




Evaluation of the potential for expanded berry production in the North Atlantic Region

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Content

Preface

This is the professional report from pre-project “Nye bærsortar og dyrkingsteknikk for Island, Færøyane og Grønland”, financed by NORA (Nordisk Atlantsamarbeid). Project partners in the pre-project were Njøs næringsutvikling AS (Norway); Agricultural University of Iceland, Reykir (Iceland); Bunaðarstovan (Faroe Islands); Upernaviarsuk Agricultural Station (Greenland), Sognabær DA (Norway); Graminor AS (Norway); Sagaplant AS (Norway) and AL Gartnerhallen (Norway). During the pre-project contacts has also been established with growers at Iceland interested in starting a test production of berries (primarily raspberries) in plastic tunnels and plastic houses.

Leikanger 24.05.10, Dag Røen

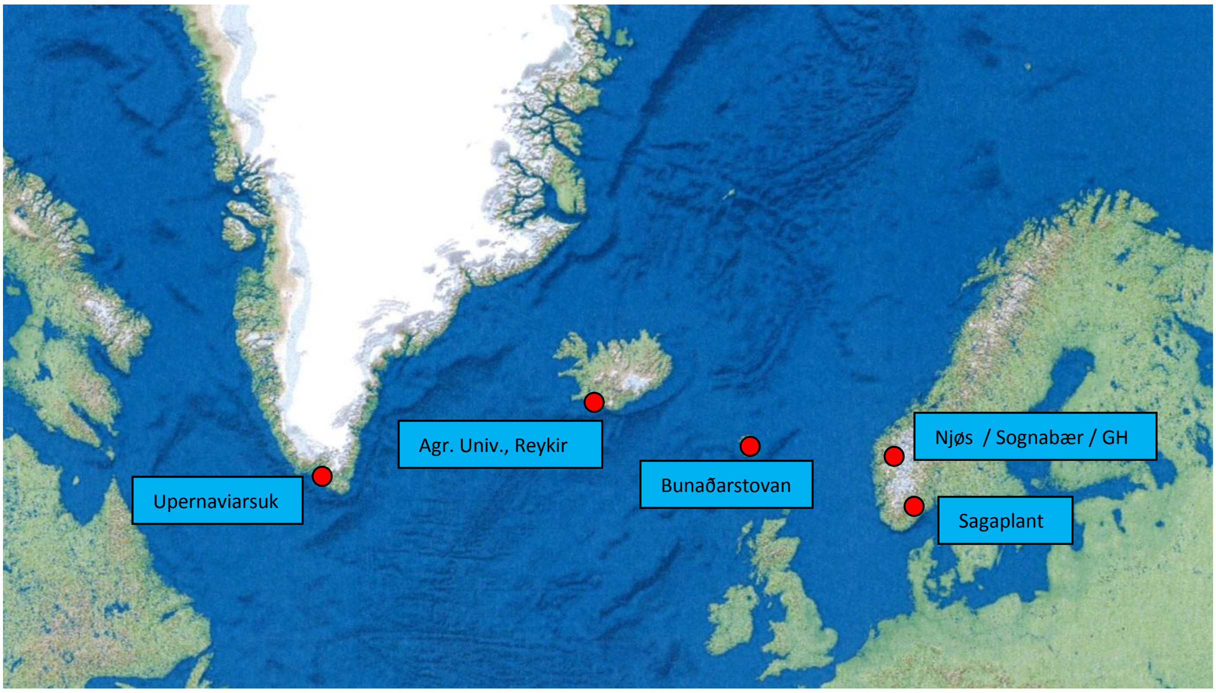


Figure 1. Location of project partners.

Introduction

The aim of this report is to give the first survey of the possibilities for expanding the berry production in the North Atlantic region, with focus on the locations at Iceland, Faroe Islands and Greenland with the assumed best possibilities for such a production. This is done primarily by collecting climate data and comparing them to locations in Norway with berry production today.

Domestically produced berries today

Iceland

Agriculture and horticulture in short

Iceland is primarily a food-producing country. For centuries, the country's basic industries have been agriculture, fishing and fish processing

Cultivation is almost exclusively confined to the lowland areas although most of Iceland's land area consists of highlands. Out of a total land area of around 100,000 km^2, about 15,500 km^2 is arable. About 1,500 km^2 of this land has been cultivated as hayfields. The rest is used mainly for grazing. Forests only cover about 1% of the total land area, and this number is slowly increasing.

There are about 3800 farms in Iceland at present, but their numbers are decreasing. The majority of Icelandic farmers, about 75%, live on their own land, and holdings have often been in the same family for generations.

A special characteristic of Icelandic agriculture is greenhouse production. Over 100 growers are engaged in this production method, utilizing a total area of about 180,000 square metres under glass. Greenhouses have been built on sites in close proximity to geothermal energy and use either hot water or steam from boreholes to provide their heat source.

Most growers specialize either in vegetables or cut flowers or potted plants, with the major crops consisting of tomatoes, cucumbers, green peppers, roses, gerberas, lilies and various kinds of potted plants

Traditionally, there is no commercial outdoor berry growing in the country. In recent years, however, a few growers have been experimenting with various berry species and cultivars and interest in berry production is rapidly growing.

Commercial production of berries

In Iceland there is one grower (Eirikur Ágústsson, Fluðir) that grows 5 haa strawberries in greenhouse / plastic tunnel. Otherwise there is no commercial berry production in Iceland today.

Eirikur Ágústsson grows the cultivars 'Elsanta' and 'Sonata' in bags (peat, pumice), 5 l pots with peat and in rockwool slips. Imported tray plants are put in a propagating greenhouse in June / July, and moved to production house in early July. Harvest period from these first year plants is from 5 weeks after planting until late October. The plants are then kept at + 3 °C until 10 February, followed by two weeks at 13 °C. Harvest period of these plants are from end of April, with a peak in May/June.

Home production of berries

Red currant (*Ribes rubrum*), black currant (*Ribes* nigrum) and strawberries(*Fragaria x ananassa*) are the main berries grown in home gardens in Iceland, but gooseberry (*Ribes uva-crispa*), red raspberry (*Rubus idaeus*) and cloudberry (*Rubus chamaemorus*) are also found in gardens .

Red currant berries are used for jelly, decoration, marmalade, pastries and pies, deserts and salad. The most common cultivar is 'Rød Hollandsk', other cultivars include 'Losvar','Jonkheer van Tets' and 'Hvit Hollandsk'.

Black currant berries are used for jam, juice, jelly, pastry, pies and liqueur. Officially recommended cultivars for outdoor production are 'Sunderbyn II',' Melalahti', 'Jänkisjärvi', 'Nikkala XI' and 'Öjebyn'.

Wild berries

Wild growing berries in Iceland include crowberry (*Empetrum nigrum*), arctic bilberry (*Vaccinium uliginosum*), bilberry (*Vaccinium myrtillus*) and stone bramble (*Rubus saxatilis*).

Crowberries are used in jam, jelly, juice and vine. Also a lot is consumed fresh with skyr.

Bilberries grow mainly in hill-moors and are common over all parts of Iceland except in the south. Flowering time is May-June and harvest period August-September. Bilberries are used fresh with cream and sugar, in jam, jelly, pastries, pies, desserts, juice and wine. The demand is increasing for Farmers ice-cream, skyr and homemade milk products with bilberries.

Stone bramble grows mainly in hill-moors, wood and shrub areas, and is common over all parts of Iceland but not abundant. The berries are used in jam and jelly.

Faroe Islands

Agriculture and horticulture in short

There are about 60 full time farmers in Faroe Islands producing milk, beef and mutton. In addition there are 2-3000 part time farmers running sheep farms. In Faroe Islands they are self-sufficient with milk. There are 30 dairy farms producing about 7,5 mill. liter milk. Average size is 30 dairy cows per farm.

Sheep production is based on outdoor grazing all the year round with a total stock of about 70.000 adult sheep. The main product is "skerpikjøt". This is lamb meat, which has been air dried under natural conditions. A few farmers are producing potatoes for sale. There is no commercial production of vegetables in Faroe Islands, but vegetables are grown in gardens for own consumption

Commercial production of berries

There is no commercial production of berries in Faroe Islands today. There is however a commercial production of rhubarb (*Rheum x hybridum*).

Figure 2. Commercial rhubarb production at Vestmanna in Faroe Islands. Photo: Rólvur Djurhuus.

Home production of berries

For a long time, black currant (*Ribes nigrum*), red currant (*Ribes rubrum*) and gooseberry (*Ribes uva-crispa*) have been grown in private gardens as a supply for one's own consumption. This is also the situation today. In recent years strawberries (*Fragaria x ananassa)* and red raspberries (*Rubus idaeus*) have been introduced. The most popular garden plant with berry-like use has been rhubarb (*Rheum x hybridum*). It is well adapted to the Faroe Islands climate, starts growing early, grows fast and produces a high yield. Normally it is harvested three times per season – e.g. May, July and September.

Table 1. Berry cultivars sold from nurseries in Faroe Islands in the recent years.

Crop	**Cultivars**
Red currant	'Rondom', 'Jonkheer van Tets'
Black currant	'Titania', 'Øjebyn'
Gooseberry	'Invicta', 'Hinnonmäki Rot', 'Careless'
Red raspberry	*plants sold but cultivar information not available*
Blackberry	'Loch Ness'
Strawberry	'Zephyr', 'Dania', 'Honeoye', 'Korona', 'Ostara', 'Senga Sengana', 'Elsanta'

Source: Skógrøkt landsins - Forestry service of the Faroe Islands.

The harvest season for berries has normally been in August, but in recent years the harvest has started earlier. In 2009, mature berries of black and red currants were harvested before medio July, presumably due to a higher spring and summer temperature along with more sunny days than normal.

Almost all production of berries is outdoor, but a small number of small garden greenhouses and small plastic tunnels are also used.

Figure 3. Home production of red raspberries, red currants and black currants in a garden in Faroe Islands. Photo: Sigga Rasmussen.

Wild berries

Wild growing berries in Faroe Islands include bunchberry (*Cornus suecica*), bilberry (*Vaccinium myrtillus*) and lingonberry (*Vaccinium vitis-idaea*) which all develop fruit. In addition stone bramble (*Rubus saxatilis*) and bog bilberry (*Vaccinium uliginosum*) grow well and develop flowers though they normally do not develop fruit.

Greenland

Agriculture and horticulture in short

In January 2008 there were 48 full time farmers in Greenland. In total they have 1000 haa of cultivated land, mainly hayfields for silage, and more than 60.000 haa of mountain pasture. Average farm size (cultivated land) is 20 haa, with an average production of 4 tons DM per haa. The major production is sheep, with approximately 22.000 winter sheep and a production of 28.000 lambs per year. In Greenland there are 6-7 farms growing vegetables and potatoes on a commercial scale. This is mainly potato production, but vegetable production is being developed based on pre-cultivated plants.

Goals for the Greenland agriculture until 2015 are:

- to increase the self-supply of meat and other agricultural products
- to increase the amount of lambs slaughtered
- to develop alternative agricultural productions , including horticulture, and have less dependency on lamb production

Commercial and home production

There is neither commercial production nor home production of berries in Greenland today.

