

Northern Periphery and Arctic Programme
Northern Cereals – New Markets for a Changing Environment

**CURRENT CEREAL GROWING SITUATION IN FIVE NORTHERN REGIONS AND
THE POTENTIAL FOR USING LOCAL CEREALS IN FOOD AND DRINK PRODUCTS**

A Project Report

Deliverables T1.2.1 and T1.3.1



By

Peter Martin, Olafur Reykdal and Hilde Halland,

March 2016

Northern Periphery and Arctic Programme
Northern Cereals – New Markets for a Changing Environment
CAV Diary Number 304-8673-2014

CURRENT CEREAL GROWING SITUATION IN FIVE NORTHERN REGIONS AND THE POTENTIAL
FOR USING LOCAL CEREALS IN FOOD AND DRINK PRODUCTS - A Project Report

Authors:

Peter Martin, Olafur Reykdal and Hilde Halland,

With contributions from:

Sæmundur Sveinsson, Agricultural University of Iceland

Valur N. Gunnlaugsson, Matis, Iceland

Sigríður Dalmannsdóttir, Norwegian Institute of Bioeconomy Research

Mette Thomsen, Norwegian Institute of Bioeconomy Research

Jens Ivan í Gerðinum, The Agricultural Centre, Faroe Islands

John Wishart, Agronomy Institute, Orkney College UHI, Scotland

Vanessa Kavanagh, Forestry and Agrifoods Agency; Newfoundland and Labrador, Canada

Northern Cereals Partners:

Matis – Icelandic Food and Biotech R&D

Agricultural University of Iceland

Norwegian Institute of Bioeconomy Research

Agronomy Institute, Orkney College UHI, Scotland

Agricultural Centre, Faroe Islands

Forestry and Agrifoods Agency, Newfoundland and Labrador, Canada

CONTENTS

Summary	3
1 Introduction	4
2 Regions, Populations and Cereal Consumption	7
3 Cereal Imports and Production	11
3.1 Cereal grain imports compared with domestic production	11
3.2 Cereal production in the NPA regions	13
3.3 Cereal production and on-farm use	13
3.4 Cereal production for off-farm use	15
4 Recent Trends In Cereal Production In The Partner Regions	22
5 Economics Of Cereal Production	25
5.1 Introduction	25
5.2 State support	27
5.3 Economics of cereal cultivation within the region	28
5.4 Market prices	32
6 Regional And World Market Trends In Cereal-Based Food Products	33
6.1 Introduction	33
6.2 Regional cereal food trends	34
6.3 Review of global and regional trends in cereal food markets	36
6.4 Health benefits of barley	39
6.5 Recent health issues of relevance to barley	41
7 Regional And World Market Trends in The Beer And Spirits Market	45
7.1 Introduction	45
7.2 Regional trends	45
7.3 Review of recent global trends in spirits and craft brewing	47

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals
In Food And Drink Products

7.3.1	World spirits.....	47
7.3.2	The craft brewing market	51
7.4	Conclusions	53
8	Acknowledgements.....	54
9	References	54

Summary

The status of cereal cultivation in Iceland, northern Norway, Faroe Islands, Orkney and Newfoundland has been studied in a project supported by the Northern Periphery and Arctic Programme (NPA). In Orkney, Iceland and northern Norway cereal cultivation is well established while the Faroe Islands are re-establishing, and Newfoundland is starting, cultivation. The project transfers knowledge between the regions and aims to increase the value of cereal products, indicate new innovative products and increase cultivation of cereals.

In this report, the cereal value chain is described to inspire companies and initiators to identify new opportunities and create new jobs. Total cereal grain production in the five regions was about 38,000 tons in 2014 while imports were about 146,000 tons, just for Iceland, Orkney and Newfoundland. The population of the region is about 1.4 million and the annual number of visitors is above 2 million. Considerable amounts of cereal-based products are consumed in the regions. These include many different foods (bakery products, breakfast cereals, snacks, flour, porridges etc.) and beverages (e.g. beer and whisky) and offer many opportunities for using local cereals.

Recent trends in the cereal food market are very conducive to the development of new products and greater local production within the project regions. Interest in local food and drinks is increasing and food producers need to respond to increasing demand from visitors. In all of the regions, barley is the most important cereal grown. Barley contains several health-enhancing nutritional components including β -glucan and antioxidants and, with growing awareness of the need for healthy eating, there is increased interest in it as a raw material for the food industry. Barley is also used for the production of malt which is a key ingredient for the production of beer and whisky. The number of microbreweries has grown and they are now found in remote regions. For breweries to distinguish themselves from competitors, product differentiation is becoming increasingly important and an attractive way of doing this is to use local ingredients (barley, malt and herbs). However, in order to utilise local barley for beverage production, it will usually be necessary to develop a local capacity for malting.

1 Introduction

This report reviews the current cereal growing situation in five northern regions (Orkney, N-Norway, Iceland, Newfoundland and Faroe Islands) and the potential for using local cereals in food and drink products. This task is a part of the project "Northern Cereals – New Markets for a Changing Environment" supported by the Northern Periphery and Arctic Programme. The aim of the project is to increase value of products from the cereal production chain and to increase cereal utilisation for new products. Therefore it was necessary to study the current status of cereal production and the market for cereal products. We hope that this report will be a helpful tool for companies, initiators and farmers to identify new opportunities.

The current status of cereal cultivation differs greatly between the project partner regions. In Orkney, Iceland and northern Norway it is well established while the Faroe Islands are re-establishing, and Newfoundland is starting, cultivation. In all of the regions barley is the most important cereal, or is likely to be the most important one, as it is the cereal which is most suited to northern climates. To provide an introduction to this report, the following paragraphs provide a brief summary of the situation in each region.

Iceland. Barley was grown in Iceland from the time of settlement (from ca. 874 AD) but ceased during the Little Ice Age. Barley has now been grown uninterrupted in Iceland for about 50 years. Barley cultivation has increased considerably during these 50 years and the harvest was 10,000 – 16,000 t per year in the period 2003-2014. However, the climate in Iceland is variable from one year to another and unfavourable weather conditions for cereal growing have occurred, e.g. the summers of 2013 and 2015. In the year 2014 the number of farmers growing barley was 436 and the barley area was about 4,000 hectares. Some farmers have been successful in growing small areas of wheat and even using wheat for small scale bread baking. Oats and rye have also been grown successfully on a small scale.

With Iceland's climate, grain needs to be dried after harvest to make it a viable commercial commodity. A few small scale drying facilities are available for farmers, most of which are located on farms. Farmers also make silage from cereals which is used as cattle feed.

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals In Food And Drink Products

Most of the barley production is used as concentrates for cows and, to a lesser extent, for pigs. Although interest is growing, only a very small proportion of the barley production is used for food and about four farmers are marketing cereals for food and drink purposes.

North Norway. Barley has been grown in North Norway since at least the late Bronze Age (c. 1100 BC) and although many landraces were grown in the 19th century, most of these have now been lost. Barley cultivation is now limited in North Norway and the skill to cultivate barley has been lost in some areas. However, a few farmers in Alta and South Varanger in Finnmark, in Inner-Troms and parts of Lofoten cultivate barley for animal feed production. Along the Helgeland coast in Nordland County, there are farmers growing barley to full maturity and some of these farmers are experimenting with their own breweries. Most of these farmers are localized in the municipality of Sømna. The farmers growing barley in North Norway follow both organic and conventional systems. The short growing season is a limiting factor for barley cultivation. Therefore, an extended growing season resulting from climate change, may create new opportunities for crop production. Likewise, use of new varieties with early maturation could improve the cultivation and increase yields.

Faroe Islands. Recently, two dairy farmers have started to grow about 2 ha of a barley/ryegrass mix for silage, but before this cereals had not been grown in the Faroe Islands for more than 50 years, and all cereals for feed and food were imported. Formerly, however, farmers grew barley for centuries to bake their own bread. Normally the barley did not fully ripen outdoors but was harvested and then stored indoors for drying and subsequent threshing. All the work was carried out by hand. As the labour and money moved from agriculture towards the fishing industry in the first half of the 20th century, barley production in the Faroe Islands gradually decreased and finally came to an end about 50 years ago. The end of barley cultivation was also a result of competition from cheaper imports from areas with a more suitable climate and more efficient production.

There is potential for re-introducing cereal cultivation, especially barley, for feed on dairy farms as well as for brewing and baking. Farmers will face many challenges, however, especially coping with the high precipitation at the end of the growing season.

Orkney, Scotland. There is evidence of cereal cultivation in Orkney dating back to the Early Neolithic (c. 3000-3500 BC) and cereal cultivation has been important in these islands for many thousands of years. For much of the last thousand years, an ancient barley landrace, Bere, was the staple barley which was grown for milling, malting and as animal feed. Although Bere is now only grown on a

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals In Food And Drink Products

small scale, about 4,300 ha of modern barley is grown which is mostly harvested at a high moisture content, treated with a preservative and used for animal feed. Oats were commonly grown as an animal feed and for human consumption on Orkney from the Iron Age but there has been a dramatic decline in the area grown since the 1940's (when tractors replaced horses on the farm) and now only about 100 ha are grown, almost entirely for animal feed. Very little wheat has ever been grown in Orkney.

Although grown primarily for animal feed, small quantities of cereals are also grown for food and drink markets. Thus, Bere, oats and wheat are grown for local milling while both Bere and modern malting barley are grown for niche market whisky and beer production. Orkney's high rainfall can create difficulties for many cereal operations, but a high level of mechanisation allows farmers to make the most of suitable weather-windows for cultivation, planting, spraying and harvesting.

Newfoundland, Canada. The agriculture/agrifoods sector of Newfoundland and Labrador provides direct and indirect employment for 4,000 persons on farms and in the food and beverage manufacturing sectors. Value of farm production has grown in 27 of the last 30 years with sales of \$111 million in 2008, while Agrifood processing reached \$501 million. The dairy industry has led this growth with expansion on farms and in dairy processing of value-added milk products such as cheese and novelty ice creams. Higher energy costs are having an effect on agriculture operations, with significant impacts on livestock production. These impacts are direct, such as equipment operations, and indirect, such as higher feed costs due to the demand on grain for ethanol.

Historically, barley was grown on the island, but with time Newfoundland became dependent on the rest of Canada for its grain requirements. In today's economy, increasing fuel prices and biofuel diversions have meant that the cost of importing grain has climbed to where it is no longer economical to import substantial quantities. Unfortunately, there are no commercial cereal operations in Newfoundland to supply its livestock industries. The province's short season ends with a rainy period that makes harvesting dry grain problematic. A high moisture grain system appears promising to accommodate these challenges, allowing earlier harvest at higher moisture contents. Newfoundland is in the early stages of a cereal program which is primarily focussed on animal feed production.

2 Regions, Populations and Cereal Consumption

The regions covered by this report include four regions within the European Union's Northern Periphery Area, and 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 province of Newfoundland & Labrador.

Populations in the regions are reported in Table 1. The total population is about 1.4 million with most people living in Newfoundland and North Norway - about 0.5 million in each region. The smallest population is in Orkney (21,590).

Table 1. Resident populations in the project region and annual visitor numbers.

