Agriculture in Iceland: Conditions and Characteristics

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Contents

1 Population, geography and natural characteristics

1.1 Population and geographical statistics

The population of Iceland is approximately 317.000[1], smaller than any of EU member states, although similar to the population of Malta. The overwhelming majority of the population lives on the main island, which is about 103.000 km^2 but a few thousand inhabit 3-4 small islands close to the coast. Approximately quarter of the land is below 200 m and all major settlements as well as most agricultural production are to be found in those locations. The geographical size of Iceland is close to the median of European countries along with Portugal, Hungary and Bulgaria (see Table 1).

Table 1. Population, area and population density of European countries and selected regions.

Country/Region	Population[1]	Area[2] km^2	Population density (inhabitants per km^2)[3]
Germany	82.314.906	357.114	229,9
France	63.623.209	632.834	100,9
United Kingdom	60.781.352	242.900	250,8
Italy	59.131.287	301.336	201,2
Spain	44.474.631	505.992	87,9*)
Poland	38.125.479	312.685	121,9
Romania	21.565.119	238.391	93,7
Netherlands	16.357.992	37.354	485,3
Greece	11.171.740	131.957	85,6
Portugal	10.599.095	92.090	115,2
Belgium	10.584.534	30.528	350,4
Czech Republic	10.287.189	78.867	133,8
Hungary	10.066.158	93.028	108,1
Sweden	9.113.257	441.370	22,3
Austria	8.282.984	83.871	98,8
Bulgaria	7.679.290	110.879	69,0
Switzerland	7.508.739	41.284	188,8
Denmark	5.447.084	43.094	126,7
Slovakia	5.393.637	49.034	110,1
Finland	5.276.955	338.419	17,4
Norway**)	4.681.134	323.802	15,5
Croatia	4.441.238	56.594	78,5
Ireland	4.312.526	70.273	63,7
Lithuania	3.384.879	65.300	53,9
Latvia	2.281.305	65.449	36,5
FYR Macedonia	2.041.941	25.713	82,0
Slovenia	2.010.377	20.273	100,2
Estonia	1.342.409	45.227	30,9

[1] Jan 1, 2010.

Cyprus	778.684	9.251	84,2
Luxembourg	476.187	2.586	184,1
Northern-Norway***)	462.237	112.948	4,3
Highlands and Islands UK	442.400	39.500	11,2
Malta	407.810	316	1.290,5
Iceland	307.672	103.000	3,1
Fr. Guiana	213.031	83.534	2,6
Liechtenstein	35.168	160	219,8

**) Numbers in italic were missing in the original datasets but are calculated on basis of the numbers in the two other columns.*
***) Without Svalbard and Jan Mayen, which are 62.422 km^2*
****) Northern Norway: Finnmark, Norland and Troms.*

The population density is extremely low; 3.1 inhabitants/km^2, compared to 112 inhabitants/km^2 in EU-27. Even the Scandinavian countries Norway, Finland and Sweden are several magnitudes above Iceland with 15-22 inhabitants/km^2. To find comparable densities one has to go to regional levels where French Guiana and a few of the northern most regions of Finland, Sweden and Norway[4] have a population density close to Iceland (see Table 1).

Almost 80% of the Icelandic nation lives in the south west corner of the country; in or close to the capital area. This means, that for most of the agricultural areas, population density is well below the country average (as seen in Figure 1).