Wild berries

The most common wild berry in Greenland is the crowberry (*Empetrum nigrum* ssp. *hermaphroditum*) that previously was used as an important vitamin supplement and today is eaten fresh or as jam. Alpine bilberry (*Vaccinium uliginosum*) and lingonberry (*Vaccinium vitis-idaea*) are also growing wild on some locations in Greenland.

Norway

Agriculture and horticulture in short

In 2007 the cultivated area in use in Norway was 1,03 mill haa, 64 % of this acreage was forage crops and pasture, 31 % cereal and oil seed crops. Acreage of edible horticultural crops was 14.500 haa, consisting of 2.440 haa top fruits, 2.410 haa small fruits and 9.660 haa vegetables.

Commercial production of berries

Table 2. Commercial acreage of small fruit crops in Norway in 2007.

Crop	Acreage in haa (2007)	% of total small fruit acreage
Strawberry	1.575	65,4
Red raspberry	395	16,4
Black currant	323	13,4
Highbush blueberry	24	1,0
Other berries	94	3,9
SUM	2.410	100,0

Source: http://www.ssb.no/jordbruk/

In Norway there is a berry production both for fresh consumption and for industrial purposes (jam/ juice/lemonade). The strawberry production is the largest, and the production was about 4000 tons for fresh consumption and 1100 tons for industry in 2008. The consumers in Norway have had a clear preference for Norwegian strawberries, however, the amount of imported berries (mainly from Holland, Belgium and Spain) has increased rapidly over the last 10 years and in 2005 the amount of imported berries for fresh consumption passed the amount of berries from Norway. Most of the Norwegian berries are sold in June, July and August, while imported berries are sold the whole year. The main variety for fresh consumption is 'Korona' (Dutch variety). Other varieties in production are 'Polka' (Dutch), 'Honeoye' (from USA), 'Florence' (from UK) and 'Frida' (Norwegian). For the industrial market, 'Senga Sengana' is still an important variety. The size of the production area on each farm is varying, from 0,5 haa to 30 haa. Most of the strawberries are grown in open fields, only a small amount is grown in plastic tunnels, and an even smaller amount in greenhouses.

The raspberry production has traditionally been for industrial purposes, and the main production area has been in the western part of Norway. 'Veten' (from Njøs, Norway) has been the main variety for more than 30 years. However in the 1990's, a production of berries for fresh consumption was developed, based on new varieties with big, firm and tasty fruits. The development of the production was done in cooperation with research, wholesalers and growers. Today 'Glen Ample' (from Scotland) is the main variety, both for fresh consumption and industry. A large part of the production for fresh consumption is in plastic tunnels, and the production is about 1000 tons today. The biggest wholesaler, Bama, sold 700 tons in 2009. The industry production that year was about 900 tons. Still the main production area is in the western part of Norway, in Sogn og Fjordane county, but the production is also increasing rapidly in other parts of Norway. It is also some production (in plastic tunnels) in the North of Norway.

All the black currant production has been for industrial purposes, but research Institutes (Bioforsk and Njøs Næringsutvikling AS) and advicer units (Norsk landbruksrådgiving), together with a few growers, has started to develop a production for fresh consumption. The main goal is to find suitable varieties, with big, sweet and tasty fruits. The Scottish Crop Research Institute has developed some very promising varieties.

In the early 1990's it was a great interest for highbush blueberries in Norway, and quite a few growers started with a production. But there are only a few of them left today. One main problem is low yield, because of frost damage and slow growth of the plants the first 3-5 years after planting. Another problem is that the hand picking is very time consuming and expensive, as a picker is only able to pick 4-6 kg per hour. It is a pity because the blueberries are very popular among the consumers. But labour is very expensive in Norway, and therefore it is very difficult to compete with berries from countries with cheaper labour, as for example Holland and Poland.

Home production of berries

It is very common with berry plants in home gardens all over Norway. The most planted crops are strawberries, raspberries, black currants, red currants and gooseberries, but also highbush blueberries and blackberries are found to some extent in home gardens. Which cultivars that are used in home gardens are mainly determined by what is available from nurseries and garden shops. Some of these cultivars are not fully adapted for outdoor production in the Norwegian climate.

Table 3. Some berry cultivars available from nurseries and garden centers in Norway.

Crop	**Cultivars**
Strawberry	'Korona', 'Florence', 'Polka', 'Senga Sengana', 'Frida', 'Bounty', 'Honeoye', 'Glima', 'Zefyr'
Red raspberry	'Glen Ample', 'Admiral', 'Asker', 'Borgund', 'Preussen', 'Stiora', 'Varnes', 'Vene', 'Veten', 'Autumn Bliss'
Blackberry and hybrid berry	'Kotata', 'Bedford Giant', 'Loch Ness', 'Black Satin', ''Silvan', Thornless Evergreen', 'Tayberry', 'Thornless Loganberry'
Black currant	'Ben Tron', 'Hedda', 'Imandra', 'Kristin', 'Melalahti', 'Narve Viking', 'Sunderbyn', 'Titania', 'Øjebyn'
Red currant	'Rød Hollandsk', 'Jonkheer van Tets', 'Hvit Hollandsk', 'Rosetta', 'Losvar'
Gooseberry	'Hinnonmäki Gul', 'Hinnonmäki Rød', 'Invicta'
Highbush blueberry	'Bluecrop', 'Blueray', 'Bluetta', 'Chippewa', 'Duke', 'Earlinblue', 'Hardy Blue', 'Nelson', 'Northland', 'Patriot', 'Saint Cloud', 'Sierra', 'Spartan', 'Toro'

Sources: Catalogue Grimstad planteskole, http://www.aabergeplanteskule.no/, http://www.horpestad-plantesalg.no, http://www.eggegaard.no/

Wild berries

Wild growing berries that are commonly picked in Norway for home use are cloudberry (*Rubus chamaemorus*), red raspberry (*Rubus idaeus*), bilberry (*Vaccinium myrtillus*) and lingonberry (*Vaccinium vitis-idaea*). Blackberries (*Rubus* spp.) are also growing wild and picked to some extent for home use in coast and fjord areas in south and southwest. Crowberries (*Empetrum* nigrum) is common in the mountains, but are rarely picked. Cranberries are also quite common, but rarely picked as it is difficult to find large quantities. A species of diploid strawberry (*Fragaria vesca*) grows all over the country, but is seldom found in larger quantities and are mainly picked by children.

Cloudberries and crowberries are picked in wild populations for commercial use in Northern Norway.

Climate

Chosen locations

Climate data for this report has been delivered from The Icelandic Met Office (Iceland), The Danish Meteorological Institute (Faroe Islands and Greenland) and The Norwegian Meteorological Institute (Norway). In addition we got some climate data from observations at Bunaðarstovan at Kollfjørður in Faroe Islands and at Upernaviarsuk Agricultural Station in Greenland. In Iceland the stations Hæll, Hella, Samstaðir, Eyrarbakki, Hjarðarland and Kálfhóll were chosen to represent the climate in the potential production area in southwest. At Faroe Islands the stations at Tórshavn and Vagar Floghavn is used, and at Greenland the station at Qaqortoq. Meteorological observations from Bunaðarstovan at Kollfjørður in Faroe Islands and from Upernaviarsuk Agricultural Station in Greenland will be compared to the Tórshavn and Qaqortoq data. In Norway we use climate data from the stations Vangsnes, Værnes, Brønnøysund lufthavn, Andøya and Alta lufthavn to cover the range of climates from the main production area of raspberries today (Vangsnes) until the Finnmark climate (Alta lufthavn). Unfortunately, we did not get all the data we asked for from The Norwegian Metorological Institute and the wind data we got from The Icelandic Met Office was in another form than requested, thus making comparison of wind between locations in different countries difficult.

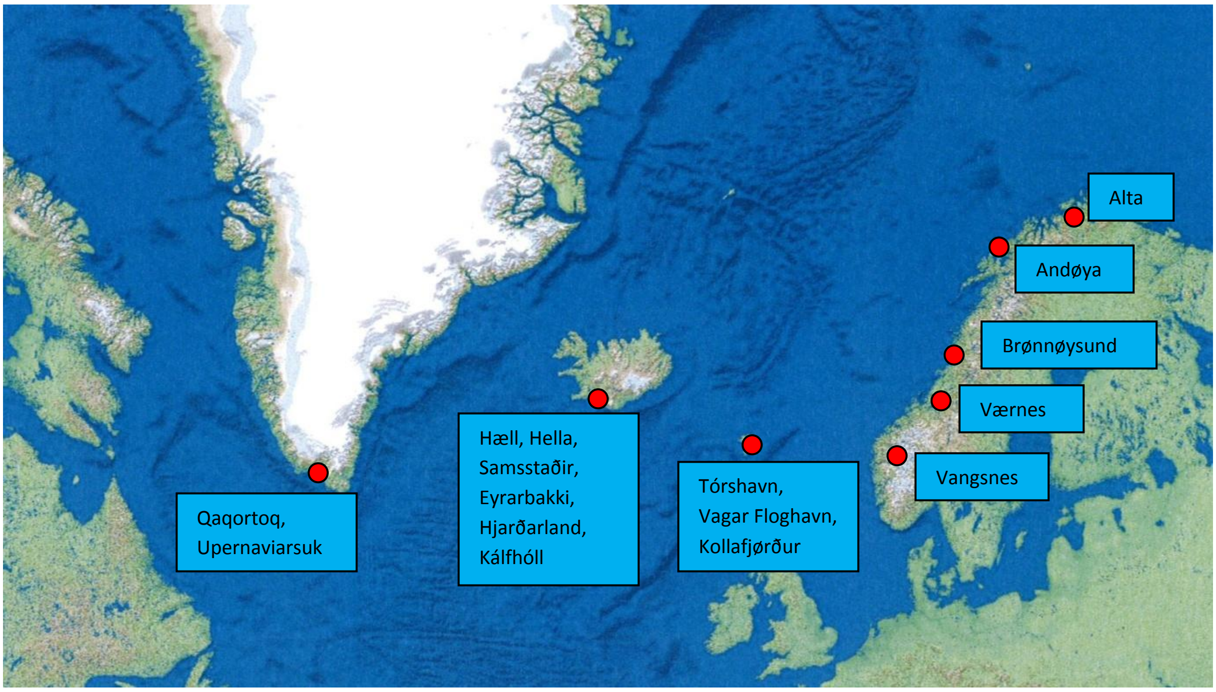


Figure 4. Location of stations for climate data collection.

Climate in short

Climate in Iceland

The climate in Iceland can be classified as cool temperate maritime. A branch of the Gulf Stream flows along the southern and the western coast greatly moderating the climate. However, this brings mild Atlantic air in contact with colder Arctic air resulting in a climate that is marked by frequent changes in weather and storminess. Furthermore this leads to more rainfall in the southern and western part than in the northern part of the island.

The annual mean temperature along the coasts of southern and southwestern Iceland reach 4-6°C, but are lower in other parts of the island. The average July temperature exceeds 10°C in the lowlands of southern and western Iceland, but is usually below that in other parts of the country. This makes the larger part of Iceland belonging to the arctic climate zone. The warmest summer days around Iceland can reach 20-25°C.

Winters in Iceland, on the other hand, are generally mild for this northerly latitude. The coastal lowlands have mean January temperatures close to 0°C. The lowest winter temperatures in northern Iceland and the highlands are generally in the range -25 to -30°C.