Region	Year	Population	Visitor numbers per year
Iceland	2015	329,100	1,289,140
North Norway	2015	480,740	NA
Faroe Islands	2015	48,652	110,000
Orkney	2014	21,590	195,000
Newfoundland	2015	527,756	507,900
Total		1,407,838	2,102,040

Population sources: Iceland: Statistics Iceland, retrieved 13.11.2015 from: <http://www.statice.is>. Norway: Statistics Norway, Population and population changes, Q1 2014, <http://www.ssb.no>. Faroe Islands: Statistics Faroe, <http://www.hagstova.fo>. Orkney: Orkney Islands Council Area - Demographic Factsheet, National Records of Scotland (2015). Newfoundland: <http://www.statcan.gc.ca>.

Visitor sources: Icelandic Tourist Board, retrieved 26.02.2016 from: <http://www.ferdamalastofa.is>. Faroe Islands: Estimation based upon Tourist Board information (www.visitfaroeislands.com). Orkney: Orkney Visitor Survey, 2012/13; <http://www.orkney.gov.uk/OIC-News/cruise-survey-indicates-huge-benefits-for-local-economy.htm>. Newfoundland: Newfoundland and Labrador Department of Tourism, Culture and Recreation, 2014. http://www.btcrcd.gov.nl.ca/tourism/tourism_research/stats/index.html

NA, data not available.

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals In Food And Drink Products

Apart from their resident populations, all regions receive a significant number of visitors annually (Table 1), many of which are tourists. These create a significant market for food and drink products. Although it is not possible to get accurate numbers for all regions, the estimated number of visitors to all regions, except Norway, is about 2.1 million per year. For Iceland, it was about 1.3 million in 2015, an increase of about 29% on the previous year. In addition, about 100,000 passengers visited Reykjavik on cruise liners in 2015. For Orkney 142,000 visitors were estimated in 2012/13, with an additional 51,000 visiting on cruise liners and 2,000 coming on their own boats and staying at local marinas. The number of cruise ships has increased considerably in recent years and exceeded 80 in 2015. Good data for tourists visiting the Faroe Islands are not available, but it is thought that there are about 60,000 visitors each year with an additional 50,000 passengers on around 60 cruise liners.

Data for North Norway is lacking in Table 1 as there are no good estimates of the total number of tourists visiting North Norway every year. The trend is however for this number to increase, 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).

An indication of the market within the region for cereal-based products can be obtained from food consumption or purchase surveys. Comparison of cereal food consumption between regions might indicate opportunities for increased production. The consumption or purchase of cereal foods in Iceland, Norway and Scotland is presented in Table 2.

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. Institutional households such as hospitals, boarding houses etc. were not included. Data for Scotland come from the UK Government's Family food statistics and datasets web site and are from 1395 households and were collected using self-reported diaries supported by till receipts of all purchases over a two-week period. Food consumption data is not officially collected in

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals
In Food And Drink Products

Newfoundland and therefore cannot be provided. Data from Statistics Canada and the Canadian Council and Food and Nutrition (CCFN) suggests, however, an overall decline in the consumption of grain products and few people making 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. Based on observations, however, this trend is not as pronounced in Newfoundland and consumption and demand of grain products still appears to be high.

Table 2. Consumption or purchase of cereal foods in Iceland, Norway and Scotland.

Food	Region	Consumption or purchase (kg/person/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	Scotland	35.0
Flour	Scotland	1.8
Biscuits and crispbread	Scotland	8.8
Cakes, buns and pastries	Scotland	7.2
Other cereal and ceral products	Scotland	29.1
Cereal products, total	Scotland	81.9

Sources: Iceland: Thorgeirsdottir et al (2011). Norway: Statistics Norway (2013). UK (2013): <https://www.gov.uk/government/statistical-data-sets/family-food-datasets> .

The data from Table 2 indicate an average consumption of cereal food products across the Region of about 80 kg per person per year. This suggests that the population of the partner regions (1.4

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals In Food And Drink Products

million, excluding visitors) would need 112,000 tons of cereal-based food per year. This is of course not the same as cereals needed but is a useful indication of the size of the market. These data exclude cereal-based beverages like beer and spirits.

3 Cereal Imports and Production

3.1 Cereal grain imports compared with domestic production

An estimate of cereal grain production and imports (as whole grains, but excluding agricultural seed) by the partner regions is reported in Table 3. Iceland imported about 79,472 t of cereals in 2014 (Statistics Iceland, n.d.), including 18,231 t for food production, 4,009 t of malt and 57,232 t for feed. The cereals were imported for 3,352 CIF¹ million ISK (about 24 million EUR). These data were collected by using classification from the Icelandic Directorate of Customs. A more detailed breakdown is reported in Table 4; amongst the feed imports, there were 12,131 t of barley which could potentially be produced domestically. The annual barley harvest in Iceland has varied from 10,000 to 17,000 t during the last 10 years. About 80 t 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 (0-7 t annually).

Table 3. Estimated cereal grain production and imports in different regions. Cereal seed is excluded.

Region	Year	Cereal grain production (t)	Cereal grain imports (t)	Cereal production plus imports (t)
Iceland	2014	13,927 ¹	79,472	93,399
North Norway	2014	1,134 ²	NA	NA
Faroe Islands	2015	0	NA	NA
Orkney	2014	22,610 ³	6,800 ⁴	29,410
Newfoundland	2014	90	60,000	60,090
Total		37,671	146,272 ⁵	182,899 ⁵

¹ Calculated for crop areas of 3,989 ha (determined by The Farmers' Association of Iceland) and estimated yields of 3.5 t/ha. Estimated for grain at 85% dry matter.

² North Norway production has been estimated assuming a yield 4.5 t/ha over a crop area of 252 ha

³ The cereal harvest for Orkney was estimated using crop areas from the Scottish Government's 2014 Report on Scottish Agriculture and multiplying the areas for barley, wheat and oats by a yield of 5.0 t/ha. This is a typical grain yield for each of these crops in trials and is for grain at 85% dry matter.

⁴ See explanation in the text for how this was estimated.

⁵ North Norway and the Faroes are excluded.

NA, data not available

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

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.

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals In Food And Drink Products

It was not possible to quantify the amount of cereals imported into the Faroe Islands, but in 2015 it included: 0.5 t barley, 1,459 t wheat, 1,830 t rye and 0.1 t oats (Taks, engl. Custom Service). No cereals were produced in the Faroe Islands in 2015.

Data for cereal imports to Orkney are not readily available as there are many different companies which do this. Discussions with major importers and transporters suggest that the total for grain is about 6,800 t which includes about 1,600 t of barley for malting and feed and about 5,200 t of malt used by the islands' two distilleries and two breweries. Other imported cereal products include about 1,000 t of flour and meals imported by bakery and biscuit companies, about 700 t of hay and straw and 1,600 t of agricultural feed. The quantity of hay and straw depends upon the amount produced each year in Orkney. Hardly any rye, oats and rapeseed were imported as grain. It is estimated that about 15% of the cereal seed used in Orkney is "farm saved", suggesting that about 680 t of cereal seed is imported per year.

Table 4. Cereal imports to Iceland in 2014.

	Cereals (t)	Value (million ISK)	Value (million EUR)
Cereals for feed	57,232	2,014	14.3
Cereals for food, excluding rice	18,231	1,047	7.4
Rice	1,433	311	2.2
Malt	4,009	291	2.1
Breakfast cereals	1,870	1,093	7.8
Biscuits and cakes	5,792	2,888	20.5
Pasta	1,514	521	3.7
Cereals and cereal products, total	90,081	8,165	58.0
Beer and pilsner	4,841	714	5.1
Whisky	102	155	1.1

Source: Based on data retrieved on 13.11.2015 from Statistics Iceland (<http://www.static.is>).

About 60,000 t 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 and wheat in the region was only in 2013 and totalled 122 t.

Data for cereal imports to North-Norway are not available since imports are recorded for the country as a whole. 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 t of barley have been used for food in Norway in recent years (Norwegian Agricultural Authority, 2013). All of the barley grown today in North Norway is used for fodder.

3.2 Cereal production in the NPA regions

The total number of farms and those producing cereals is shown in Table 5. It can be seen that the proportion of farms producing cereals is relatively low. For the Faroe Islands the number of farms is reported to be 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, while in Orkney almost 50% of farms are less than 10 ha. Iceland and Orkney have the largest areas under cereals but it is estimated that the greatest production occurs in Orkney because of the higher yields achieved there (Table 5). Iceland is second for production. Small amounts are harvested in North Norway and Newfoundland. In the Faroe Islands there is presently no cereal grain production.

Table 5. Number of farms producing cereals and estimated cereal production in the different regions.

Region	Year	Total number of farms	Farms producing cereals	Area of cereals (ha)	Cereal production (t)
Iceland	2014	2,592	436	3,989	13,927
North Norway	2014	3,546	26	252	1,134
Faroe Islands	2015	380	2	2	¹
Orkney	2014	1,818	436	4,522	22,610
Newfoundland	2014	510	8	50	90
All regions		8,846	908	8,815	37,761

¹ The barley grown in the Faroes in 2015 was part of a ryegrass/barley silage mix, not for grain.

Sources: Iceland: The Farmers Association of Iceland and the Agricultural University of Iceland. North Norway: Norwegian Agricultural Authority. Faroe Islands: Statistics Faroe. Orkney: Economic Report on Scottish Agriculture 2014. Orkney production has been estimated assuming a yield of 5.0 t/ha at 85% dry matter. Newfoundland: 2011 Census of Agriculture – StatsCan.

North-Norwegian production has been estimated assuming an average yield of 4,5 t/ha

3.3 Cereal production and on-farm use

In all regions, barley is the most important cereal grown and Table 6 shows the number of farms producing barley and the estimated production of barley in each region. The main producers are

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals
In Food And Drink Products

Orkney and Iceland. The totals for all regions are 980 farms, 8,817 ha of cereal fields and an estimated annual cereal production of about 38,000 t.

Iceland. There are about 436 farmers growing barley and most of these are dairy farmers growing it for their own use. A few pig farmers also grow barley on a larger scale, up to 300 ha each, for on-farm use. Average grain yields are about 3.5 t/ha (at 15 % moisture content).

Table 6. Production of different types of cereal across the project region.

Region	Cereal	Year	Number of farms	Area (ha)	Average grain yield (t/ha)	Estimated grain production (t/year)
Iceland - South	Barley	2014	213	2,281	3.4	7,755
Iceland - West	Barley	2014	53	633	3.4	2,152
Iceland - North	Barley	2014	154	944	3.8	3,587
Iceland - East	Barley	2014	16	131	3.3	432
Iceland - Total	Barley	2014	436	3,989		13,927
N-Norway	Barley	2014	26	252	4.5	1,134
Faroes	Barley	2015	2	2	1	1
Orkney	Barley	2014	436	4,359	5.0	21,795
Orkney	Oats	2014	21	163	5.0	815
Orkney	Wheat	2014	1	2	5.0	10
Orkney - Total		2014	458	4524		22,620
Newfoundland	Winter wheat	2014	2	10	3.1	35
Newfoundland	Winter triticale	2014	3	20	2.6	45
Newfoundland	Barley	2014	3	20	2.1	10 ²
Newfoundland - Total		2014	8	50		90
All regions			980	8,817		37,770

¹ Barley planted in the Faroes in 2015 was grown in a ryegrass/barley silage mix, not for grain.