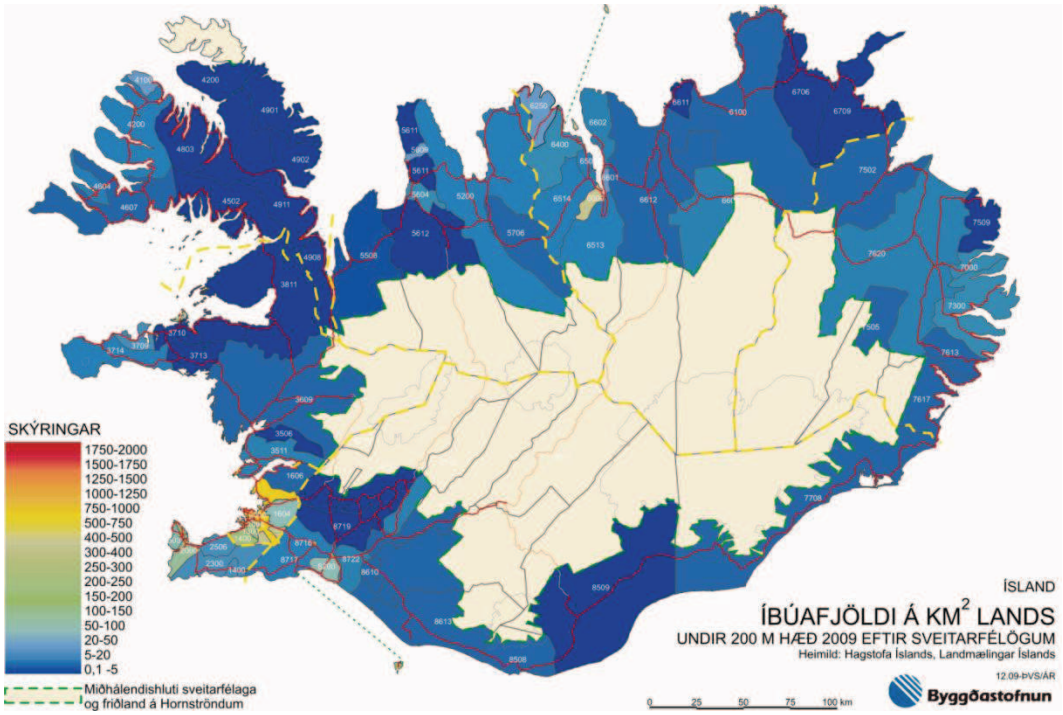

Figure 1. Population density below 200 m, divided by municipalities[5].

The small population size and considerable dispersion have widespread implications for agricultural production in Iceland:

- The local market is small so it is very difficult for the processing industry to gain from the benefit of scale and the industry produces a wide range in very small quantities.
- Transport cost is high, both for live animals (and raw milk) from farmers to the processing plants, but also of processed food from the plants to consumers.

- Centralized services, like technical service, farm extension service and health inspection is bound to be scattered in small, often inefficient units. Each unit only serves relatively few farmers but has nonetheless large distances to cover.
- The retail market is dominated by few companies, which means that the farming industry has a weak position against the retail industry. This would be especially critical if import restrictions were removed.

Taken together, the unique demographical conditions in Iceland result in vulnerable and non-competitive agricultural industry.

1.2 Natural conditions

Iceland lies in the North Atlantic, just south of the Arctic Circle between the latitudes 63.2° N and 66.3°N. The shortest distance to neighbouring countries is 290 km to Greenland; 800 km to Scotland and 970 km to Norway[6].

Most of the centre of the country is uninhabited highland and most of the farming is located in the deep valleys of the north and the southern lowlands. Due to the volcanic activity of Iceland, soil is ample in the lowlands but the composition of the soil is rather unique. According to the Icelandic Classification System, soils in Iceland are dominated by Andosols when covered by vegetation, Vitrisols in deserted areas and the highly organic Histosols in some wetland areas[7]. The Andosols are characterized by high organic content and water holding capacity but a general lack of cohesion. This means, that if the vegetation is weakened (e.g. by overgrazing) these soils are vulnerable to erosion by water or wind. Additionally, the Icelandic flora is mostly lacking nitrogen fixating plants, although e.g. the Nootka lupine has been imported from Alaska. This fact might add to the vulnerability of the Icelandic vegetation.

At the time of settlement, approximately 60% of Iceland was vegetated and some 15-20% covered by forest. By now, however, only 27% of the country is vegetated and natural forest only covers about 1% of the total area[8].

Figure 2 shows a map of land degradation in Iceland. According to this classification 40% of the island is “considerably”, “severely” or “extremely” eroded[9].