Climate in Faroe Islands

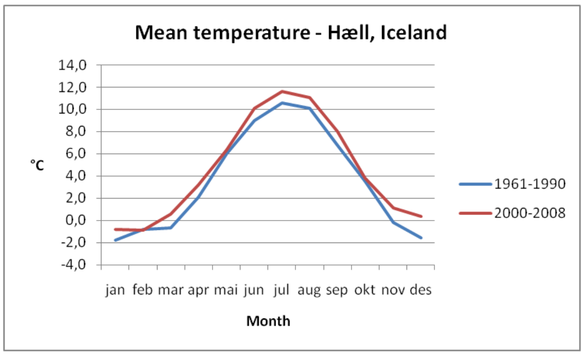
The climate in Faroe Islands is typical oceanic, with warm winters and cool summers. The northeast bound heading gulfstream passing the islands is keeping the air temperature close to the sea temperature, and there is a close correlation between sea and air temperature. In summer the air is slightly warmer and in winter slightly colder than the sea. During the last ten years measurements indicate an increase in air temperature at the Faroe Islands, especially in the summer season. This correlates with an increase in sea temperature recorded by Faroe Marine Research Institute. On the other hand it tends to be windier. Heavy storms and hurricanes seem to be more frequent than before.

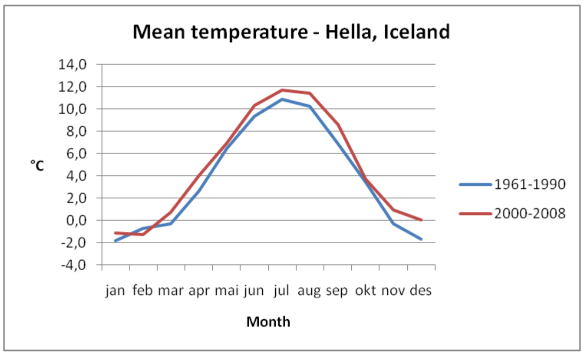
Climate in southernmost Greenland

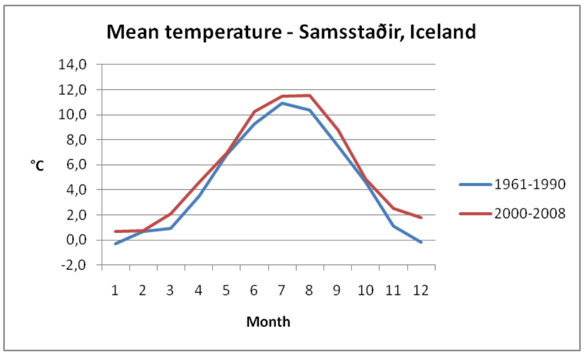
In Greenland it is obvious that plant production in sub-arctic areas is challenging. Upernaviarsuk is situated at 60 ° N, with a similar light regime to Bergen and Oslo in Norway. The winters in South Greenland are relatively mild, and there is no drifting ice during the winter. Drifting ice occurs in the spring and is found to a smaller or larger extent during the summer. One major challenge is strong fall winds from the ice cap (piteraq situations) which can have extremely strong wind gusts. They occur all year, but when plant production is concerned, it is the foehn winds during summer that gives the largest problems. The phenomena arise when the air over the inland ice is heated up and is being pressed down into the fjords. The wind gusts can have a speed of above 40 m per second. It is like standing in a large hair dryer. Usually the wind will blow for 2-3 days, and drought damage to plants can be seen on exposed locations and where irrigation is not available. Due to this wind, special solutions must also be made in building construction.

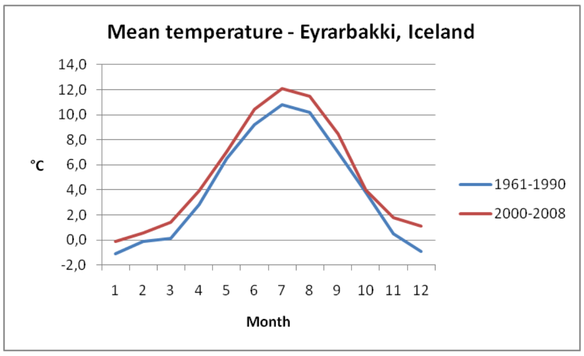
Climate data

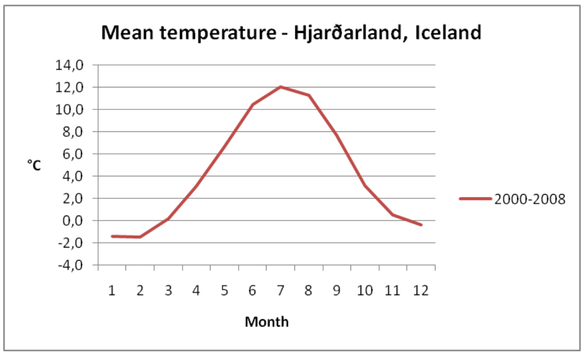
Temperature and precipitation

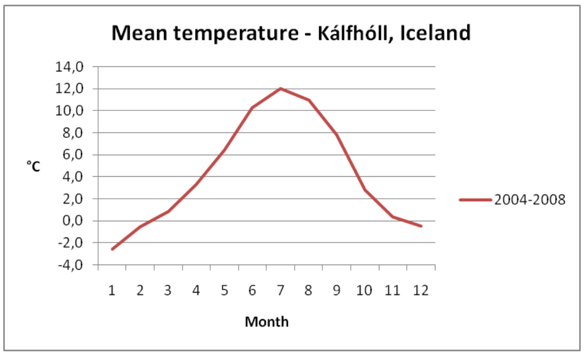


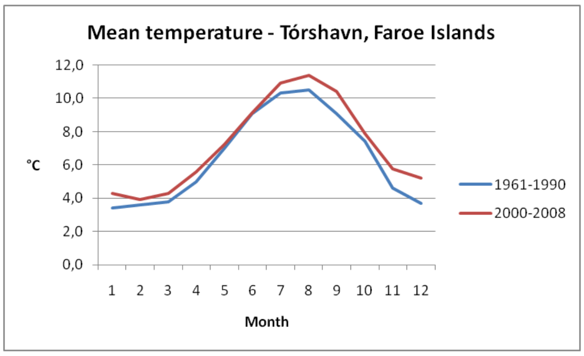


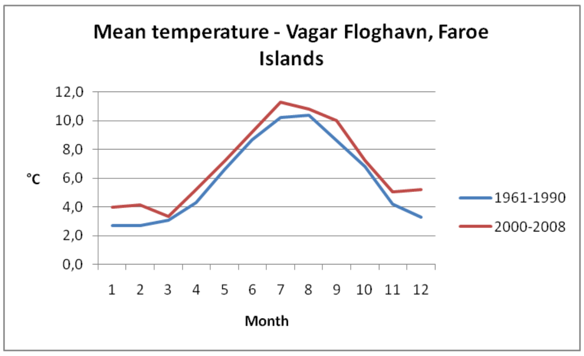


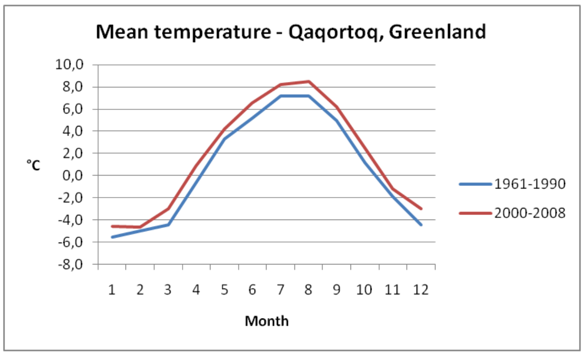


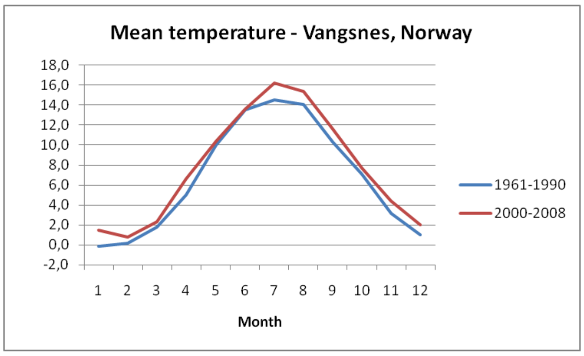

Mean temperature - Hjarðarland, Iceland
°C
Month
2000-2008

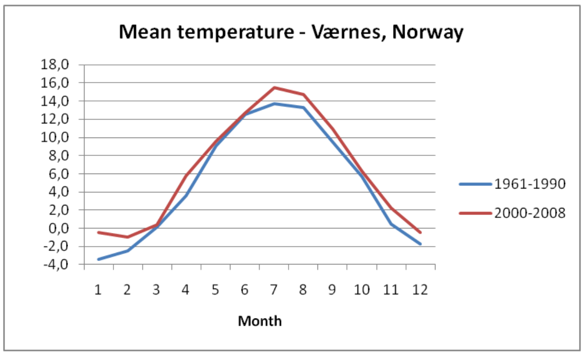

Mean temperature - Kálfhóll, Iceland
°C
Month
2004-2008

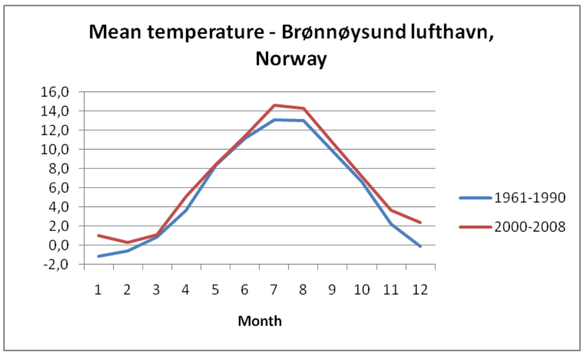

Mean temperature - Tórshavn, Faroe Islands
°C
Month
1961-1990
2000-2008


Mean temperature - Vagar Floghavn, Faroe Islands
°C
Month
1961-1990
2000-2008


Mean temperature - Qaqortoq, Greenland
°C
Month
1961-1990
2000-2008


Mean temperature - Vangsnes, Norway
Month
1961-1990
2000-2008


Mean temperature - Værnes, Norway
Month
1961-1990
2000-2008


Mean temperature - Brønnøysund lufthavn, Norway
Month
1961-1990
2000-2008

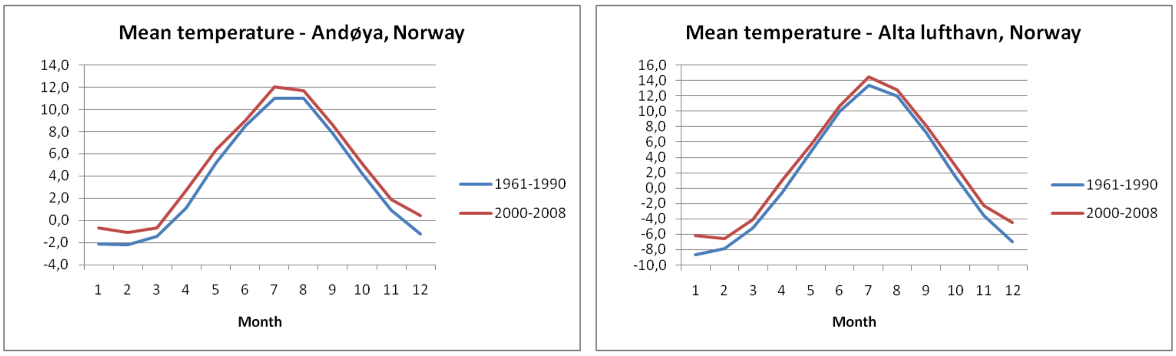


Figure 5. Mean temperature 1961-1990 and 2000-2008 at selected locations in Iceland, Faroe Islands, Greenland and Norway. The figures are based on data from The Icelandic Met Office (Iceland), The Danish Meteorological Institute (Faroe Islands and Greenland) and The Norwegian Meteorological Institute (Norway).