² Newfoundland: some barley fields could not be harvested

Sources: Iceland: Farmers' Association of Iceland and Agricultural University of Iceland. Norway: Statistics Norway. The data are based only on applications for incentives and are therefore underestimates. Newfoundland: Agrifoods Development Branch.

The number of farms producing cereals in North Norway was 26 in 2014 and most of these are located in Nordland which is the most southerly county in the region. In the period 2000-2014 the number of farms has been variable but in the range 25-50. Most farmers in North Norway grow barley as feed in combination with milk and sheep production. Only two farmers in Nordland are solely focusing on barley production. In Nordland the production is on average about 4.5 t/ha, but

can be up to 5.0 t/ha in a good year. In Lofoten most of the barley is used as feed for goats, but also for cows and sheep. Spare land is available to expand cereal production in North Norway.

In Trøndelag, the county south of Nordland, barley is grown to full maturity. In a trial (Bergjord and Weiseth, 2011) with four different varieties, grain moisture content was between 18 and 26% and yield was between 4.7 and 5.6 t/ha. If a yield of 4.5 t/ha is assumed, the total production (at about 20% moisture content) in North-Norway is about 1,134 tons barley (4.50 t/ha × 252 ha).

There has not been commercial production of cereals in the Faroe Islands for the last 50-60 years. However, a few dairy farmers have started to grow barley as part of a barley/ryegrass mix for ensiled feed. In 2015, about 1 ha was grown at each of the following farms: Sigert Patursson in Hoyvík near Tórshavn and Jóannes Johannesen and Hjørdis H. Jensen in Sandur in Sandoy. Although biomass production is high, it is uncertain yet whether the silage increases the milk yield of the dairy cows.

In Orkney, all cereal farmers grow cereals to produce feed for their livestock enterprises. Primarily this is for beef and dairy production (529 farms for the two enterprises) but sheep are also important (528 farms) and there are 21 farms with pigs. For feed, most cereals are harvested with a moisture content of about 25% and treated with a preservative for storage. Only a small amount of grain is harvested for drying. Expansion of the cereal area in Orkney could only be done by reducing the area under grass (16,858 ha of grass under 5 years old in 2014) but currently farmers need most of this for livestock.

There are no commercial cereal producers in Newfoundland and Labrador. For the current government-led cereal programme there are 6 producers participating in 2013-2014, which will change each year and may include up to 3 more. The programme is constrained by equipment as it only has one large combine and one no-till grain drill. Five farmers are dairy producers and one farmer is a vegetable producer. Participation in the programme is limited to dairy producers (with one exception) because the government is funding the cereal expansion research. In this way the farmers use the grain that is harvested from their land and offset their own feed costs.

3.4 Cereal production for off-farm use

The production of cereals for off-farm markets is generally poorly developed within the region, although this has developed on a small scale in both Orkney and Iceland in recent years.

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals In Food And Drink Products

Four farms in Iceland supply the food industry and consumer markets with cereals:

- Mother Earth farm (<http://www.vallanes.is/> (Móðir Jörð)) produces barley flour, whole barley and other barley products.
- Thorvaldseyri farm (<http://www.thorvaldseyri.is/> (Eyrarbúið ehf. Þorvaldseyri)) produces barley flour for the baking industry.
- Birtingaholt 4 farm (http://www.foldvegur.is/iskorn/um_iskorn/) produces barley flour.
- Belgsholt farm (<http://belgsholt.is/>) produces barley for breweries.

The first three farms are also food processors with a licence for food production and have equipment for small scale cereal processing (e.g. mills). Although production is mainly barley, small quantities of wheat have been available in some years.

The company Lifland 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 produced breads made from domestic barley and wheat. Myllan bakery developed a barley bread named after the source of barley (Thorvaldseyri farm). Since then, the use of barley by bakeries has decreased and the Thorvaldseyri bread is no longer available. A few bakeries still sell barley bread all year round:

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

In 2013 the Association of Bakeries held a bread baking competition. One of 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 Ltd produced a barley breakfast cereal, called Byggi, made by extrusion from domestic barley. The production of Byggi stopped in 2014. 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 proportion 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 majority of the beer produced in the country: Egill Skallagrímsson brewery and Vífilfell brewery. About 7 microbreweries operate in the country and the following use domestic barley:

- Egill Skallagrímsson Brewery, <http://www.olgerdin.is/> (is. Ölgerðin Egill Skallagrímsson)
- Borg Microbrewery
- Steðji Microbrewery

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

Although there is no commercial use of cereals grown in the north of Norway, there are a number of potential users amongst bakeries and breweries.

Bakeries. There are approximately 100 bakeries and a larger number of small hobby-based bakeries producing *lefse* (a traditional flatbread). Companies which have expressed an interest in using barley include:

- Tromsø bakeri AS. A medium-sized bakery in Tromsø which used considerable amounts of barley in 2013.
- Eldhusbakeriet. A small bakery in Sortland which has recently used whole barley grains.

Barley seldom constitutes a big percentage in the recipes of baked goods and since barley is the only cereal that can be grown to full maturity in the north it is likely that bakeries will have only limited interest in locally produced cereals. However, barley flours could be interesting for some bakeries producing other baked goods (other than bread). For example, there has been interest from Dyrøy mat AS, a processing company producing meat products, catering and precooked dinners. Although

they do not currently use barley, they are interested in using barley grain in their precooked dinner dishes.

Breweries. In the whole of North Norway the only large brewery left is Mack Brewery AS, in Tromsø. In addition, interest in hobby-brewing and micro-brewing has exploded. The rules and regulations concerning brewing and selling beer have been simplified in recent years, and some smaller breweries are today selling their own beer in their own restaurants and about 10 to 12 microbreweries also sell beer in bottles. Companies which have expressed an interest in using local barley include the following:

- Mack Brewery AS. Although this is a large brewery, it also includes a microbrewery with the possibility of producing small batches of 200 l.
- Hemnes mikrobryggeri AS. A microbrewery which is located in the area with the best growing conditions for grain (Helgeland) in Northern Norway.
- Bannak leir AS. A microbrewery in Finnmark which is about to start selling its products. It has started producing its own grain at a family farm.

In spite of interest from many companies in using local cereals, this would be quite costly because of the special equipment which would be needed. The investment which this would require would entail considerable economic risk, especially for small companies, even though some financial support may be available from the government (up to 25%). New investments necessary for utilizing locally produced barley would include the purchase of equipment for sowing, harvesting, drying, malting etc.

Faroe Islands. The Faroe Islanders grew barley for centuries, although the islands were seldom self-sufficient in grain. It is most likely that the first settlers brought this tradition with them from Ireland and Norway and cultivation continued unbroken until the middle of the 20th century.

The grain was used only for food and after the harvest it was dried in specially equipped houses with open fire and smoke. Before use it was milled in either small water mills or indoors with small, hand-powered stone mills.

There is currently considerable interest in re-starting the tradition of grain production. Some farmers are interested 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 the market.

- Føroya Bjór, Klaksvík. The largest brewery in the 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 are very keen to source local barley.

But the Faroe Islands have a long way to go before commercial cereal growing becomes a reality. In particular, there are some basic machinery and equipment needs like drying facilities and stores. Investment would also be required in a mill, although it is also possible that some of the old mills could be renovated to produce niche market products.

Orkney has a number of companies which use significant quantities of cereals. These include two distilleries (Highland Park and Scapa), two breweries (Swannay Brewery and The Orkney Brewery), about four bakeries and one large producer of oatmeal biscuits. The islands are also very fortunate to still have a functioning water mill (Barony Mill) which supplies stone ground flours to the public and bakeries. This is run by Birsay Heritage Trust. The following approximate quantities of local cereals are grown for some of these companies:

Cereals for milling. About 12-15 t of grain of Bere, an ancient type of barley, is grown by Birsay Heritage Trust and used for milling into beremeal, a traditional Scottish product. About 2-3 t/year of wheat and oats are also grown for milling. The above flours and meals are mainly supplied to local bakery companies and shops, but small quantities of beremeal are also exported. Some of the local bakeries (e.g. Argo's) have developed successful commercial products (e.g. biscuits) using local flours and these are sold more widely in Scotland.

Modern malting barley. About 55 t of grain of a modern variety of malting barley is grown annually by a supply chain consisting of 5 growers for Orkney's Highland Park Distillery. 'Golden Promise', a

variety of malting barley released in the 1960's is still grown by a few farmers in Orkney because of its earliness. In 2015, 7 t of this was also malted and used by Swannay brewery for brewing.

Bere for brewing and distilling

An Orkney supply chain for Bere, consisting of 3-4 growers, is run by the Agronomy Institute. This produces about 60 t of grain annually. Most of this, about 48 t, is supplied to Bruichladdich distillery on Islay for specialist whisky production. In some years, small quantities have also been provided to Valhalla Brewery in Shetland and Swannay Brewery in Orkney.

Other uses

Other higher value uses of locally grown cereals include the following:

- When available, surplus grain or straw is often sold locally. There is also a regular demand for these products in Shetland and a few farmers have started producing crops for this trade.
- Two farmers produce certified seed of barley and oats annually which are mainly sold locally or in Shetland.
- There is a very small market for oat straw for weaving which is mainly used for making the backs of traditional Orkney chairs. It is estimated that about 2 ha are grown for this purpose.

In relation to the development of the above markets for Orkney cereals, the following are important factors:

- A high level of farm mechanisation and the availability of contractors usually allows the timely planting and harvesting of crops, even though there are often very narrow windows of opportunity for these operations.
- A number of growers have purchased grain dryers which allow grain to be dried to an acceptable moisture content for storage and processing.
- Barony Mill provides local milling facilities.
- The Agronomy Institute has provided crucial research support for the development of some of these markets, especially for brewing and distilling, and also manages supply chains which facilitate this.
- Malting of barley is still carried out on the island at Highland Park, but only for its own use. Bere for Bruichladdich distillery can, however, be conveniently malted in Inverness while it is

on route to the distillery. Here, Bairds Malt still maintains facilities for malting 50 t quantities of grain.

- Malting of local barley for breweries is much more difficult as they usually only require small quantities (<5 t) and the nearest commercial facilities for this are in England.

Newfoundland farmers need all the grain that can be produced on their own farms. However, interest in 'locally' milled flours and baked breads has led to one farmer committing to a 2 ha plot of milling wheat for 2016.

Interest in the use of domestic cereals is increasing. Yellow Belly Breweries in St. John's Newfoundland and other local brewers are very interested in using local grains for their beer products and another company has expressed interest in local grains for whisky. Although the Provincial Government is working on a strategy to test small volumes of local grain for alcoholic beverage production, the current priority is to reduce livestock feed imports. As awareness of the capacity for cereal growing increases, more inquiries and interest from the public and end-users can be expected.

4 Recent Trends In Cereal Production In The Partner Regions

In Iceland, the area of barley planted (Table 7) has increased from 2,600 ha in 2003 to 3,989 ha in 2014 (about 53%). Production (Table 7) has increased by a slightly lower percentage (from 9,800 t to 13,927 t), and the low production of 2013 (9,800) shows how susceptible this is to adverse weather conditions.

Cereal farming is a new development in Icelandic agriculture and is thought to be on the verge of a major expansion. It also has the major advantage of bringing innovation to feed production as field rotation is allowing old hayfields to be replaced by much more productive grass fields.

