, 2014). The main goal for the project is to gather old and new knowledge about the commodities for producing beer. This will create new possibilities for innovation in brewing companies in Norway. The project will focus on knowledge about the use of old and new Norwegian cereal varieties for malting, Norwegian varieties of hop and wild and cultivated herbs suitable for beer production. The project will also contribute to increased knowledge of malting and contribute to the development of a Norwegian malting facility, as well as creating a knowledge base about these areas that will be available to all interested companies.

Several scientific papers on antioxidants and other components in barley are available from other Norwegian projects (Holtekjølen et al., 2008a; Holtekjølen et al., 2008b; Holtekjølen et al., 2006). Results from these projects will be very useful for development of cereal products in the north although the properties of cereals might be different.

In the period 2006 to 2011 Matis and The Agricultural University of Iceland carried out work on two cereal food projects supported by the Icelandic Agricultural Productivity Fund (Reykdal et al., 2008; Reykdal et al. 2012). The aim of the projects was to promote barley for food production and add value to the barley production. The main topics in the projects were as follows:

- Nutrient value and safety of Icelandic barley
- Quality criteria for barley
- Barley bread and sensory evaluation of it
- Experimental malting of Icelandic barley and beer production
- Internal control for barley processing
- Views of consumers towards Icelandic barley

The project “Increased value of Icelandic barley” was carried out during the years 2006 to 2008 in cooperation between Matis ohf, Agricultural University of Iceland, barley producers and food manufacturers. Nutrients, contaminants and microbes were measured in Icelandic barley. The water soluble dietary fibre, beta-glucan, was of special interest. The safety of Icelandic barley was sufficient according to measurements of contaminants and microbes. Barley was tested for bread baking and it was found that barley-wheat mixtures can be used for bread. Breads with and without barley were tested by sensory evaluation and consumer testing. Barley breads had special sensory properties and were well accepted. Malt was produced from Icelandic barley and used for production of beer. The beer was of good quality but the main problem with the malt production was a low proportion of sprouting barley. Quality criteria were drafted for Icelandic barley for the production of bakery products and malt.

Another project on the use of Icelandic grain crops for food production was carried out at Matis and the Agricultural University of Iceland in 2009 to 2011. The purpose of the project was to support the

increasing use of domestic cereal grain crops for the production of foods. To enable this, quality requirements were developed for barley and a handbook on internal control was written for on-farm barley processing. Proximates and inorganic elements were measured, product development was supported and finally consumer views towards Icelandic barley were studied.

Quality requirements for barley to be used for food and alcoholic drinks were developed as a frame of reference for businesses. The text for internal control can be adapted for individual farms. The starch in Icelandic grain crops was similar to that of imported crops. The Icelandic grain crops were rich in dietary fibre. The concentrations of heavy metals in the Icelandic crops after the Eyjafjallajökull eruption were very low.

10. CONCLUSIONS

During the project an effective collaborative network was established between cereal researchers in Iceland, Northern Norway, The Faroes, Orkney and Newfoundland. Furthermore, the partners identified several companies in each region keen to participate in a future project developing higher value uses for locally grown cereals.

There is a wide range of cereal growing expertise/capability amongst growers in the partner regions – from very good in Orkney and Iceland to very limited in The Faroes and Newfoundland. This situation should make the partnership in a future project particularly appropriate as it will facilitate a rapid transnational flow of knowledge and experience to areas where cereal cultivation is least developed. The preparatory project has also helped to identify the complementary skills which the partners will bring to a future project, in particular:

- Icelandic partners have been involved in cereal research for a long time and product development for several years and, in addition, have skills related to large project management.
- Bioforsk has considerable experience in developing food products and has good links with growers and end-users.
- The Agronomy Institute in Orkney has links with distilleries, breweries and mills and has been involved in the development of successful drinks products and the handling of local cereal supply chains.
- The Agricultural Centre in the Faroes and Newfoundland have early stage links with both enthusiastic growers and end-users which will provide the means of starting a cereal industry in these regions. They also benefit from Government support for these activities.

The project has quantified the large imbalance between local cereal production in the partner regions and cereal consumption calculated from both average dietary intake data and estimates of imports. Furthermore, it has identified that only a very small amount (<1%) of the cereals grown locally are used for food and drink purposes. In all partner regions, a number of high value products have been identified which could be made from local cereals.

While the emphasis of a future project on the development of higher value food and drink products from local cereals will be useful for all partners, for some (especially Newfoundland and The Faroes) it will also be necessary to consolidate cereal growing by establishing feed uses which will help reduce reliance on costly feed imports.

Within the future project partnership the partners will bring considerable cereal expertise to the project. There will also be the benefit, however, of links which the partners have with other organisations and with research results generated from other initiatives with which the partners are familiar.

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