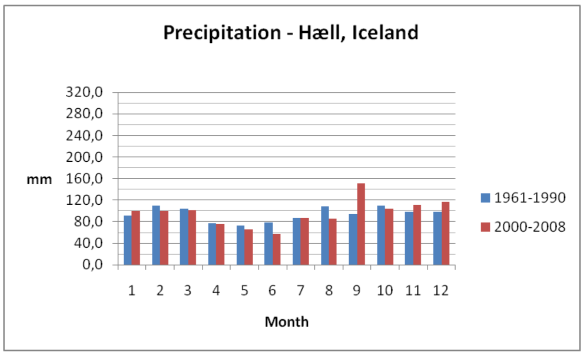
Table 4. Lowest measured temperature per month 1961-1990 at selected locations in Iceland, Faroe Islands, Greenland and Norway. Based on data from The Icelandic Met Office (Iceland), The Danish Meteorological Institute (Faroe Islands and Greenland) and The Norwegian Meteorological Institute (Norway).

	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Des	Year
Hæll	-18,5	-20,6	-19,9	-15	-8,6	-2,2	1,1	-1,3	-5	-14,6	-15	-19	-20,6
Hella	-21,8	-22,3	-20,1	-17,8	-8,2	-2,4	0	-3,1	-8,2	-17,8	-16,3	-20,2	-22,3
Samstaðir	-17,9	-19,1	-17,0	-19,2	-8,0	-2,4	1,0	0,0	-4,1	-12,5	-17,9	-18,2	0,0
Eyrarbakki	-19,7	-19,3	-18,9	-18,8	-8,1	-3,0	1,4	-1,1	-5,8	-14,9	-17,9	-19,8	-19,8
Qaqortoq	-30,0	-25,2	-26,0	-16,4	-12,8	-6,0	-2,4	-3,4	-8,5	-11,0	-18,0	-21,6	-30,0
Tórshavn	-8,0	-11,0	-8,4	-9,9	-3,0	0,0	1,5	1,5	-0,6	-4,5	-7,2	-10,5	-11,0
Vagar Floghavn	-10,0	-11,7	-10,6	-9,9	-5,0	-0,3	1,4	1,0	-2,5	-6,4	-10,0	-10,9	-11,7
Vangsnes	-14,4	-11,2	-10,0	-4,4	-0,5	1,4	6,5	6,0	1,0	-3,4	-8,4	-14,8	-14,8
Værnes	-25,0	-25,5	-20,4	-13,9	-4,7	-0,2	2,3	1,3	-4,9	-9,8	-19,0	-21,9	-25,5
Brønnøysund lufthavn*	-12,2	-18,6	-13,4	-6,6	-2,0	0,0	2,6	2,4	-4,4	-4,6	-8,9	-11,5	-18,6
Andøya	-19,9	-18,4	-19,8	-13,6	-10,5	-1,1	0,6	0,5	-4,2	-11,0	-14,1	-17,4	-19,9
Alta lufthavn	-30,3	-30,3	-26,5	-21,5	-11,4	-3,8	0,3	-1,2	-7,4	-19,4	-25,8	-27,7	-30,3

* Data for Brønnøysund lufthavn for 1961-1990 was not provided from The Norwegian Meteorological Institute, and the figures in the table are from the period 2000-2008.

Table 5. Location, mean temperature, precipitation, number of growing days and degree days in growth period of selected locations in Iceland, Faroe Islands, Greenland and Norway. Based on data from The Icelandic Met Office (Iceland), The Danish Meteorological Institute (Faroe Islands and Greenland) and The Norwegian Meteorological Institute (Norway).

See table in separate Word document		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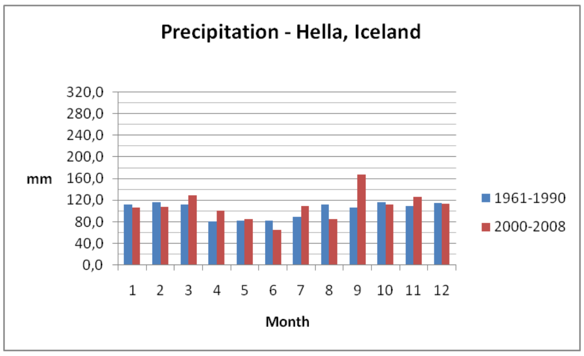
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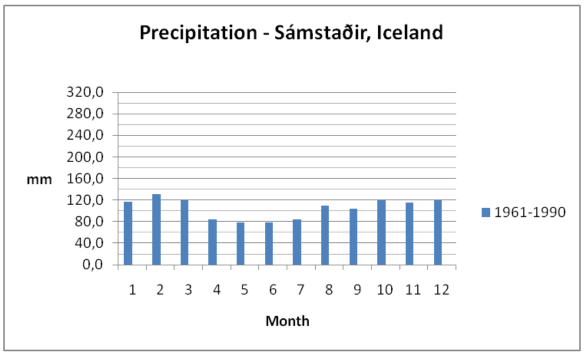
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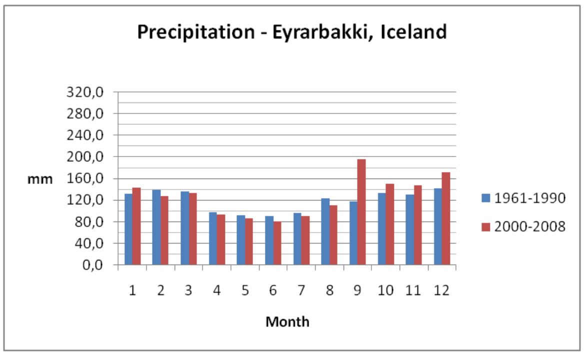
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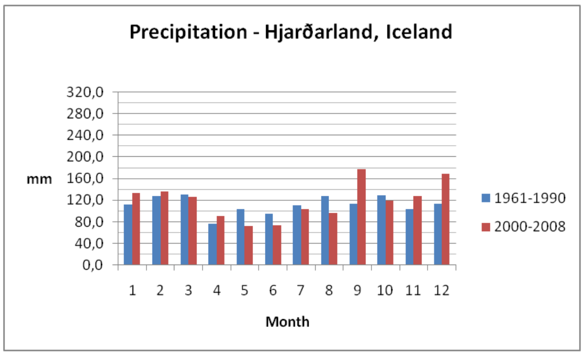
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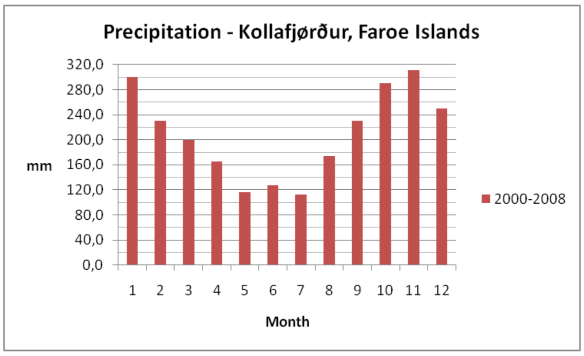
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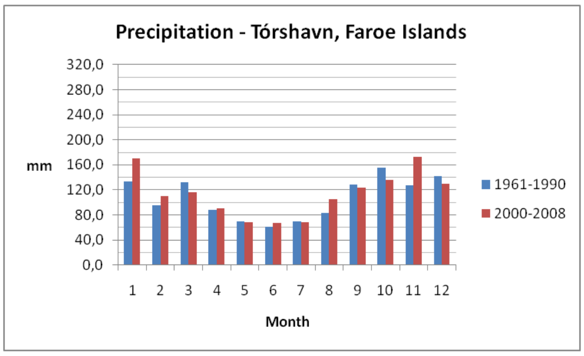
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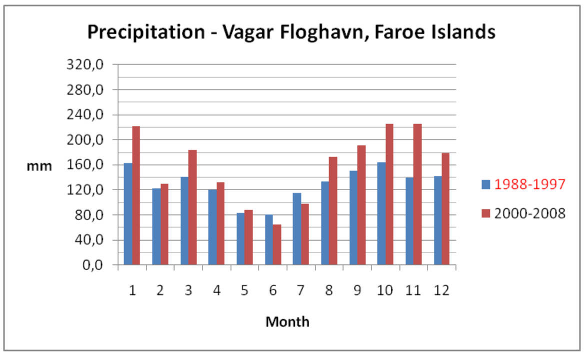
2000-2008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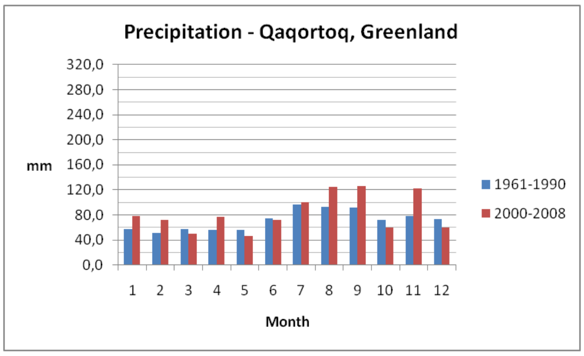
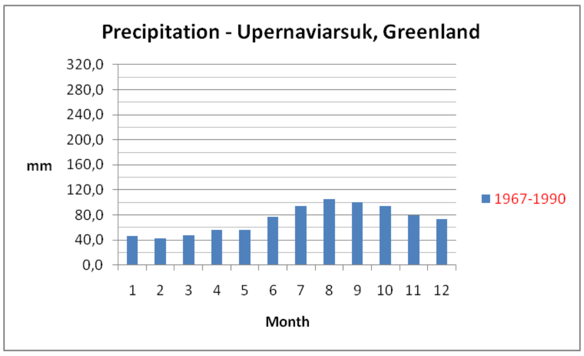
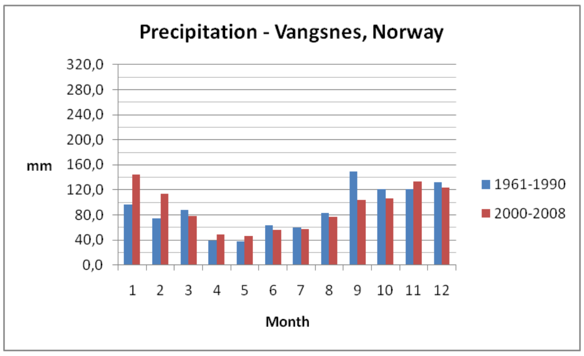
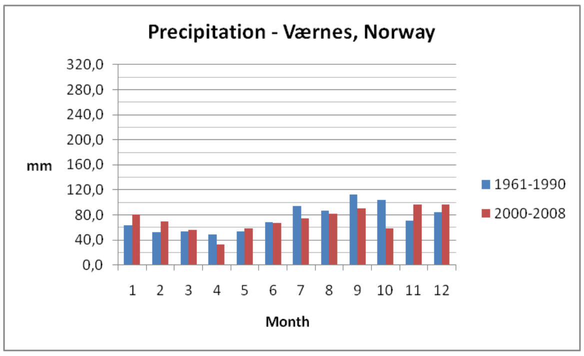
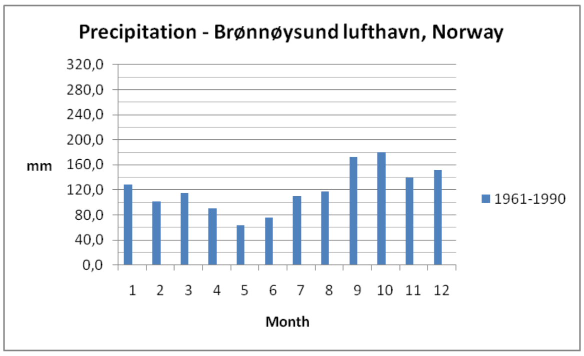
2000-2008