The barley yield per hectare has increased during the last decade because of increased knowledge among the farmers and also favourable weather conditions. The most important factor, though, might be the progress in plant breeding in the Nordic region as a whole. It has been estimated at the Agricultural University of Iceland that plant breeding has increased the yield in Iceland per year by 0.5% for 2-row barley and 1.1% for 6-row barley.²

Table 7. Changes in the area of barley planted and barley production from 2003 to 2014.

Year	Barley area ha			Barley production (t)		
	Iceland	N-Norway	Orkney	Iceland	N-Norway	Orkney
2003	2,600	186	3,946	9,800	493	NA
2004	2,878	254	4,029	11,100	636	NA
2005	3,636	315	3,915	10,500	428	NA
2006	3,588	309	3,988	11,500	561	NA
2007	3,576	276	4,079	12,200	461	NA
2008	4,328	309	4,316	16,400	799	NA
2009	4,764	342	4,644	16,200	511	NA
2010	4,295	348	4,349	16,800	742	NA
2011	4,381	318	4,427	11,800	617	NA
2012	4,502	297	4,286	16,800	700	NA
2013	4,250	186	4,300	9,800		NA
2014	3,989	252	4,359	13,927	(1,134)	NA

Source: Agricultural University of Iceland. 98% of the cereal area is barley. Barley production is calculated at 85% d.m. Norway data from Statistics Norway (Statistisk sentralbyrå). Orkney: areas are from annual Economic Reports on Scottish Agriculture; production figures are not known.

² Jónatan Hermannsson, Agricultural University of Iceland.

In northern Norway, there have been small year-to-year fluctuations in both the area of barley planted and production since 2003, but overall there has been little change (Table 7).

In Orkney, there has been a small increase in the area planted with barley so that from 2003 to 2008 the average area was 4,046 ha and from 2009 to 2014 it was 4,394. Most of this increase has been due to greater planting of feed barley although there has also been a small increase in the area of Bere planted (from about 5 to 30 ha) and the start of planting of malting barley (about 10 ha annually since 2010). More barley may also have been planted in recent years for both farm-saved and certified seed.

Barley represents about 96% of the area of cereals grown in Orkney. The remainder is mainly oats (about 163 ha in 2014) and a very small amount of wheat. Oats appear to have become a more popular crop in recent years and some farmers claim they are less susceptible to damage from geese.

Increased barley growing since 2000 may have been encouraged by the availability of more efficient agricultural machinery allowing farmers to make better use of narrow windows of opportunity for planting and harvesting. The trend for an increasing amount of drilling and combining to be done by contractors is continuing, particularly as both the cost and output of machinery increase. For example, individual contractors can plant 24 to 32 ha per day; only about half this was possible 10 years ago. Some contractors like single pass, others are still using 2-pass. One contractor planted about 1000 ha in 2013. Changes in machinery (e.g. Vaderstad disc drill) are expected to increase this output and on some soils may allow direct drilling. Larger combines can now harvest about twice the area of 10 years ago in the same time. One contractor with a 4-WD combine with a 6 m cutter bar managed to harvest 29 ha in one day (more typical rates are c. 1.2 ha/hr). He has 2 combines and has the potential of harvesting about 40 ha per day. In 2013, he harvested about 440 ha for his customers. In spite of the apparent advantage of contractors with large combines, farmers may have to wait for a contractor and for small areas of specialist cereals it may be useful for farmers to have the independence of their own combine.

Newfoundland. For the last 20 years, cereal research has been carried out periodically on the Island with small plot trials. With promising results from these trials and growing interest from farmers keen to reduce their feed costs, a multi-year grain programme for Newfoundland was started in

2012 by the Forestry & Agrifoods Agency. The Agency has purchased an appropriate range of equipment (e.g. self-propelled combine and seed drills) and transports it to each farm, as necessary. It also supplies the seed and inputs for the crop during this experimental stage. The Agency is investigating the two cereals which are most likely to reach maturity in the local climate – winter wheat and barley. Since it has been difficult, with the Newfoundland climate, to obtain low grain moisture at harvest, high moisture grain appears to be a potential solution as this can be harvested earlier than dry grain and under more adverse conditions (e.g. with light rain). There are still many aspects which need further investigation – for example, identification of the best varieties for the region, pest and disease management, soil fertility, and most importantly how to successfully plant with no-till technology into a grass forage field which has been killed off by herbicide. The last point is important because dairy farmers have the highest need of grain on the island and their current land base is usually a grass-legume forage blend. Cultivating soil in the province is very problematic because it is very rocky and rock picking machines are not only expensive to buy, but also expensive to run. Farmer uptake would be substantially higher if an effective system could be found which killed off the established forage field and allowed the no-tilled cereals to grow without competition from recovering grass forage later in the season. The current herbicide regimens and recommendations have not been effective so far.

5 Economics Of Cereal Production

5.1 Introduction

The economic feasibility of cereal cultivation is governed by two primary factors, the cost of production and the value of the end product. These factors have been reviewed for Iceland (Reykdal, et al. 2014).

The production cost per 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. These are costs which 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.

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 other food purposes. 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 imported 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. The main potential for added value in Icelandic cereal production at present appears to be associated with tourism. There seems to be considerable demand for food and drink products which use local ingredients and are 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.

The link between cereal production and an emerging cultivation culture is an added value. One of the benefits of this is the opportunity to renovate grass fields resulting in higher quality roughage for livestock. Cereal cultivation will encourage the renovation of grass fields through crop rotation. This factor has probably been underestimated in recent years, as it is difficult to convert it to a monetary value.

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

Considering the current importation of cereals, and plans for the use of homegrown cereals 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.

5.2 State support

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.³ The support in the year 2015 for a common/ traditional farmer was:

- 2-30 ha 19,800 ISK (about € 140) per ha – minimum size 2 ha.
- 30-60 ha 14,800 ISK (about € 105) per ha.
- Above 60 ha 2,800 ISK (about € 20) per ha.

The support for cereal cultivation on pig farms in 2015 was:

- 2-75 ha 19,800 ISK (about € 140) per ha – minimum size 2 ha.
- 75-150 ha 14,800 ISK (about € 105) per ha.
- Above 150 ha 2,800 ISK (about € 20) per ha.

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.

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

³ Eiríkur Loftsson, Icelandic Agricultural Advisory Centre.

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

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

5.3 Economics of cereal cultivation within the region

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.

No economic research results are available for cereal production in the 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 harvesting, 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 fertilizers which will be a combination of imported mineral fertilizer (N, P and K) and slurry from their dairy cows.

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

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

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

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 ha) 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 of producing barley for silage with molasses (Røthe, 2006). The results are positive compared to the use of alternative fodder. The investment in machinery is 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

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals
In Food And Drink Products

- Fungicide

Current, approximate costs of inputs and operations (costed at contractor rates) for growing malting barley are provided below, but returns are very variable and depend on the terms of the contract between the grower and distillery (see Table 8 and notes below). Many growers would also perform some of the operations themselves which would reduce costs.

Table 8. Cost and income for growing of barley for malt production in Orkney (2015 prices).

	Cost/ha GBP (£)	Cost/ha (EUR)
Spreading farmyard manure	20.00	26
Ploughing	42.50	55
Seed ¹	(108.00)	(140)
Fertiliser	167.00	217
Single Pass Drilling	82.50	107
Rolling	17.29	22
Herbicide (spraying + chemical)	33.00	43
Fungicide (spraying + chemical)	45.00	59
Combining	100.00	130
Baling (14 bales @ £2/bale) ²	28.00	36
Grain Drying (5.8 t from 22% to 13% moisture content) ³	(230.00)	(299)
Total Cost ⁴	873.29	1135
Grain Value (5.2 t at 14% moisture content and £200/t) ⁵	1040.00	1352
Straw value (14 bales @ £14/bale)	196.00	255
Total Income	1236.00	1607

^{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.

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

⁵ £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.

In comparison to a grain price of about £200/t (€260/t) for malting barley, feed barley is sold occasionally for a price of about £120-140/t (€156-182/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.

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals
In Food And Drink Products

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 (€390-520/t) compared with a purchase price of about £540/t (€702/t) for commercial seed.

Newfoundland. The cost of production is outlined in Table 9. Excluded from these costs are labour, equipment purchases and insurance as they are highly variable across farms depending on wages and type of equipment purchased (i.e. new or used, 2WD, 4WD etc.). The labour requirement to establish, maintain and harvest a cereal area of 1.0 ha is estimated as: 0.8 hours to plant, 0.4 hours per pesticide application (herbicide or fungicide) and 0.5 hours to harvest. The cost of materials per hectare in 2014 including seed, fertilizer, herbicide, combine fuel, Ag bag and preservative was €341 for winter wheat and €260 for spring wheat and barley. The cost per tonne was €110 for winter wheat and €102 for spring wheat and barley. Program success has led to an almost tripling of the harvested area in 2014 compared with that of 2013 and farmers are beginning to plant their own crops with the cultivation techniques they have learnt.

Table 9. General material costs for Newfoundland and Labrador 2013-2014.

Item	Winter Wheat Costs (€/ha)	Winter Wheat Costs (€/t)	Spring Wheat/ Spring Barley Costs (€/ha)	Spring Wheat/ Spring Barley Costs (€/t)
Seed (including shipping)	€77.72	€24.97	€75.58	€30.25
Fertilizer (including shipping)	€138.02	€44.35	€92.01	€35.81
Pre-Planting Herbicide	€8.47	€2.72	€8.47	€3.30
In-Crop Herbicide	€32.86	€10.56	-	-
Fungicide	€32.86	€10.56	€32.86	€12.79
Combine Fuel	€17.28	€5.55	€17.28	€6.73
Ag Bag	€20.54	€6.60	€20.54	€8.00
Acid Treatment	€13.14	€4.22	€13.14	€5.12
Total	€340.89	€109.53	€259.88	€102.00

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals In Food And Drink Products

5.4 Market prices

Table 10 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 %.

Table 10. 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	2015	ton	40,000	ISK	284
Milled barley for baking industry	Iceland	2015	ton	112,000	ISK	794
Icelandic barley flour (supermarket)	Iceland	2015	kg	594	ISK	4.2
Icelandic pearl barley (supermarket)	Iceland	2015	kg	1,118	ISK	7.9
Icelandic wholemeal wheat	Iceland	2015	kg	598	ISK	4.2
Imported wholemeal wheat	Iceland	2015	kg	192	ISK	1.4
Imported wheat flour (supermarket)	Iceland	2015	kg	137	ISK	1.0
Imported wheat flour, high protein	Iceland	2015	kg	230	ISK	1.6
Barley bread	Iceland	2015	kg	1,510	ISK	10.7
Whole wheat bread	Iceland	2015	kg	569	ISK	4.0
Whole wheat bread, health-style	Iceland	2015	kg	893	ISK	6.3
Dried barley for feed	N-Norway	2014	ton	2,320	NOK	250
Dried barley (whole) for baking industry	N-Norway	2014	ton	8,710	NOK	940
Milled barley for baking industry	N-Norway	2014	ton	8,730	NOK	942
Milled whole barley for baking industry	N-Norway	2014	ton	9,070	NOK	978
Whole wheat bread	N-Norway	2014	loaf	35	NOK	3.7
Whole wheat bread	Faroe Islands		kg	40	DKK	5
Preserved (Propcorn) barley for feed	Orkney	2015	ton	120	GBP	156
Dried barley for feed	Orkney	2015	ton	130	GBP	169
Straw (Round bale, 1.2 x 1.2 m)	Orkney	2015	bale	13.5	GBP	17.6
Milled barley for baking (Beremeal)	Orkney	2015	kg	2.52	GBP	3.3
Beremeal bread	Orkney	2015	kg	2.26	GBP	2.9
Wholemeal wheat bread (local baker)	Orkney	2015	kg	3.75	GBP	4.9
Wholemeal wheat bread (supermarket)	Orkney	2015	kg	1.11	GBP	1.4
Dried barley for feed	Newfoundland	2015	ton	375	CAD	309
Dried wheat for feed	Newfoundland	2015	ton	390	CAD	321
Dried oats for feed	Newfoundland	2015	ton	300	CAD	257
Whole wheat bread	Newfoundland	2015	kg	6.50	CAD	4.3

Sources: Iceland: Market prices recorded in supermarkets in November 2015 and information from farmers and companies.