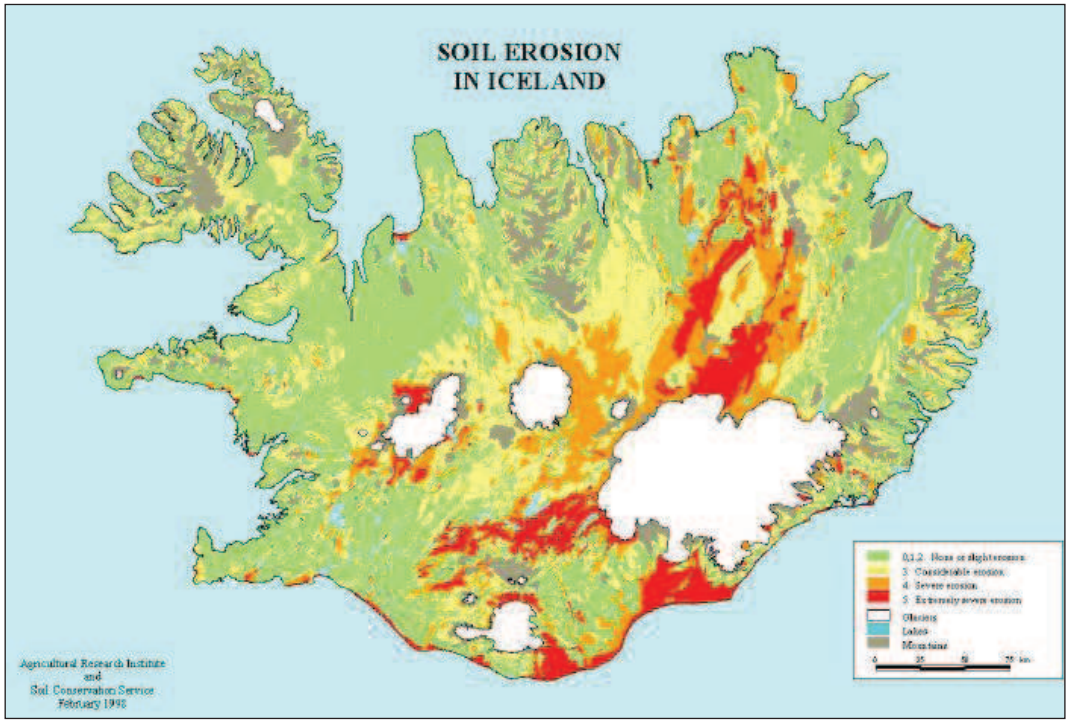

Figure 2. Soil erosion in Iceland.

Soil erosion in Iceland has been systematically fought since the establishment of The Soil Conservation Service (SCS) in 1907. First, by stopping widespread sand storms in the southern cost of Iceland, but later by extensive sowing of *Leymus* grass, *Lupine* and several other native and imported plants. In 1990 the SCS started working systematically with farmers, yielding financial incentives and technical/scientific support to encourage land restoration projects. Currently 650 farmers are participating in this program[10].

1.3 Climate

Despite northern location, temperature in Iceland is relatively mild in winter due to the Gulf Stream, bringing warm sea from the south. There is, however, a considerable difference between south west and north east, the former mild and wet but the latter with the character of continental climate and weather conditions in general can be extremely unstable (see Table 2).

Table 2. Long term[11] average temperature and annual precipitation different European places. If not otherwise indicated, data are from http://www.worldweather.org/europe.htm

	Jan		July		
City	Daily min °C	Daily max °C	Daily min °C	Daily max °C	Annual precipitation (mm)
Reykjavik[a)] (lat. 64.4 N)	-3.0	1.9	8.3	11.3	799[12]
Edinburgh[b)] (55.6 N)	0.3	6.2	10.3	18.8	676[13]
Helsinki[b)] (lat. 60.1 N)	-8.5	-2.6	11.8	21.8	642[14]
Rovaniemi[b)] (lat. 66.5 N)	-15.1	-8.5	11.0	19.4	577
Tromsø[a)] (lat. 69.6 N)	-6.5	-2.2	8.7	15.3	1031[15]
Brussels[b)] (lat. 50.5 N)	0.7	5.6	13.6	22.4	821[16]
Vienna (lat. 48.1 N)[17]	-2.0	-1.0	15.4	25.6	607[18]

a) Data from 1961-1990; b) Data from 1971-2000

The most striking difference between the Icelandic locations and those on mainland Europe is the unusually low summer temperature. This low temperature considerably limits the growing potential for a range of agricultural plants both which plants can be grown and their yield. Another difference, not apparent from Table 2, is the highly fluctuating climate with temperatures repeatedly dropping (or rising) 10-20°C within a day.

Growing degree-days is another recognized parameter for comparing cultivation conditions between countries. Figure 3 shows the Accumulated Day Degrees in few northern cities, calculated on the basis of monthly temperature averages from April to September.