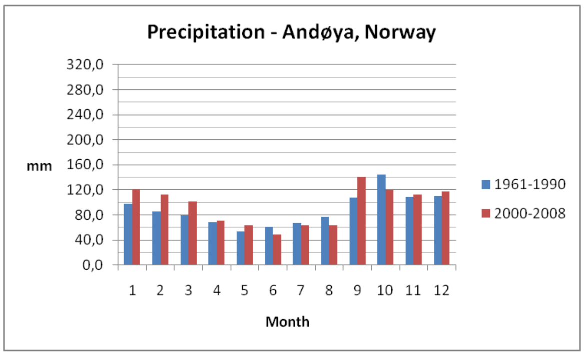












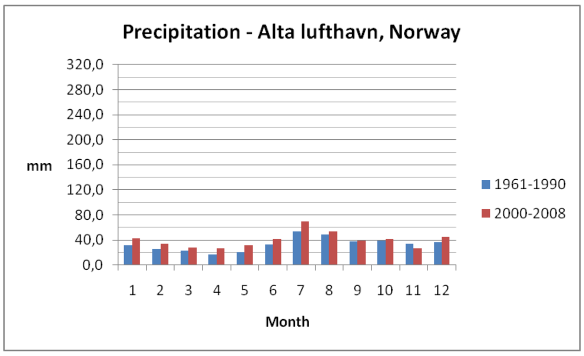


Figure 6. Annual precipitation 1961-1990 and 2000-2008 at selected locations in Iceland, Faroe Islands, Greenland and Norway. The figures are based on data from The Icelandic Met Office (Iceland), Bunaðarstovan (Kollafjørður), The Danish Meteorological Institute (other Faroe Islands stations and Greenland) and The Norwegian Meteorological Institute (Norway). Precipitation data were not available for Kálfhóll, Iceland.

Wind

Strong wind is expected to be an important restriction to the use of plastic tunnels especially at Greenland and Faroe Islands. When writing this report, it was planned to compare frequency of strong winds on potential production sites at Greenland, Faroe Islands and Iceland to locations where we have experience with plastic tunnels in Norway. Unfortunately, only the Danish Meteorological Institute delivered wind data in the requested form for this report. Wind data from The Icelandic Met Office was delivered in a somewhat different manner, and The Norwegian Meteorological Institute did not deliver any wind data at all in spite of repeated requests.

Table 6. Maximum wind gusts in m/s (10 min average) per month in the period 2000-2008.

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Qaqortoq	36,0	43,8	28,3	28,3	28,3	19,8	25,7	24,9	36,0	29,3	29,3	25,7	43,8
Tórshavn	29,5	26,6	25,3	22,7	21,6	20,6	23,7	20,1	26,3	28,3	25,2	27,8	29,5
Vagar Floghavn	28,3	21,1	22,7	19,6	20,8	15,4	14,5	21,6	22,1	25,2	22,7	20,6	28,3

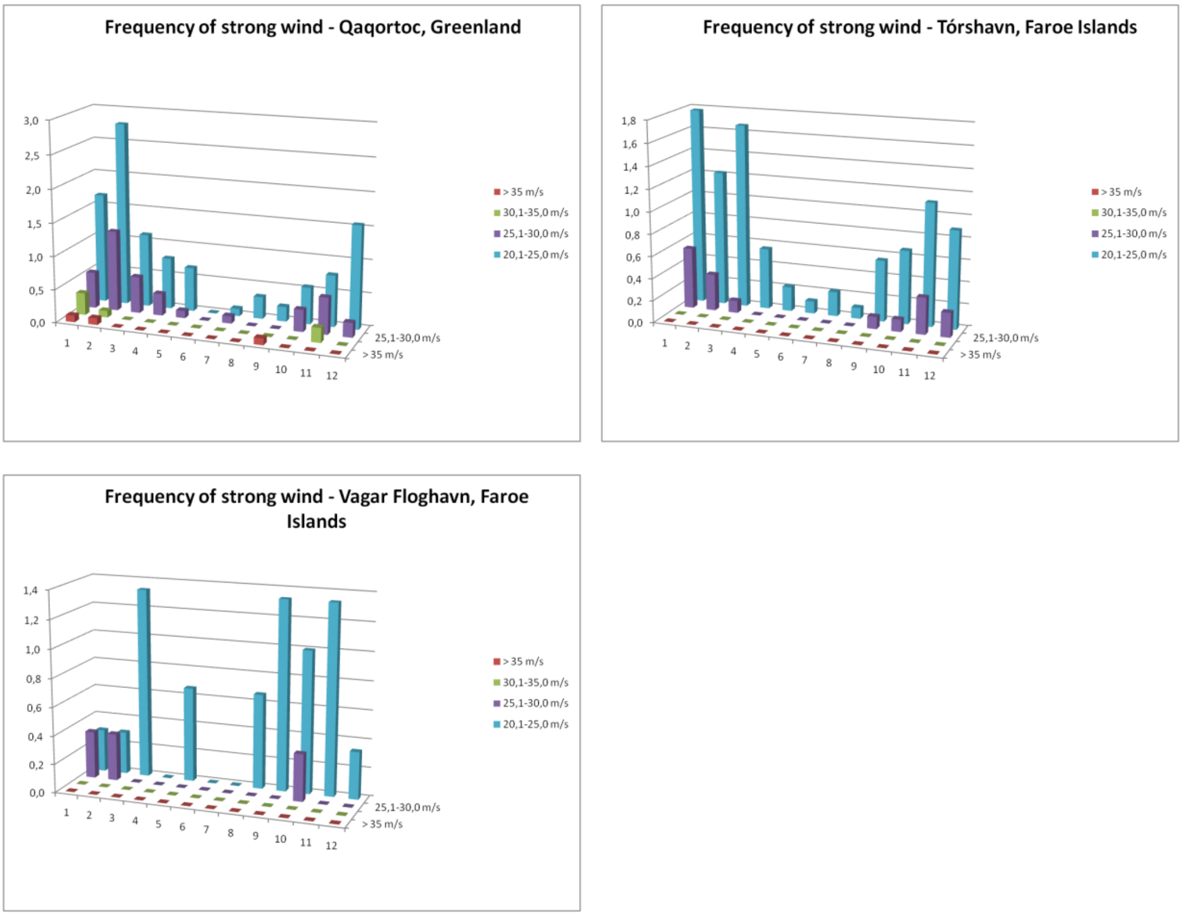


Figure 7. Average number of days per month with wind in the intervals 20,1-25.0 m/s, 25,1-30,0 m/s, 20,1-35,0 m/s and > 35 m/s for the period 2000-2008 for one station at Greenland and two stations at Faroe Islands.

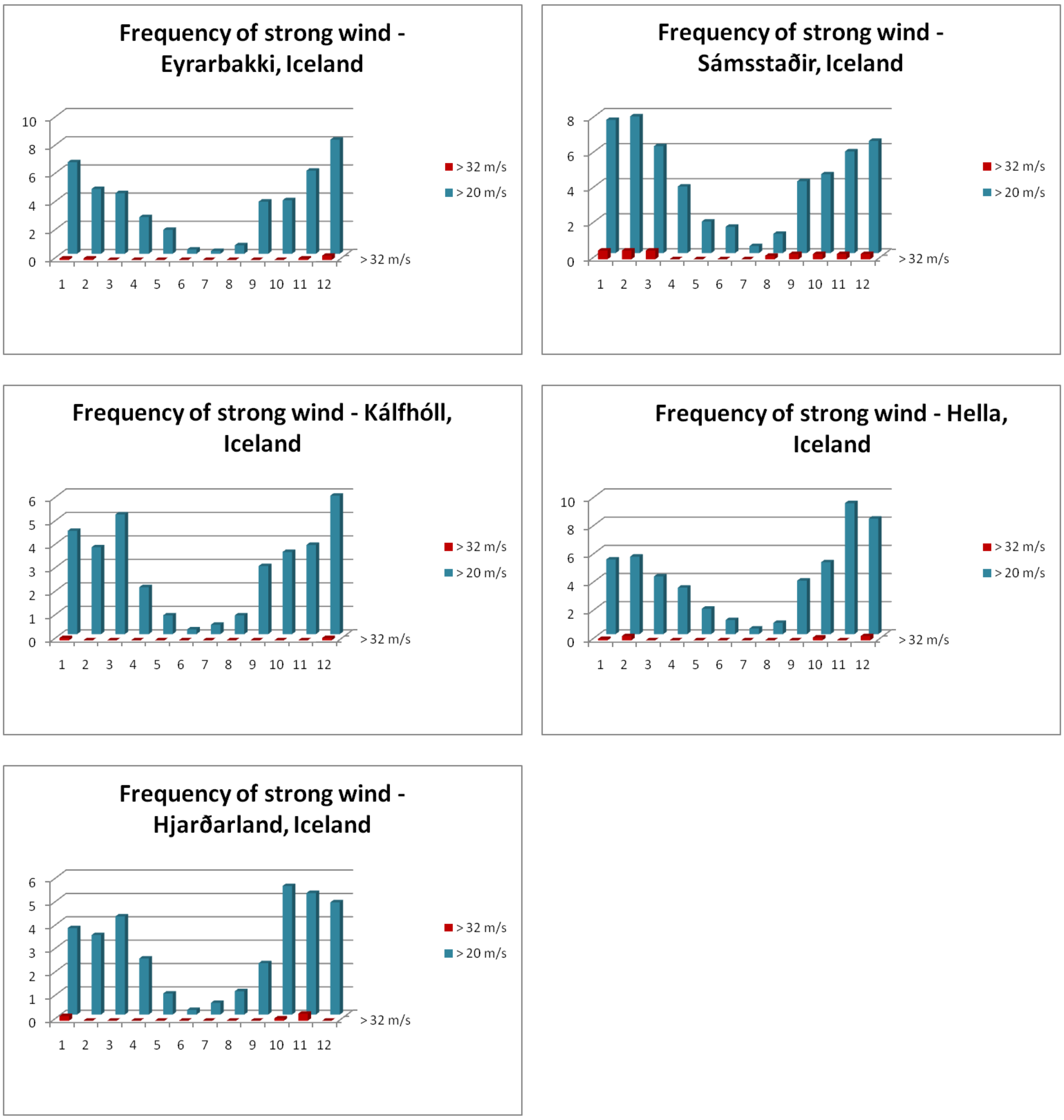


Figure 8. Percentage of hours with wind gusts above 20 m/s and above 32 m/s for the period 2000-2008 for some stations at Iceland.