6 Regional And World Market Trends In Cereal-Based Food Products

6.1 Introduction

The main cereal grown throughout the Northern Cereals project partner regions is barley. Global production of barley averaged 141 Mt from 2000 to 2010 (Arendt and Zannini, 2013b) and barley is about the fifth most important crop for dry matter production. Most of this, however, is used either for animal feed or malting and only about 2% is used for human food (Baik and Ullrich, 2008). Nevertheless, in some regions it has greater traditional importance for food (Newman and Newman, 2006) and traditional barley foods, often using barley flour, are still made in some of the project partner regions. A major difference between wheat and barley flour is that the former contains more gluten which gives wheat dough its visco-elastic properties which allow it to be expanded by fermentation and then baked into bread or processed into pasta, noodles or other foods (Shewry and Halford, 2002). This is important for producing light breads and other bakery products. In contrast, barley flour usually produces much heavier products and is often mixed with wheat flour to produce lighter products. In spite of this major limitation, there has been a revival of interest in using barley as a human food, mainly for health reasons. In particular, barley is a source of dietary fibre, β -glucan and antioxidants and because of their β -glucan content barley foods are of interest in their ability to reduce serum cholesterol and hence to reduce the risk of cardiovascular disease (Ames and Rhymer, 2008). As a result of its role in traditional northern foods and its potential for contributing to products with a high nutritional value, the Northern Cereals project is therefore promoting barley as a potentially important local ingredient for northern food producers.

Although, barley is the main cereal grown across the partner regions, other cereals are also sometimes grown in some regions - with varying success. Surprisingly, winter wheat has been grown successfully in Iceland and the grain has been milled locally and used for baking, but the crop is very dependent on favourable weather conditions. In Orkney, spring wheat and oats are both grown on a small scale and are milled locally and supplied to local bakery companies. Renewed interest in oats as a food crop has been driven mainly by nutritional factors (Arendt and Zannini, 2013a). In particular, oats have a high content of β -glucan, but they can also be used to produce foods with a low glycaemic index, which can help management of diabetes, and are promoted by some for their possible role in a gluten-free diet for people with coeliac disease. Growing spring oats and wheat in northern areas is generally more challenging than barley, however, because they require a greater

number of degree days to reach maturity. For this reason, the remainder of this chapter concentrates on barley.

6.2 Regional cereal food trends

Several of the project's associate partners are bakeries, or have links to the bakery industry, and are therefore interested in using local cereals, especially barley for food products. The associate partners which fall into this category are listed in Table 11.

Table 11. Project associate partners involved in food production activities.

Partner Region	Associate Partner	Description of Associate Partner
Iceland	Federation of Icelandic Industries (<i>Samtök iðnaðarins</i>)	A trade organisation with links to about 30 bakeries.
Iceland	Modir Jord (<i>Móðir Jörð</i>)	A farm producing barley and small amount of wheat, but also food products from these cereals.
Norway	Tromsø bakeri AS	Bakery.
Norway	Eldhusbakeriet	Bakery.
Norway	Dyrøymat AS	Producer of pre-cooked meals.
Orkney	Birsay Heritage Trust	Runs Barony Mill which produces beremeal (a traditional barley flour). The Trust has links with many bakeries.
Orkney	Orkney Food and Drink	A marketing organisation which includes all of Orkney's main bakeries.
Faroes	Hotel Føroyar	One of the largest Faroese hotels with affiliate restaurants and central bakery.
Faroes	Gutti Winther	Prominent chef and entrepreneur.

To identify important local market trends, key industry informants were identified and interviewed using a small number of questions as a guide to the discussion. Most of these informants were from the companies listed in Table 11. The questions used to guide the discussion and a brief summary of the replies is provided in Table 12. The table is based upon interviews with 7 stakeholders.

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals
In Food And Drink Products

Table 12. Summary of questions and responses about key local market trends in cereal-based food products.

Questions	Brief Summary Of Responses
1. What are the most important market trends which have influenced the company in the past 5 years?	The number of bakeries has decreased but surviving bakeries are bigger than before. Growing interest in healthy and “natural” products. Interest in traditional products. More products required for one-person households. Increased demand for convenience foods. Customers looking for foods with a strong local identity.
2. What are likely to be the most important market trends in the next 5 years?	Wholesomeness. Use of food labels and the health claims which can be made More convenience foods. Traceability.
3. Are there any new cereal-based products the company would like to develop? If yes, specify.	Breakfast cereals. Porridge mixes. Bread mixes. Ready-made foods. Bread. Flatbread. Crispbread. Barley grains used as a substitute for rice, for making porridge and in soups.
4. What are the unique selling points which help to sell products made from local cereals?	Taste. Wholesomeness.
5. Are there any products which do not work well with local cereals?	Products are limited by the properties of barley, although there is no reason why this can’t be mixed with other imported flours to produce a more versatile flour.
6. Which cereal-based products might be more suitable for small-scale producers than large scale producers?	The local cereal most likely to be used is barley and it may be easier for small bakeries to adapt their practices to using barley flour (which does not rise) compared with larger bakeries.
7. Which products have potential for export?	Most companies were not interested in exporting. They considered it more important to concentrate on satisfying the tourist market.

Although only a small number of companies were interviewed, there are some clear trends emerging from the interviews, particularly when the results are considered against the background of trends

which can be seen in the world market which are presented in the next section. The main findings from the interviews are:

- The main trends which have affected local companies are a growing interest in local, healthy and traditional foods. Convenience and ready-to-eat foods are also increasingly important.
- It is thought that these trends will continue over the next few years.
- Several of the new products of interest to companies reflected the interest in healthy, convenience foods (e.g. breakfast cereals, porridge mixes, crispbread, flatbread).
- Generally, bakery companies were not interested in developing exports and felt it was more important to meet the demand from the domestic and tourist market.

6.3 Review of global and regional trends in cereal food markets

There have been several recent analyses of food trends at all levels - global, regional and local. Through their group, Global Consumer Insights (GCI), the company General Mills annually makes a list of the Top 10 Global Food Trends. Their top 10 list in 2014 (Grayson, 2014) contained the following trends:

- i. **Snack Mania** - Expect increased interest in healthier and “better-for-you” snack options that are convenient and easy-to-eat.
- ii. **Wellness Foods** - Instead of seeing food as functional for health, consumer mindsets are shifting to see food as a tool for wellness.
- iii. **Protein Obsession** - Health benefits will drive demand for protein, while desire for cultural diversity will shift demand from traditional meats to exotic meats, egg dishes and more vegetarian alternatives.
- iv. **Turn Up the Heat** - Flavours get bigger and bolder as once exotic taste profiles have become ordinary flavours. Look for heat and spice in new categories including yogurt, ice cream, chocolate, soft drinks and more.
- v. **Love for Local** - Expect greater food transparency, visible food footprints, more sustainability initiatives and increased interest in animal welfare.
- vi. **Sugar Crash** - Some consumers are turning away from chemical-based artificial sweeteners and turning to alternative and plant-based sweeteners like stevia (from *Stevia rebaudiana*), monk fruit (*Siraitia grosvenorii*) and honey.

- vii. **Back to the Future for Health** - Expect ancient grains to expand from quinoa (*Chenopodium quinoa*) to freekeh (made from *durum* wheat) and chia (*Salvia hispanica*). New superfoods will include heirloom vegetables, such as parsnips (*Pastinaca sativa*) and artichokes (*Cynara cardunculus* var. *scolymus*).
- viii. **Good Taste, Less Waste** - Food waste is a global concern. Expect to see more single-serve packs, freezable products and recyclable materials.
- ix. **Food as Activity** - Preparing and eating food has become a leisure-time activity.
- x. **Wheat-Free Movement** - Expect to see more gluten-free labels and wheat-free/gluten-free alternatives.

In the above list, i, ii, v and x are particularly relevant to the aims of the Northern Cereals project and similar trends were found by most project partners in their own areas. These trends are especially pertinent to the development of new cereal food products by associate partners.

For bread and grain products, the trends are towards using healthier grain types and varieties. This is also reinforced by the ongoing work from Health authorities in the different countries. In Norway, a report (Developments in the Norwegian diet 2015)⁴ produced by the Norwegian Directorate of Health identified increased consumption of wholegrains as being one of the main areas to concentrate on.

A consumer survey, Breadhabits 2011, was carried out in Norway in 2011 by *Opplysningskontoret for brød og korn*.⁵ This showed that 76 % of respondents eat mainly bread for breakfast and 67 % eat mainly bread for lunch. The most important factor that determines the choice of bread is good taste (73 %), but the percentage of wholegrain is also an important factor (66 %). Amongst children under 15 years old, 55 % eat mainly semi-wholegrain bread, 51 % mainly wholegrain bread and only 8 % white bread. It seems that Norwegians are eating less bread than before (30 % claimed to eat less bread than earlier). The main reason mentioned for this reduction (79 %) is dieting.

In the Nofima article “Wholegrain and fiber is the new wine”,⁶ Stefan Sahlstrøm, Senior Scientist at Nofima says that: “Surveys of grain production and consumption in Norway, the Nordic countries

⁴ <https://helsedirektoratet.no/Lists/Publikasjoner/Attachments/1021/Utviklingen-i-norsk-kosthold-2015-IS-2382.pdf>

⁵ <http://www.brodogkorn.no/sitefiles/5/NO2011-0234ToplineResultaterBrodvaner-OpplysningskontoretforBrodogKorn.pdf>

⁶ <http://nofima.no/nyhet/2012/05/fullkorn-og-fiber-blir-den-nye-vinen/>

and the EU show a great need for more and new types of coarse grains - preferably based on barley, oats and rye". He also says that developing such products requires closer cooperation along the entire value chain - between research, grain millers, bakers and consumers. In the same article, Hilde Skotland Mortvedt and Astrid Nilsson, both in Nofima, reported on a trend analysis for the Norwegian grain industry. "Healthy and tasty", "natural and traditional" are words describing their findings. There has also been a rapid growth in *convenience foods*. Busy days mean that many resort to fast food, and they identified "healthy fast food" as tomorrow's winning concept. The survey found that consumers want fresh, good, natural and healthy meals, and an increasing number of shops-in-shops - for example, bakeries or cafes within grocery stores. Porridge is popular both as a small snack and as a fast food product. Consumers want to buy genuine and natural food, often made from local ingredients. In addition, they have a desire to preserve old traditions. There has therefore been a revival of old-fashioned food, but presented in new ways. This is also part of the reason for the success of cake, sticky-bun and bread mixes. This segment has grown considerably in recent years and new varieties are constantly appearing. The dream of the old days has also left its mark on packaging in the bakery industry. "It's all about roots and nostalgia in modern packaging", concludes Mortvedt.

The trend for increasing consumption of local food is demonstrated by a study from Norway which found that over the last five 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 13 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.

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 starting 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, "Year of Food and Drink Scotland 2015"⁷; was a Scottish Government initiative

⁷ www.visitscotland.org/business_support/advice_materials/toolkits/year_of_food_and_drink_2015/about_year_of_food_and_drink.aspx. Accessed 18 December 2015.

led in partnership by EventScotland, VisitScotland and Scotland Food & Drink. The aim of Year of Food and Drink 2015 was to spotlight, celebrate and promote Scotland's natural larder and quality produce to both the Scottish population and visitors and in doing so, further develop Scotland's reputation as a land of food and drink.

Table 13. Comparison of the turnover of local food and all food and drink in the Norwegian market from 2010 to 2014.

	2010	2011	2012	2013	2014
Total turnover for local food	€ 280 m	€ 320 m	€ 340 m	€ 360 m	€ 470 m
Growth of local food turnover in the last year	7.3 %	13.0 %	6.7 %	8.4 %	10.3 %
Growth of total category food and drink turnover in the last year.	3.5 %	4.0 %	5.0 %	3.6 %	3.5 %

6.4 Health benefits of barley

A prominent theme in the previous section was the health benefits associated with barley. In view of the potential importance of this for developing barley food products, a brief summary of this topic is provided below. It is important to stress, however, that great care needs to be taken, particularly on food packaging or in advertisements, not to make any health claims for a product which cannot be substantiated or which might be misleading. There are major nutritional differences between the main types of northern cereal (barley, wheat, oats and rye) but, even within the same type, significant nutritional differences exist between different varieties or between grains of the same variety grown in different locations. Furthermore, processing of the grain and the method of manufacture of food products also have a major modifying effect on the nutritional value of the final product and need to be taken into account.

Barley was one of the first cereals to be domesticated in the "Fertile Crescent" and there is considerable evidence for its importance as a food in the ancient world. Gradually, especially in

areas where the climate was well-suited to wheat, barley appears to have been displaced by wheat for making into food, particularly for the more affluent classes. Thus, in ancient Rome, bread made from wheat was preferred by those who could afford it; interestingly, however, gladiators continued to consume barley bread, in the belief that it gave them greater strength and stamina and, consequently were called “hordearii” or “barley men” (Newman and Newman, 2006). As agriculture spread through Europe, it seems that wheat was the crop of choice for human food in areas where it grew well, but in northwest Europe barley and, in some areas, oats dominated because they were more suited to lower temperatures and wetter conditions. Until about the middle of the 19th Century, wheat was probably little used by poorer people in these areas because of their geographical isolation and the high cost of importing it. As a result, traditional foods based on these non-wheat cereals have survived. In Scotland, for example, beremeal is still produced from a traditional type of Scottish barley (Bere) and is made into a flatbread or bannock. Barley flatbreads were also common in other parts of the region (e.g. Norwegian “flatbrød”) as well as barley porridge, like the Norwegian “vassgraut” or water porridge.

A detailed review of the composition of barley is available in Arendt and Zannini (2013b) and a summary was also provided by Baik and Ullrich (2008). These reported that whole barley grains consist of about 65-68% starch, 10-17% protein, 4-9% β -glucan, 2-3% free lipids and 1.5-2.5% minerals. Total dietary fibre ranges from 11-34% and soluble dietary fibre from 3-20%. Barley grains are a source of vitamins and contain all the vitamins and choline, except for vitamins A, D, K, B₁₂ and C; they also contain higher amounts of fat-soluble vitamin E (tocols) than the other major cereals (Arendt and Zannini, 2013b). De-hulled barley and naked barley contains 11-20% total dietary fibre, 11-14% insoluble dietary fibre and 3-10% soluble dietary fibre. Amongst the different types of barley, most of those currently grown in Europe have the hull attached to the grain (hulled barley). In hulless, or naked barley, the hull readily separates from the grain during threshing or processing. Hulless varieties may therefore be preferred for food production because they need less processing, although for brewing and distilling hulled varieties are preferred because the hull helps to filter the mash.

6.5 Recent health issues of relevance to barley

In the past few decades concern has grown in western societies about the increasing prevalence of a number of health issues which are linked to life-style and diet. These include cancer, obesity and related chronic diseases like hypertension, stroke, cardiovascular disease and type-2 diabetes. There is increasing evidence that these conditions can be affected by diet, especially the intake of dietary fibre or whole meal products. Since barley is a good source of dietary fibre, there is increasing interest in its potential for improving diets, especially as consumers are becoming more aware of health issues and receptive to healthy foods. In the following paragraphs, some of these important health issues are briefly reviewed, together with aspects of barley's nutritional composition which are relevant to these conditions.

In western countries, Cardiovascular Disease (CVD) is the leading cause of mortality and is caused by a thickening of the arteries (atherosclerosis) resulting from a deposition of low density lipoprotein (LDL). This can lead to a heart attack or stroke. Several epidemiological studies have shown that a high fibre diet is inversely associated with CVD. Barley has attracted attention because its grains are a good source of β -glucan, a type of soluble fibre, which has been shown in clinical trials to reduce circulating blood cholesterol. This has resulted in approved health claims for the cholesterol lowering effect of barley β -glucan in the United States, Europe and Canada. In Europe, the EFSA (2011b) approval states that at least 3 g per day of barley β -glucan should be consumed to reduce blood cholesterol. Typically, the β -glucan content of barley is 3-8 g/100 g dry matter, although this varies with both barley variety and environment (Dickin et al., 2011). Most barley β -glucan is located in the cell walls of the starchy endosperm so that processing the grain (e.g. pearling) may be a means of raising the concentration of β -glucan in the barley kernel. It is also possible to produce fractions with much higher β -glucan concentrations by modifications to standard milling and sieving procedures (El Khoury et al., 2012).

Type-2 diabetes (non-insulin-dependent diabetes) is a disease which results from the body failing to produce sufficient insulin or ceasing to react to it, so that there is an increase in the level of glucose in the blood. It is a major health concern in developed countries and is especially associated with obesity and people over 40 years old. To manage this condition, particular attention needs to be given to controlling blood sugar levels, and diet plays an important role in this. Research has shown that, following a meal, some carbohydrate-containing foods result in a rapid rise in blood sugar levels while others result in a lower elevation. This gave rise to the concept of Glycaemic Index (GI)

which ranks foods according to how quickly they elevate blood sugar levels (British Dietetic Association, 2013). Highly processed foods containing carbohydrates which are rapidly digested and absorbed result in a fast and high response and therefore have a high GI. In contrast, low GI foods (e.g. wholemeal cereal products) are digested more slowly and release glucose more slowly into the bloodstream. Cereal fibre, like barley β -glucan, in foods can slow the onset of raised blood sugar levels and so can help people with type-2 diabetes to manage their condition. It is thought that this effect of β -glucan results from an increase in the viscosity of food and delayed gastric emptying. As a result of evidence submitted to the EFSA (2011a), it was concluded that the consumption of β -glucans from oats or barley contributes to the reduction of the glucose rise after a meal and that in order to obtain the claimed effect, 4 g of β -glucans from oats or barley for each 30 g of available carbohydrates should be consumed per meal.

Colorectal cancer (CRC) is the third highest cause of cancer mortality, and diets high in red and processed meat, obesity, lack of physical activity and smoking are amongst the risk factors associated with the disease. Possible mechanisms for the effect of whole grains and dietary fibre on helping to prevent CRC include a decrease in faecal transit time which may reduce the exposure of the gut to carcinogenic compounds and to antioxidants in wholegrains which may restrict the production of carcinogenic compounds. Barley β -glucan extracts have been shown to be a rich source of polyphenols and antioxidants, although the content varies with the method of preparation (Thondre et al., 2011). Diet has an important influence on the composition and diversity of the microorganisms found in the gut (gut microbiota). There is accumulating evidence that a high fibre diet stimulates the development of specific microorganisms which may produce anti-inflammatory metabolites (especially short-chain fatty acids) which may protect against CRC. As a result of their effect on the gut microbiota, there may also be potential for using barley β -glucan in prebiotics (substances that induce the growth or activity of microorganisms which contribute to the well-being of the host).

At its most basic, Obesity is being very overweight with an abnormally high amount of body fat. It is commonly defined by a body mass index (BMI) above 30 kg/m². Obesity usually results when more calories are consumed than are expended, which can easily be achieved when fatty or sugary foods are consumed; the excess is then stored as fat. Obesity is often accompanied by some of the health issues described above (especially CVD and type-2 diabetes), or may result in these conditions developing. It is usually treated by encouraging a change to a healthier, reduced-calorie diet,

combined with increased exercise. There are many elements in a healthy diet, but one of the most basic is:

- An *appropriate balance and quantity* of different types of food – fruit and vegetables, starchy foods (especially from wholegrains), protein (meat, fish, eggs and beans), dairy foods, and a relatively small proportion of food or drink which is high in sugar or fat (<http://www.nhs.uk/Livewell/Goodfood/Pages/eatwell-plate.aspx>)

For people with obesity, the following modifications to diet are usually recommended:

- Reduced consumption of sugar, sugary drinks and foods containing saturated fats
- Reduced consumption of highly refined starchy foods like white bread and white rice and increased consumption of wholegrain, high-fibre products

The high fibre content of barley, together with its minerals and vitamins, makes barley foods well-suited for inclusion in a healthy diet. For treating obesity by weight loss, a particularly relevant property of barley foods is that some have been shown to increase satiety so that people often feel fuller and less hungry after eating them compared with after eating high glycaemic index foods (El Khoury et al., 2012). Barley foods could therefore help to limit calorie intake.

Cereal proteins are nutritionally important, but they can also affect the way the grain or flour can be utilized for food production. This is especially the case with wheat, where gluten provides dough with its ability to make light bakery products. Another aspect of gluten, however, is that people with Coeliac Disease (CD) are unable to tolerate it in their diet. The incidence of CD is about 1-3% of the population worldwide, but this varies from country to country (Gilissen et al., 2014). It is caused by intolerance to the proteins in certain cereals, especially a large and complex group called the prolamins which are particularly rich (30-70%) in the amino acids proline and glutamine. Prolamins in wheat are known as gliadins and glutenins, in barley as hordeins, in rye as secalins and in oats as avenins. Together these are often called “gluten”. Gluten intolerance or celiac disease (CD) is an auto-immune disease which results in a chronic inflammation of the small intestine and is often accompanied by acute symptoms, e.g. diarrhoea, as well as chronic consequences of poor nutrient absorption, e.g. weight loss and anaemia. Gluten proteins are incompletely digested in the gastrointestinal tract and this results in the formation of fragments (epitopes) which trigger the auto-immune response in susceptible individuals. The most severe and immuno-dominant epitopes for CD are present in the gliadin fraction. It is important to appreciate that, while barley does not contain

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals In Food And Drink Products

the same gluten which gives wheat its good baking properties, it contains prolamins (hordeins) which are not tolerated by individuals genetically predisposed to CD. For this reason, barley is not classified as a gluten-free food.