Figure 9. Wind damage to plastic tunnels with raspberry production at Leikanger, Norway. Photo: Stein Harald Hjeltnes.

Figure 10. Wind damage to plastic tunnels by a storm 28 May 2009 at Grytøya, Norway. The tunnels are now replaced by a reinforced version of the Arctic tunnel. Photo: Pål Alvereng

Day length

The potential production area around Qaqortoq in southern Greenland is on about the same latitude as Flåm and Hamar in Norway. The potential production area in southwestern Iceland is on about the same latitude as the city Steinkjer in Norway. The central part of Faroe Islands is on about the same latitude as Måløy and Dombås in Norway. The potential production area at Iceland has a similar temperature regime to Grytøya in Northern Norway, where there is commercial production of raspberries in tunnel. The day length at Grytøya is however quite different, as it is situated at 68°55 N, which is well north of the polar circle (66°34 N).

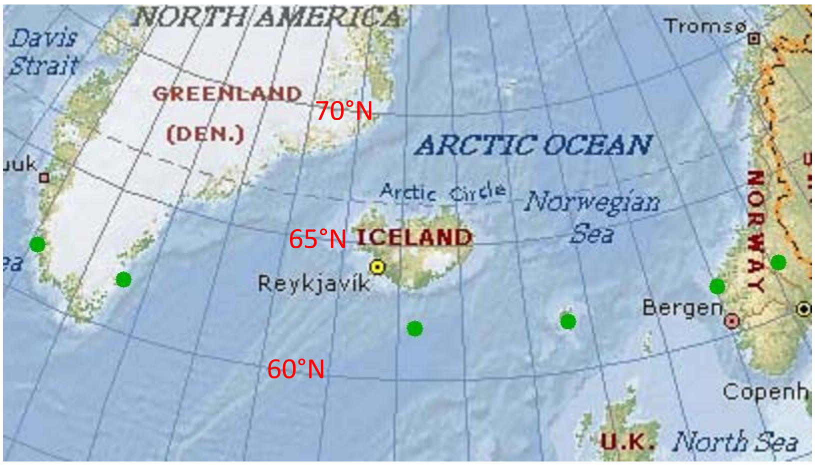
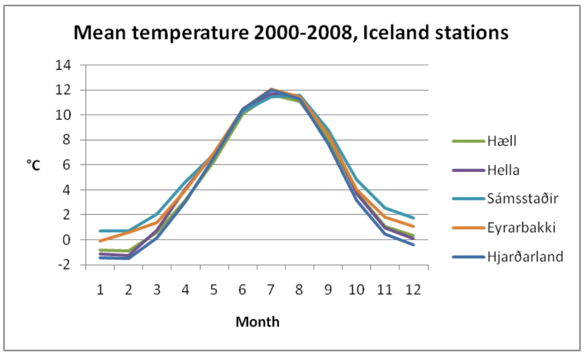
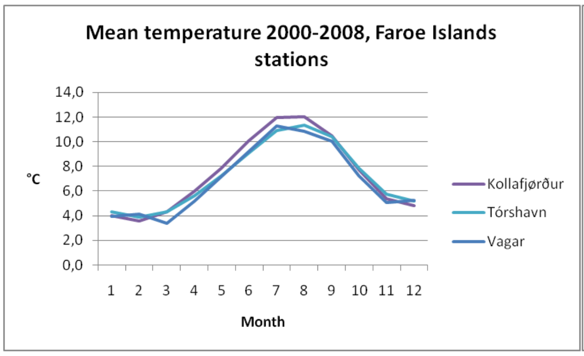


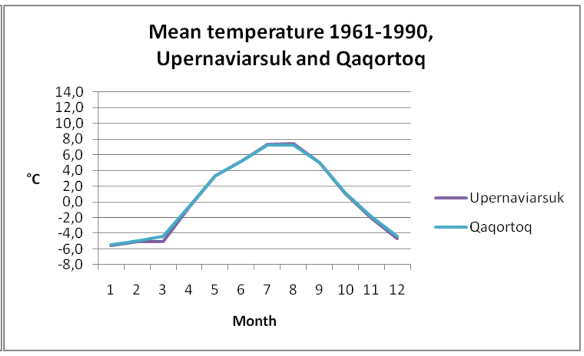
Figure 11. Comparison of latitude of Faroe Islands with Greenland, Iceland and Norway.

Comparison of climate between locations

Comparisons are here made on mean temperature per month between different stations within countries and between locations across countries. Further comparisons can be made using the figures presented in Table 5. The comparisons are made in order to extrapolate use of species and cultivars from experience with those at locations in Norway.







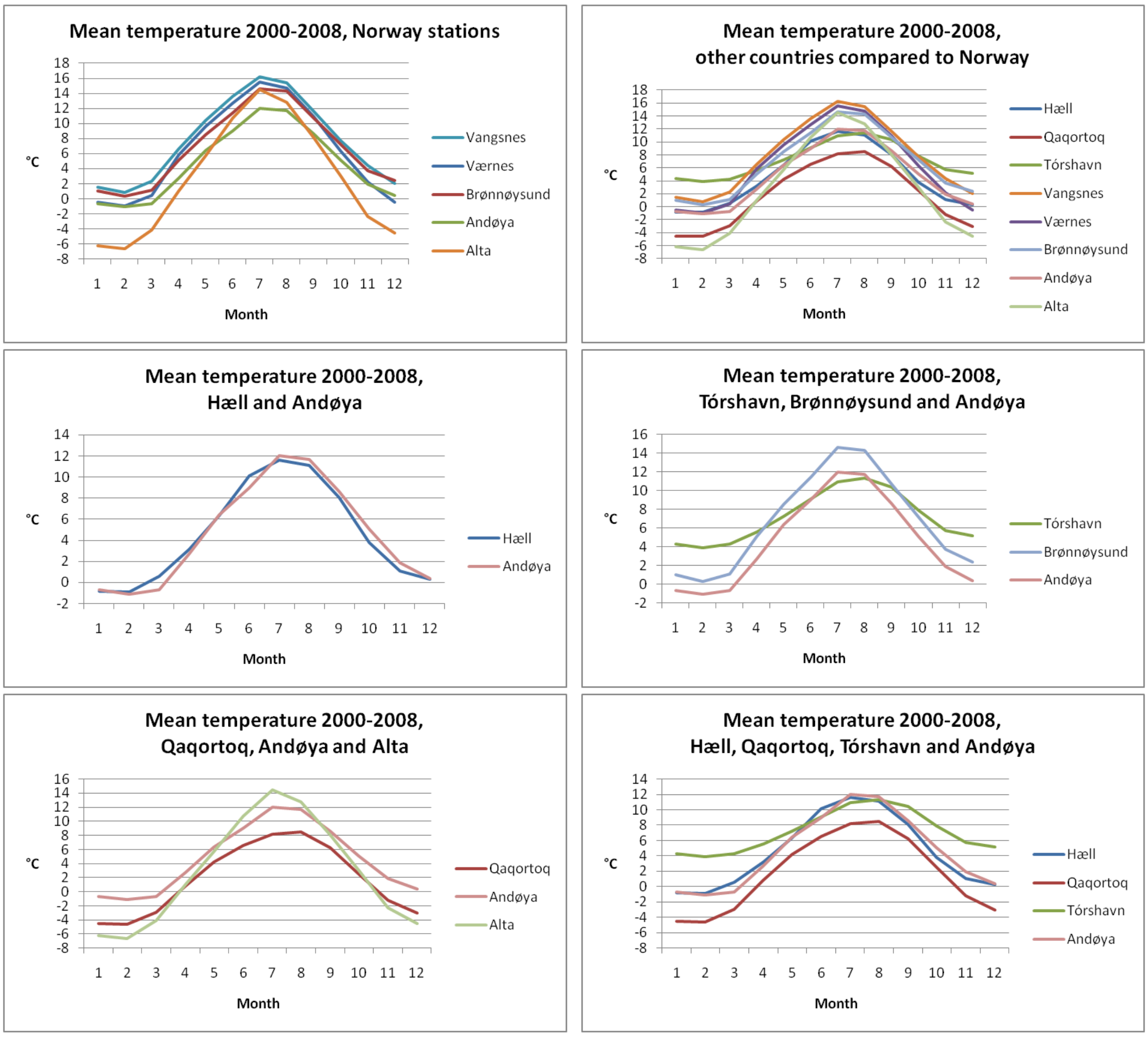


Figure 12. Comparisons made between mean temperature per month at selected locations in Iceland, Faroe Islands, Greenland and Norway. The figures are based on data from The Icelandic Met Office (Iceland), Bunaðarstovan (Kollafjørður), The Danish Meteorological Institute (other Faroe Islands stations and Qaqortoq), observations by Paul Bjerge (Upernaviarsuk) and The Norwegian Meteorological Institute (Norway).

Figure 13. Raspberry production in plastic tunnels on 68 °N at Grytøya, Norway. Photo: Pål Alvereng

Potential for expansion of berry production

Market potential

The market potential is only briefly judged in this report.

Table 7. Population per country.

Country	Population	Population figures from
Iceland	317 000	Dec 2009
Faroe Islands	48 000	Dec 2007
Greenland	58 000	July 2009
Norway	4 843 000	Oct 2009

Sources: Iceland - http://www.statice.is/Statistics/Population
Faroe Islands - http://no.wikipedia.org/wiki/Færøyene (estimated population)
Greenland - http://en.wikipedia.org/wiki/Greenland (estimated population)
Norway - http://www.ssb.no/befolkning/

Table 8. Import of fresh berries to Iceland in mean of 2007 and 2008.

Berry group	Tons per year	Kg per capita
Strawberries	385	1,2
Rubus and mulberries	17	0,06
Vaccinium berries	117	0,4
Others (including *Ribes*)	35	0,1
SUM	554	1,8

Table 9. Import of fresh berries to Faroe Islands 2000-2008.

Berry group	Tons per year	Kg per capita
Strawberries	20,5	0,43
Rubus and mulberries	1,85	0,04
Vaccinium berries	0,55	0,01
Others (including *Ribes*)	0,07	0,001
SUM	23	0,5

A population of 48.000 persons is used as an average for the period 2000-2008 when calculating import per capita.

Table 10. Consumption of fresh berries (domestically produced and import) in Norway 2006-2009.

Berry group	Tons per year	Kg per capita
Strawberries	8243	1,73
Raspberries	687	0,14
SUM	8930	1,87

Source: OFG

The figures for Norway are on berries sold through wholesalers, and 46 % of the tonnage was from domestic production. There is a large direct market in Norway, in particular on strawberries, and berries are commonly grown in home gardens. The total consumption of fresh berries is thus higher than these figures indicate, and the domestically produced part larger. The tonnage of raspberries for fresh consumption has increased rapidly during the last few years, and the consumption per capita was twice as high in 2009 as in 2006.

Consumption per capita of berries sold through wholesalers in Norway has increased from 1,51 kg per year in 2002-2005 to 1,87 kg per year in 2006-2009. It is expected that this will further increase.

The berry consumption per capita on Iceland is already comparable to the situation in Norway, but is to a much larger extent based on import. The market potential for domestically produced berries is expected to be good. In the Faroe Islands berry consumption seem to be relatively low at the moment, and the potential for an increased consumption here should be good.

In Greenland prices of berries in supermarkets are very high. Import of berries to Greenland is mainly by plane from Europe, with freight costs + 40 DKK per kg. Expected retail price for strawberries / raspberries is approximately 120 DKK per kg.

In Greenland it is an aim for the government to make the country less dependent on import. The people at Greenland are loyal towards products from Greenland, and buy these whenever available. This makes the retailers very positive to vegetables from Greenland, and they wish to participate to a expansion of the production. Even if the transport costs by import is very high, it is however impossible to avoid that transport costs will be high also on domestic products. Although the majority of the population lives on the west coast, there are still quite a few people living in smaller communities that are not always as easy accessible. The potatoes and vegetables produced in Greenland today are transported by boat to the largest cities. During transport there are good opportunities for cooling, so the transport does not reduce product quality much.

Grower situation

Iceland

In Iceland several growers are interested in starting berry production in plastic tunnels or plastic houses. One grower east of Hvolsvollur and three growers northeast of Selfoss has already signed up for participation in a applied main project, aiming at building of plastic tunnels and planting plants in 2011. One of these growers will plant raspberries in an existing plastic house in 2010.

Faroe Islands

Since there is no commercial berry production in Faroe Islands and due to the risk of wind damages, a testing tunnel should be set up at the Research Station at the Agricultural Centre in Kollafjørður. Meetings and demonstrations for potential growers and other interested persons can easily be arranged in Kollafjørður as it is situated in the middle of The Faroe Islands.

Greenland

Due to the high risk and lack of experience with tunnel production of berries in Greenland, a first testing should take place at Upernaviarsuk Agricultural Station. Only if these tests show potential for an economically viable commercial berry production in Greenland, commercial plantings by farmers should be established.

Plant material

Cultivars

Strawberry

'Gudleif' is a cultivar from Graminor Breeding Ltd., Norway, and is a cross between 'Cavendish' and 'Marmolada'. It is a competitor to 'Polka' and 'Korona'. 'Gudleif' is a medium-late cultivar, with relatively high yield and attractive conical berries. ‘Gudleif’ has attractive blood-red berries, larger in size, with great taste and firm. It is relatively resistant to powdery mildew’.

‘Blink’ is a cultivar from Graminor Breeding Ltd., Norway, and is a cross between ‘Honeoye’ and ‘Senga Sengana’. It has higher yield than check cultivars (‘Korona’ and ‘Polka’), smaller berries than ‘Senga Sengana’ and good quality. It is an interesting alternative to ‘Senga Sengana’ in jam production.

‘Sonata’ is a cultivar from Fresh Forward, Netherland, and a crossing between ‘Elsanta’ and ‘Polka’. This cultivar has well-formed, tapered and large berries with moderate to good taste. Berries are bright pink with pink colour. Berries ripen 1-2 days after ‘Elsanta’ (between ‘Korona’ and ‘Polka’) and has a longer harvest period without marked fall peaks. It is tolerant to powdery mildew.

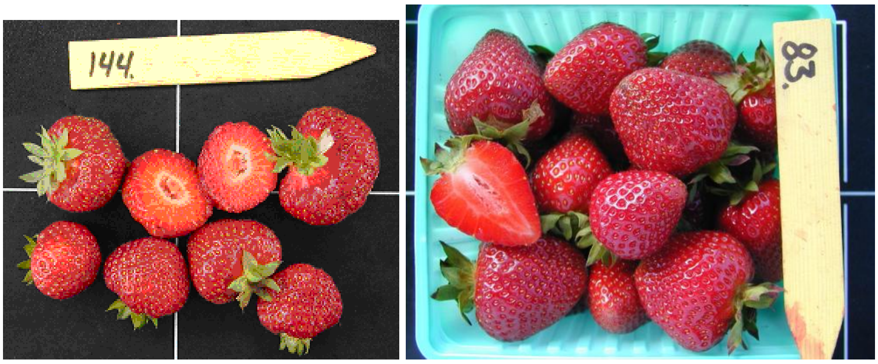


Figure 14. ‘Blink’ and ‘Gudleif. ’ Photo: Muath Alsheikh.

Figure 15. ‘Sonata’ strawberries grown in greenhouse by Eirikur Ágústsson at Fluðir, Iceland. Photo: Nina Heiberg

GNKi2484 is a selection from Graminor Breeding Ltd., Norway. The selection is a cross between ‘PV98.200’ and ‘PL98.353’. This line has great taste and better storage qualities than ‘Korona’. This line is an early cultivar (2-3 days earlier than ‘Korona’). The line has longer harvest than ‘Korona’. Yield is similar to ‘Korona’. This line seems to be relatively resistant to powdery mildew.

GNKi2634 is a selection from Graminor Breeding Ltd., Norway. The selection is a cross between ‘PK98.370’ x ‘PL98.270’. The line has great taste and better storage qualities than ‘Korona’. The berries ripen earlier than ‘Korona’ and has longer and more spread harvesting season. It has a higher yield than ‘Korona’. The line seems to be relatively resistant to powdery mildew.

Raspberry

Only cultivars suited for fresh consumption are mentioned here. Raspberry cultivars for fresh consumption should have fruits that are firm with a good appearance and taste. By production in tunnels the cultivar used must have proven that it performs well under cover. Some cultivars may be good when grown outside, but does not thrive when grown under plastic.

‘Asker’ (synonym ‘Winkler’s Sämnling’) is an old cultivar that has been grown to some extent for fresh market around Oslo in Norway. It is very winter hardy and also highly resistant to raspberry root rot (*Phytophthora rubi*). The berries are very tasty, but small and soft, which means that harvest costs are high and shelf life is short. In addition the canes are heavily spined and the yield is quite low.

‘Glen Ample’ is a cultivar from Scottish Crop Research Institute (SCRI) that is dominating in raspberry production in Norway today, and the introduction of this cultivar was one of the factors behind the rapid increase of production for fresh market during the last decade. It is spine-free and productive with large , firm and nice looking berries that taste quite good. It is well adapted to production in plastic tunnels. ‘Glen Ample’ has long laterals, which means that the number of floricanes per m row and number of buds above the wire should be reduced a bit compared to cultivars with shorter laterals. The wire can then be somewhat higher to ensure sufficient number of laterals to keep the yield up. ‘Glen Ample’ is very susceptible to raspberry leaf and bud mite (*Eriophyes gracilis*) and special care must be taken to control this pest. ‘Glen Ample’ is produced in plastic tunnels at Grytøya in Troms, Norway, in a climate that has many similarities with the climate in South-West Iceland.

‘Glen Fyne’ is a new cultivar from SCRI that is said to be very productive with firm fruits with size and shelf life comparable with ‘Glen Ample’. The taste is announced as very good. The canes are spine-free. The first trials with this cultivar in Norway will give fruits in 2010.

‘Tulameen’ is a cultivar from Canada that has been grown for fresh market due to good taste. The fruits are medium sized and not as firm as the fruits of ‘Glen Ample’. In outdoor production in Norway, fruit quality has been very good some years but only mediocre other years. Well suited for production in tunnels. It is quite productive, but can get some damage due to winter frost.

RU004 03067 is a selection from Graminor from a cross between ‘Glen Ample’ and ’Julia’. Yield, fruit size, firmness and taste is quite similar to ‘Glen Ample’, but RU004 03067 ripens one week later and is much less susceptible to raspberry leaf and bud mite. Colour of berries is less dark than on ‘Glen Ample’. Canes are spine-free. We do not have experience with this selection in plastic tunnels yet.

RU004 04106 is another Graminor-selection from a cross between ‘Qualicum’ and ‘Glen Ample’. It has firm fruits with nice appearance and good taste (high sugar content and sugar/acid ratio). Fruits are smaller than on ‘Glen Ample’. Can get some raspberry leaf and bud mite, but not as susceptible as ‘Glen Ample’. Canes are spine-free. We do not have experience with this selection in plastic tunnels yet.

‘Varnes’ is an apricot-coloured cultivar from Graminor, Norway. The fruits are quite large, have nice appearance and taste but are not as firm as the fruits of ‘Glen Ample’. It is rather susceptible to winter frost and very susceptible to raspberry root rot. The canes are thorny. In market stands and shops, a mixture of red and yellow raspberries looks very attractive. ‘Varnes’ has a potential in this concept, but should only be a niche production. ‘Varnes’ has performed well under a plastic roof, but we do not have experience with this cultivar grown in plastic tunnels.

Figure 16. ‘Glen Ample’(upper left), ‘Tulameen’ (upper right), RU004 03067 (middle left), RU004 04106 (middle right) and ‘Varnes’ (lower left). Photos: Dag Røen. Lower right: ‘Varnes’ and ‘Glen Ample’ grown organically at Helgeland, Nordland, Norway. Photo: Nina Heiberg

Red currant

Red currant cultivars for fresh consumption should preferably have a relatively high sugar/acid ratio, and large berries on long strigs. They should not be particular susceptible to leaf diseases.

‘Nortun’ is an early, Norwegian cultivar (from Johannes Øydvin) known for having a good taste. It is quite susceptible to leaf diseases. Berries are medium sized, and the strigs are short. It is only medium productive and not very winter hardy.

‘Red Dutch’ (synonym ‘Rød Hollandsk’) is by far the most planted red currant cultivar in Norway. It is winter hardy and quite strong against leaf diseases. It has large and stable yields, but fruits are only medium sized, strigs are short and taste is too acidic for fresh consumption.

'Rovada' is a late ripening cultivar with long strigs of large and firm berries. Taste is not optimal (too much acid). It is the dominating cultivar in indoor production of red currant in Belgium and The Netherlands. It is productive and the berries taste quite good.

'Rosetta' is another late ripening, productive cultivar with long strigs of medium sized berries. Used to some extent for fresh consumption, but taste is not optimal (too much acid).

Black currant
'Ben Tron' is a cultivar from SCRI that is productive with medium sized berries of good quality. Rather high sugar/acid ratio due to a relatively low acid content, high content of vitamin C. It is planted for fresh consumption to some extent in Norway. Erect growth habit.

'Kristin' is a Norwegian cultivar (from Johannes Øydvin) with medium sized fruits. Rather high sugar content combined with a relatively low acid content gives a pleasant taste. Erect growth habit. Ripens one week after 'Ben Tron', only medium productive.

Gooseberry
Gooseberry cultivars for fresh consumption should be large fruited with a sweet and pleasat taste, and the bush should be strong against mildew and preferably not too spiny.

'Hinnonmaki Red' and **'Hinnonmaki Yellow'** are two medium early culivars from Finland that are very winter hardy. Fruits are medium sized and have a good taste.

'Hönings Früheste' is an early ripening cultivar with yellow berries known for having a good taste. It is however quite susceptible to mildew.

'Invicta' is the main cultivar in gooseberry production in the UK, and planted in small scale for fresh consumption in Norway. It is productive with large green-yellow fruits of quite good quality that ripens early top medium early. It is quite strong against mildew but not totally resistant. The bush is vigorous and heavily spined.