7 Regional And World Market Trends in The Beer And Spirits Market

7.1 Introduction

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 chapter summarises information about trends in the regional and world spirits and brewing markets.

7.2 Regional trends

The project has strong partnerships in several countries with stakeholders in the alcoholic beverages industry. Table 14 presents a list of these associate partners by country and by type of producer.

Table 14. Project associate partners involved in alcohol production.

Partner Region	Associate Partner	Type of Producer
Iceland	<i>Olgerdin (Ölgerðin Egill Skallagrímsson)</i>	Brewery
Iceland	<i>Thorán Distillery ehf. (Þoran Distillery ehf.)</i>	Distillery
Norway	Hemnes mikrobryggeri	Brewery
Norway	Macks Ølbryggeri As	Brewery
Orkney	Highland Park Distillery	Distillery
Orkney	Swannay Brewery	Brewery
Faroës	The Faroese Brewery (<i>Føroya Bjór</i>)	Brewery
Faroës	Gutti Winther	Chef and entrepreneur

To identify important local market trends, key industry informants were identified and interviewed using a small number of questions as a guide to the discussion. Most of these informants were from

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals
In Food And Drink Products

the companies listed in Table 14. The questions used to guide the discussion and a brief summary of the replies is provided in Table 15. The table is based upon interviews with 7 stakeholders.

Table 15. Summary of questions and responses about local market trends in the alcoholic beverages market.

Questions	Brief Summary Of Responses
1. What are the most important market trends which have influenced the company in the past 5 years?	Breweries: Rise of microbreweries and public interest in them. Availability of local barley and other local ingredients. Interest in old or unusual beer types. Distilleries: Premiumisation of products (high value/lower volume products).
2. What are likely to be the most important market trends in the next 5 years?	Speciality beers. Beers using local ingredients (barley, malt, hops, herbs, yeast). Use of renewable energy. One respondent intends to open 2 pubs which will serve as outlets for his beer.
3. Are there any new cereal-based products the company would like to develop? If yes, specify.	Products using more local ingredients (barley, malt, hops, herbs, yeast). Diversifying into spirit production. Beer using enzyme technology.
4. What are the unique selling points which help to sell products made from local cereals?	Creates local ownership of products. Connects to local traditions and culture. Connect to local natural resources (water, herbs, berries). Reduced carbon footprint.
5. Are there any products which do not work well with local cereals?	Low value, high volume products. Any products where the resulting quality is inferior to that of the imported product.
6. Which cereal-based products might be more suitable for small-scale producers than large scale producers?	Niche market products – low volume and high value. Those which use an expensive local ingredient.
7. Which products have potential for export?	Respondents were divided: some thought it best to concentrate first on the domestic and tourist market. Others were keen to also develop exports of beer made from local ingredients.

Although only a small number of companies were interviewed, the main findings are clear, particularly when these are considered together with the review of the world market trends presented later in this chapter. The main results are summarised below:

- The growth of microbreweries and consumer interest in them is diversifying the types of beer which are available within the region.
- Microbreweries need to develop strategies which will help to distinguish them from their competitors. One very attractive method is to produce beers with a greater content of local ingredients (e.g. barley, malt, herbs).
- Consequently, several breweries are very interested in using local barley but for most this will mean developing a means of malting the barley locally.
- There was a very strong indication that breweries recognised that local barley would primarily be used initially for niche market, higher value, but low volume, products.
- Most breweries thought that the main market for new, local beers would be the domestic market and visitors, but a few felt that there would also be considerable export potential.
- Spirit producers were not well-represented in the survey (only 2 companies), but these also indicated that local barley would be well suited to developing premium, high-value products

7.3 Review of recent global trends in spirits and craft brewing

7.3.1 World spirits

This section briefly describes recent developments in the world spirits market. It then describes the Swedish whisky industry which provides an example of a new national industry which has been established from nothing within a relatively short period of time. Finally, aspects of the Scotch whisky industry are described to show some of the benefits this brings to Scotland. Particular attention is given to single malt whisky as this is mostly produced by smaller scale distilleries in the remoter parts of the country and is therefore of greatest relevance to the Northern Cereals project partners.

The world spirits market

In spite of the economic recession in many Western countries, the global market for spirits has, until recently, remained buoyant with a compound annual growth (CAGR) of 6.5% between 2007 and 2011 (Murray, 2014). The resilience of the market has been attributed to its expansion in the developing economies (India, China and South America). Growth slowed in several of these countries in 2013, however, so that global sales increased by only 0.1% to 3.09 billion nine-litre cases in 2013 over 2012 (Murray, 2014). While the biggest decline was in Europe, the largest growth was in the Americas.

In a review of the world spirits market in 2011, the following major product trends were predicted (Wright, 2011):

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

Most of the above has occurred as forecasted, although several of these trends contribute to another major trend, premiumisation. This is the growth in more expensive spirit categories like single malt whisky, whiskey and cognac. As a result of premiumisation, the value of sales has tended to increase more than the volume of sales (Ipsos, 2013). With Scotch whisky, for example, the value of all sales rose by 74% in the decade from 2004 while single malt sales grew by 159% (Scotch Whisky Association, 2015a). Within the spirits sector, there has been an expansion in sales of both traditional products (single malt whisky, bourbon, rye whiskey and cognac) and also many new products (e.g. flavoured vodkas, gins and whiskeys) 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 small-scale craft-producers and products which can demonstrate a special provenance. In the USA, for example, there has been a large increase in demand for Kentucky Bourbons and Tennessee and rye whiskey. This has resulted in a huge rise in

craft distilling in the USA where the number of licensed craft distilleries grew from 69 to 240 between 2003 and 2011 and there were reported to be over 600 by 2014 (Curtis, 2014).

To meet market demand and to appeal to a new generation of adventurous and sophisticated drinker, many of which are female, the American market has seen the appearance of a wide range of new “traditional” whiskeys, many non-whiskey products (including liqueurs) and flavoured or alternative whiskeys. Some of the most successful recent products include honey or cinnamon flavoured whiskey (e.g. Jack Daniel’s Tennessee Honey and Sazerac’s Fireball Cinnamon Whisky). The Scotch whisky industry is not allowed to use flavourings in its whiskies, but there are a number of whisky based liqueurs and in 2014 Ballantine’s Brasil, a spirit using whisky infused with lime peel in the cask, was released. In America, the recent increase in popularity of whiskey has been accompanied by a decline in the market for vodka and flavoured vodkas, suggesting that the new generation of drinkers may be more fickle and quick to change their product preferences.

For small producers with limited distribution channels, marketing of new products has been greatly assisted by the internet and this is also helping to add to the exclusivity of products (Dow and Jung, 2011).

Although the growth of the world spirits market has slowed in recent years, there is clearly still a very strong demand for innovative, high quality products, especially if this is combined with provenance and artisanal production.

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 by Wright (2011) for the growth of markets for non-Scotch whiskies.

Sweden is a large importer of Scotch whisky and so it is not surprising that local entrepreneurs have seen an opportunity to establish a domestic industry. Construction of the first Swedish distillery, Mackmyra, started in 2002 and by the end of 2014 the number of distilleries had increased to 13 (Leslie, 2014). Mackmyra released its first whisky in 2006 and is now well established as an

international whisky producer. Other Swedish distilleries which have recently started to release whiskies include Box, Smögen and Hven (<http://www.worldwhisky.com/swedish-whisky/>; Leslie, 2014). Many of the Swedish distilleries have tourist centres and are also involved in producing other types of spirit which do not need maturation. Use of Swedish raw materials like water, peat, barley and sometimes even Swedish oak for casks, together with the effects of the Swedish climate on maturation are all contributing to the development of a distinctive Swedish style of whisky (Roskrow, 2013).

Scotch whisky industry

Scotch whisky is a Scottish product with a global market and about 90% of production is exported. Exports reached a record £4.3 billion in 2012, an increase of 87% over the previous 10 years (Scotch Whisky Association, 2013). Although this figure dropped by 7% to £3.9 billion in 2014, the industry still remains strong and Scotland earns more from whisky exports than from any other class of exports. While about 54% of sales are in established markets in North America and the European Union, there is a strong conviction in the industry that the development of a huge middle class in emerging economies like India and China represent a large potential market. 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. In 2014, for example, six new distilleries of varying scale opened, several more are in the planning stage and Diageo committed to investing £1 billion in its Scotch whisky business while the Edrington Group announced a £100 million investment in facilities at its Macallan distillery.⁸

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 159% (Scotch Whisky Association, 2015a). 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. 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). For example, it is estimated that every job in the industry helps to support 2.7 in the wider economy while every £1 paid to the industry's

⁸ <http://www.scotsman.com/lifestyle/the-new-whisky-distilleries-being-built-in-scotland-1-3223616>

supply chain sustains a further £0.54 in salaries to workers in the supply chain (Scotch Whisky Association, 2015b).

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. The 52 Scottish distillery visitor centres employed 460 workers in 2010 (Scotch Whisky Association, 2011) and in 2014 attracted 1.5 million visitors with an average spend of £32.50 per head on tours or in their shops or cafés (Scotch Whisky Association, 2015b). Another very important boost to the rural economy comes from purchases of cereals. With about 88% of the malted barley used being Scottish (Scotch Whisky Association, 2015a), this had a value of about £201 million in 2008 (Scotch Whisky Association, 2010). As product differentiation has become more important in a highly competitive market, several distilleries (for example, Bruichladdich on Islay, Highland Park on Orkney and The Macallan on Speyside) have invested in developing their own local or specialised barley supply chains to produce whiskies which use barley with unique provenance (Martin, 2012; Martin and Wishart, 2015). 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.

7.3.2 The craft brewing market

Both the USA and Britain provide good examples of the way in which the craft brewing sector has gained tremendously in popularity in recent years resulting in the opening of numerous microbreweries. In the UK, for example, 170 new breweries were recorded in CAMRA's⁹ Good Beer Guide 2015, bringing the total number of breweries to 1,285 (CAMRA 2014), the majority of which were independent. This represents a huge transition from the situation in 1975 when there were only about 87 independent brewing companies and 150 breweries (CAMRA, 1975). In the UK, it was estimated in 2013 that craft beer represented about 1.9% of total beer volumes, but with year-on-year sales increasing 84% for draught and 40% for packaged products.¹⁰

The rise of the craft brewing sector in the United States can also be traced to the 1970's when the brewing industry was dominated by just 44 companies and a small number of enthusiastic homebrewers struggled to keep an independent brewing tradition alive. The number of craft brewers increased from about 8 in 1980, to 537 in 1994 and to over 2,800 in 2013 when the sector

⁹ CAMRA, Campaign for Real Ale

¹⁰ <http://www.cgastrategy.co.uk/news/news-release-craft-beer-quantified>

was supplying about 8% of the US market.¹¹ In the US, sales of craft and craft-style beers defied the recession and almost doubled between 2007 and 2012 – increasing from \$5.7 billion in 2007 to \$12 billion in 2012 (Mintel, 2013).

The rise of craft brewing was a reaction to the narrow range of standard beers which characterised the market in the 1970's and 1980's and reflects a desire by both brewers and consumers to re-discover more unusual traditional products and to discover novel ones (Nicholls, 2013) made from 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. Apart from a much wider range of hops, other new ingredients include alternative grains, smoked malt, fruit, spices and aromatic plants (SIBA¹², 2014). 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. Another aspect of many craft breweries is their strong link with their customer base. This is demonstrated by BrewDog, the most successful of the new Scottish breweries, which used several rounds of crowdfunding to expand its business, thereby bringing its customers in as shareholders.¹³

A number of craft breweries in America have become so successful that they now have a national distribution or have established secondary breweries in other parts of the country (McGough, 2015). Scotland's largest independent brewery, Brewdog, only opened in 2007 and now exports to 50 countries.

¹¹ <https://www.brewersassociation.org/brewers-association/history/history-of-craft-brewing/>

¹² SIBA, Society of Independent Brewers

¹³ <http://www.foodserviceconsultant.org/region/eame/brewdog-britains-first-craft-beer-superbrand>

7.4 Conclusions

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, the availability of local cereals could benefit these companies by providing raw material which will allow them to develop unique products which will stand out from those of their competitors. The key reasons for this conclusion are:

- Recent market trends show that both the brewing and distilling 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) are an excellent fit with the aims of the Northern Cereal project.
- 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.
- Craft breweries and distilleries make very good tourist attractions, especially if they are combined with a restaurant or café selling local food or crafts. This also helps to increase local employment opportunities.
- Spirit, in particular, is a versatile, high value product and therefore offers many opportunities for adding considerable value to local cereals, particularly if companies can mature them in cask for a few years.
- 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 with a unique provenance, it is also likely that some beverage products could be exported.

8 Acknowledgements

This work was supported by the Northern Periphery and Arctic Programme for the project *Northern Cereals – New Markets for a Changing Environment*. The support is gratefully acknowledged.

9 References

- Ames, N.P. and Rhymer, C.R. (2008). Issues surrounding health claims for barley. *The Journal of Nutrition* 1237S-1243S.
- Arendt, E. and Zannini, E. (2013a). Oats. In *Cereal Grains For the Food and Beverage Industries*. Pp 243-283. Woodhead Publishing Limited.
- Arendt, E. and Zannini, E. (2013b). Barley. In *Cereal Grains For the Food and Beverage Industries*. Pp 155-201. Woodhead Publishing Limited.
- Baik, B.K and Ullrich, S.E. (2008). Barley for food: Characteristics, improvement, and renewed interest. *Journal of Cereal Science* 48, 233-242.
- Bergjord Olsen, A. & Weiseth, L. (2011). Prøving av havre- og byggsorter i Midt-Norge. *Bioforsk Fokus* 6 (1).
- Bioforsk (2006). *Bioforsk Tema Vol.1 Nr 37 2006*.
- Brewers Association (2013). *Craft Brewing Facts*.
<http://www.brewersassociation.org/pages/business-tools/craft-brewing-statistics/facts#> Accessed 8/1/14.
- British Dietetic Association (2013). *Food Fact Sheet, Glycaemic Index*.
<https://www.bda.uk.com/foodfacts/GIDiet.pdf> (Accessed on 3/1/2016)
- Brown, P. (2013). The rise and rise of craft beer. <http://www.shortlist.com/instant-improver/food/the-rise-and-rise-of-craft-beer> Accessed 8/1/14.
- Burn-Callander, R. (2013). A craft beer revolution in brewing.
<http://www.telegraph.co.uk/finance/businessclub/10514482/A-craft-beer-revolution-is-brewing.html> Accessed 8/1/14.
- CAMRA (1975). *Good Beer Guide*. M. L. Hardman (Ed).

CAMRA (2014). Good Beer Guide 2015. R. Protz (Ed).

Curtis, W. (2014). Has craft distilling lost its spirit. The Atlantic. June 2014.

<http://www.theatlantic.com/magazine/archive/2014/06/has-craft-distilling-lost-its-spirit/361619/>

Dickin, E., Steele, K., & Frost, G. (2011) Effect of Genotype, Environment and Agronomic Management on β - Glucan Concentration of Naked Barley Grain Intended for Health Food Use. *Journal of Cereal Science*. **54**, pp. 44 – 52.

Dow, R.A. and Jung, S. (2011). Strategic management of channels of distribution and integrated marketing communications; essays on the Scotch whisky industry. *International Journal of Business and Social Science* 2, 108-113.

EFSA. (2011a). EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA): Scientific Opinion on the Substantiation of health claims related to beta glucans from oats and barley and maintenance of normal blood LDL-cholesterol concentration (ID 1236, 1299), increase in satiety leading to a reduction in energy intake (ID 851, 852), reduction of post-prandial glycaemic response (ID 821, 824), and “digestive function” (ID 850) pursuant to Article 13(1) of Regulation (EC) No 1924/2006. *EFSA Journal* 2011; 9(6) 2207. [21 pp]. Doi:10.2903/j.efsa.2011.22207.

EFSA. (2011b). EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA): Scientific Opinion on the Substantiation of a health claim related to barley beta glucans and lowering of blood cholesterol and reduced risk of (coronary) heart disease pursuant to Article 14 of Regulation (EC) No 1924/2006. *EFSA Journal* 2011; 9(12) 2470. [14 pp]. Doi:10.2903/j.efsa.2011.2470.

El Khoury, D., Cuda, C., Luhovyy, B. L. and Anderson, G. H. (2012). Beta Glucan: Health Benefits in Obesity and Metabolic Syndrome, *Journal of Nutrition and Metabolism*, vol. 2012, Article ID 851362, 28 pages, 2012. doi:10.1155/2012/851362.

Gilissen, L., van der Meer, I., Smulders, M. (2013). Reducing the incidence of allergy and intolerance to cereals. *Journal of Cereal Science* (2014), doi: 10.1016/j.jcs.2014.01.005.

Grayson, A. (2014). Top 10 global food trends. <http://blog.generalmills.com/2014/02/top-10-global-food-trends/> (Accessed on 18 December 2015).

Intellecta (2009). Kornrækt á Íslandi. Tækifæri til framtíðar / Cereal cultivation in Iceland. Opportunities for the future. Intellecta Report Febrúar 2009. (In Icelandic).

Ipsos (2013). Drinking to the future – trends in the spirits industry.

<http://www.ipsos.com/sites/ipsos.com/files/Drinking-to-the-Future-Trends-in-the-Spirits-Industry.pdf>

Leslie, L. (2014). Sweden moves from devoted whisky consumer to skilled producer. *Financial Times* 16 December 2014. <http://www.ft.com/cms/s/0/5c68c62c-7fa1-11e4-b4f5-00144feabdc0.html#axzz3hHADEjal>

Current Cereal Growing Situation In Five Northern Regions And The Potential For Using Local Cereals
In Food And Drink Products

Martin, P. (2012). Single malt Scotch whisky from 59° North. Brewer & Distiller International. July 2012, 45-47.

Martin, P. and Wishart, J. (2015). Just here for the Bere. Brewer & Distiller International. January 2015, 28-29.

McGough, W. (2015). The State of American Craft Beer. <http://gearpatrol.com/2015/03/11/the-state-of-american-craft-beer-2015/>

McFarland, B. (2013). Raising a glass to Britain's craft beer heroes. <http://www.telegraph.co.uk/men/the-filter/10341446/Raising-a-glass-to-Britains-craft-beer-heroes.html>

Mintel, 2013. The rise of craft beer in the US. <http://www.mintel.com/press-centre/food-and-drink/the-rise-of-craft-beer-in-the-us-craft-beer-sales-have-doubled-in-the-past-six-years-and-are-set-to-triple-by-2017> Accessed 8/1/14.

Murray, F. (2014). Global spirits market consumption slows. *The Drinks Report* 11 June 2014. <http://www.thedrinksreport.com/news/2014/15457-global-spirits-market-consumption-slows.html>

Newman, C.W. and Newman, R.K. (2006). A brief history of barley foods. *Cereal Foods World*, 51, 4-7.

Nicholls, L. (2013). Brewing up a storm: craft beer sales continue to climb. <http://www.bighospitality.co.uk/Trends-Reports/Brewing-up-a-storm-Craft-beer-sales-continue-to-climb> Accessed 8/1/14.

Nielsen Company (2013). AC Nielsen Scan Track. Retrieved from: www.regjeringen.no/upload/LMD/Vedlegg/div/Nielsen_markedstall_2013.pdf

Norwegian Agricultural Authority (2013), www.slf.dep.no

Reykdal, O, Martin, P., Helgadóttir, A, Halland, H., Kavanagh, V. and Djurhuus, R. (2014). Cereal Products and Markets in the Northern Periphery Region. Matis Report 21-14.

Roskrow, D. (2013). Swedish whisky revolution. *Whisky Advocate* Spring 2013.

Røthe, G. (2006). Kompetanseheving innen dirking av korn til krossing i Finnmark. *Bioforsk rapport*, Vol. 1 Nr. 49. 18 s.

Scotch Whisky Association (2011). Scotch whisky and tourism. <http://www.scotch-whisky.org.uk/news-publications/publications/documents/scotch-whisky-tourism-gives-massive-boost-to-economy/>

Scotch Whisky Association (2013). Scotch whisky exports hit record level. <http://www.scotch-whisky.org.uk/news-publications/publications/documents/scotch-whisky-exports-hit-record-level/>

Scotch Whisky Association (2015a). Annual Review 2014. <http://www.scotch-whisky.org.uk/news-publications/publications/documents/annual-review-2014/#.Vbjig03bL3g>

Scotch Whisky Association (2015b). The Economic Impact of Scotch Whisky Production in the UK. <http://www.scotch-whisky.org.uk/news-publications/publications/documents/the-economic-impact-of-scotch-whisky-production-in-the-uk-2015/#.VbjgA03bL3g>.

Shewry, P.R. and Halford, N.G. (2002). Cereal seed storage proteins: structures, properties and role in grain utilization. *Journal of Experimental Botany* 53, 947-958.

SIBA (2014). Beer Report 2014. <http://siba.co.uk/documents/local-brewing-report/>

Thondre, P.S., Ryan, L. and Henry, C.J.K. (2011). Barley β -glucan extracts as rich sources of polyphenols and antioxidants. *Food Chemistry* 126, 72-77.

Thorgeirsdóttir, Hólfríður, Hrunn Valgeirsdóttir, Ingibjörg Gunnarsdóttir, Elva Gísladóttir, Bryndís Elfa Gunnarsdóttir, Inga Þórsdóttir, Jónína Stefánsdóttir, Laufey Steingrimsdóttir, 2011. Hvað borða Íslendingar? Könnun á mataræði Íslendinga 2010-2011. Helstu niðurstöður. (The Icelandic national nutrition survey 2010-2011). Embætti landlæknis, Matvælastofnun og Rannsóknastofa í næringarfræði. (In Icelandic with English summary).

Winchester Capital Research (2012). Spirits Industry M&A Update: 2012 Market Insight. <http://www.winchestercapital.com/uploads/WC%202012%20Spirits%20Industry%20Update.pdf>

Wright, S. (2011). Trends in global spirits production. *Brewer & Distiller International* September 2011, 25-27.