Availability

Strawberry
Certified plants of 'Gudleif', 'Blink' and 'Sonata' are available from Sagaplant AS / Norgro AS. The breeding lines GNKi2484 and GNKi2634 are established in vitro at Graminor Breeding Ltd., and can be available for trial purpose from the 2011 season.

Raspberry
Certified plants of 'Glen Ample' are available from Norgro, and certified roots and plants of 'Asker', 'Tulameen' and 'Varnes' (?) from Sagaplant AS. Certified 'Glen Fyne' plants can be bought from nurseries in UK, e.g. R W Walpole (www.rwwalpole.co.uk). The selections RU004 03067 and RU004 04106 are established in vitro at Sagaplant, and tested material will probably be available for trial purpose from the 2011 season.

Ribes
Hardwood cuttings of 'Ben Tron', 'Kristin', 'Nortun', 'Red Dutch', 'Rosetta' and 'Invicta' are available from Sagaplant AS. Plants of all mentioned cultivars (except 'Rovada' and 'Hönings Früheste') are available from nurseries in Norway.

Plant material free of pests and diseases

It is very important to start a berry production with true-to-type plants that are free from important viruses, diseases and pests.

Sagaplant Ltd. is a national plant health centre situated at Akkerhaugen in the southeast of Norway. The company is responsible for the production of climatic adapted, true to type and healthy plants for the entire Norwegian and partly Nordic horticultural marked. Viruses, virus- like organisms and bacteria are eliminated by heat therapy and meristem culture and the plant material is controlled and approved by the Norwegian Food Safety Authority. Sagaplant produce propagation stock of strawberries, raspberries, blackberries, redcurrants and blackcurrants of most varieties. Through our collaboration with Norgro Ltd, we can deliver certified stock of most of the plants mentioned above.

Phytosanitary regulations

Iceland

The Icelandic Food and Veterinary Authority (MAST) functions as the official national plant protection organization of Iceland and is responsible for maintaining plant health and ensuring seed quality.
Iceland has implemented the legislation of the European Community on seed but has its own legislation on plant health. The Authority gives its opinion to the Ministry of Fisheries and Agriculture on plant health and seed legislation.

The Icelandic rules restrict imports of the main tree genera for forestry. In other aspects they follow the same principles as the EC legislation. None of these genera are important for berry production.

Faroe Islands

There are no regulations or restrictions about import of berry plants to Faroe Islands. Normally the importers prefer to buy plants from a supplier who can provide plants with any kind of a health certificate, but generally trade with plant material is based on confidence.

Greenland

There are no regulations or restrictions about import of berry plants to Faroe Islands.

Climate improvement

Compared to outdoor climate on the location, the climate inside a plastic tunnel or plastic house is characterized by higher maximum and mean temperatures, no precipitation, higher relative air humidity and a dramatically reduced air movement. The temperature effect is illustrated in the figure below.

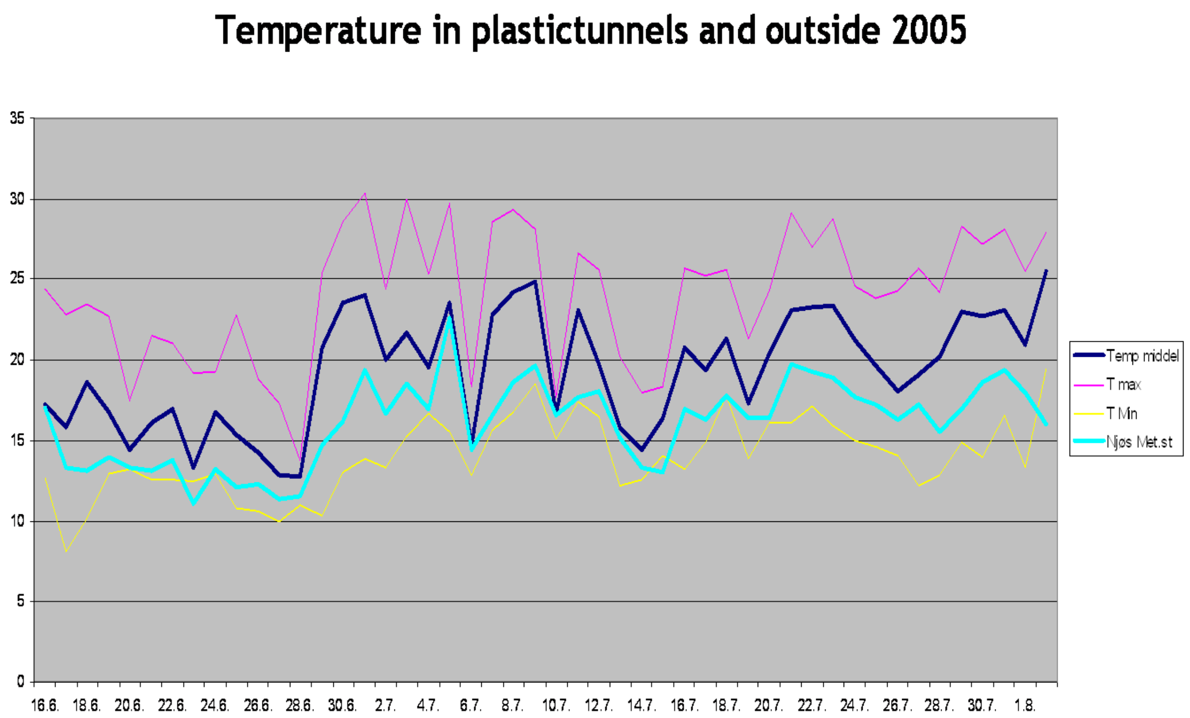


Figure 17. Mean temperature outside (turquoise curve) compared to mean (blue curve), maximum (pink curve) and minimum (yellow curve) temperatures inside a plastic tunnel at Leikanger, Norway 2005.

The table below shows accumulated degree days until harvest in raspberry grown in tunnels and outside at one location. Plants have an optimum temperature for growth, and temperatures above the optimum do not make the development in plants go faster. The temperature on sunny days may frequently be over the optimum temperature. Plants in tunnels need more degree days in total until harvest when we use a degree days definition with a base temperature (her 5 °C) but no restriction on the other side of the optimum temperature.

Table 11. Accumulated degree days by 5, 50 and 100 % harvest of 'Glen Ample' raspberry outside and in plastic tunnel at Leikanger, Norway, figures are mean of 3 years.

	Outside	Tunnel
	Base T 5 °C	Base T 5 °C
5 % harvested	795	1112
50 % harvested	893	1293
95 % harvested	1052	1436

In the following table, estimations are made on degree days if mean temperature increases by 2 or 3 degrees C at two locations in Northern Norway. Tjøtta has a climate close to Brønnøysund, and Holt a climate comparable to Andøya. At Tjøtta one can expect more than 50 % of the berries of 'Glen Ample' grown outdoor to be harvested during August, at Holt you need to grow this cultivar inside as the berries ripens too late outdoor. Inside a plastic tunnel with a 2 or 3 °C rise in mean temperature, one can expect that this raspberry cultivar can be grown successfully also as far north as at Holt. As the periods with temperatures above the optimum range is expected to occur less frequently when outdoor temperature is lower, the degree days needed until harvest inside a tunnel at northern latitudes is expected to be lower than further south.

Table 12. Measured degree days outside and modelled degree days inside a plastic tunnel with an average rise in mean temperature of 2 or 3 units at two locations in Northern Norway before 30 August. The figures are mean of 3 years.

	Basis 5 °C	Tunnel (+2 °C)	Tunnel (+3 °C)
Tjøtta	1014	1307	1460
Holt	710	1015	1167

Figure 18. Steve Saltermark growing ‘Glen Ample’ raspberries outdoor on 65 °N at Brønnøy, Norway. Photo: Nina Heiberg.

Plastic tunnels vs. plastic houses

The plastic in a plastic house is normally kept on continuously as long as the longevity of the plastic. The plastic on a plastic tunnel is rolled off and assembled along the sides of the tunnels during winter time. Problems with breakage due to snow pressure are then mostly eliminated, and winter storms normally cause no problems. In situations when heavy wind is expected during growth season (as with the heavy foehn winds at Greenland), the plastic cover can be rolled of rather fast, reducing potential damage to the tunnels, but the plants inside will then of course be exposed to the heavy wind. The plastic on the sides of the tunnels can be lifted up totally for ventilation, and the temperature inside the tunnels can thus be better controlled on warm days than in a plastic house where ventilation is normally not as good.

Figure 19. Damage to plastic house in Iceland due to snow pressure. Photo: Magnús Ágústsson

Arctic tunnel

Sognabær DA is in charge of the development, production and marketing of Arctic tunnel, which together with Haygrove tunnels dominates the market of plastic tunnels for horticultural use in Norway.

The Arctic Elite Tunnel is the model from Arctic tunnel that is most relevant for this project, with the skills to take quit much wind and snow load. The tunnels should be built as low as possible, considering the production planned placed in the tunnels. The Arctic Elite Tunnel is expected to take winds up to at least 25 m/sec, and snow load of at least 20cm, if everything is correctly done during the construction work. Lower built tunnels can possibly take even more wind. It is impossible to set a limit for what the tunnels can take, both of wind and snow load, but they can be made as strong as possible by adding extra steel to the construction, reducing the spacing between hoops/legs, and making the tunnels as low as possible. They also like to put up a ridge bar at the top of all the hoops and perimeter bars on all walls. It is also important to place the field of tunnels in a landscape location that is as much sheltered from the wind as possible.

The cost of the Arctic Elite Tunnel has to be calculated in each individual project, but an estimate on one hectare is approximately NOK 450-500.000 for all materials and plastic. Additional cost will be construction work at the building site, freight and travel expenses.

Arctic TUNNEL

Figure 20. Raspberry production in plastic tunnels at Vangsnes, Norway. Photo: Stein Harald Hjeltnes.

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Appendix 1 – Glossary berry crops

Botanical name	**English**	**Iceland**	**Faroe Islands**	**Denmark**	**Norway**
Fragária x ananássa	Strawberry	Jarðarber	Jarðber	Jordbær	Jordbær
Fragária vesca	Woodland strawberry			Markjordbær	Markjordbær
Émpetrum nigrum	Crowberry		Krákuber		Krekling
Rheum x hýbridum	Rhubarb		Rabarba	Rabrabra	Rabarbra
Ribes nigrum	Black currant	Sólber	Sólber	Solbær	Solbær
Ribes rubrum	Red currant	Rifsber	Ripsber	Rips	Rips, hagerips
Ribes uva-crispa	Gooseberry	Stikilsber	Stikkulsber	Stikkelsbær	Stikkelsbær
Rubus chamaemórus	Cloudberry	Múltuber	Moltiber		Molte
Rubus idaéus	Red raspberry	Hindber	Hindber	Hindbær	Bringebær
Rubus fruticosus agg.	Blackberry	Brómber	Bromber	Bjørnebær	Bjørnebær
Rubus saxátilis	Stone bramble	Hrútaber	Rossaber		Tågebær
Vaccínium oxycóccus	Cranberry		Tranaber		Tranebær
Vaccínium myrtíllus	Bilberry	Aðalbláber	Aðalbláber	Blåbær	Blåbær
Vaccinium uliginosum	Alpine bilberry				Blokkebær
Vaccínium vitis-idaéa	Lingonberry		Vínbláber		Tyttebær