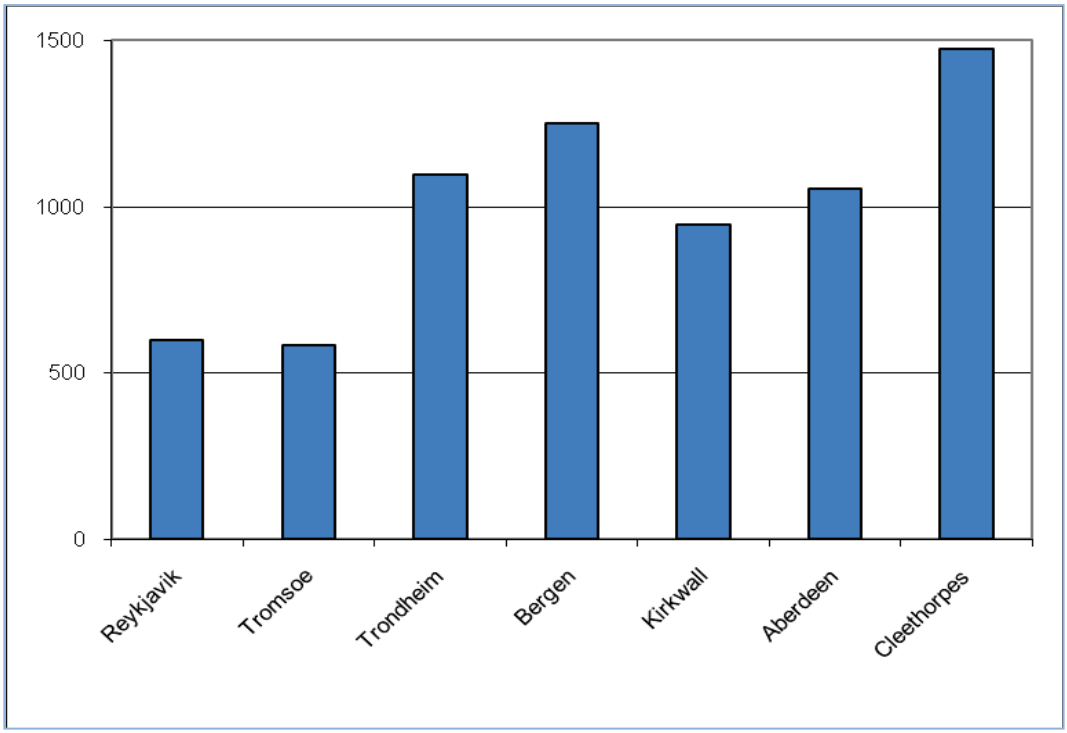

Figure 3. Accumulated Day Degrees (ADD) based on monthly temperature averages[19].

The figure shows clearly how Reykjavik, along with Tromsø is far lower than e.g. central Norway and Scotland, resulting in a permanent handicap for grain production.

Taken together, climate and soil conditions impose several limitations on farming in Iceland. Figure 4 shows recent classification of the country based on cultivation zones. Some of the areas with relatively mild climate are covered with lava or sand (red diagonal lines) further limiting the potential land use.

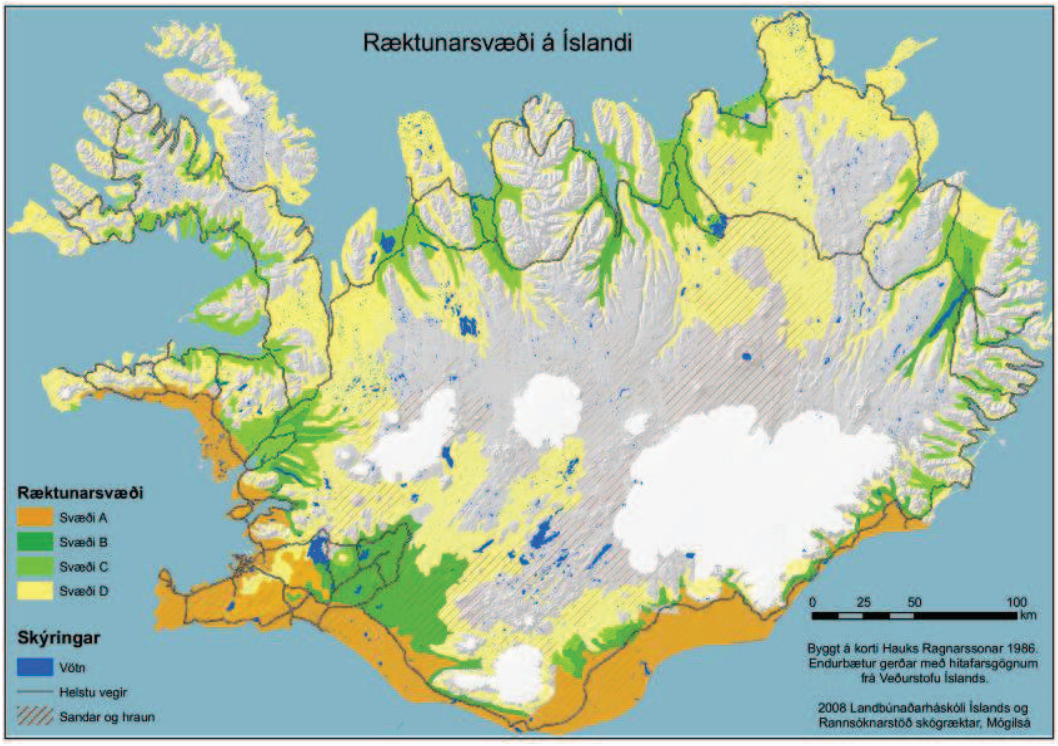

Figure 4. Map of Iceland patterned according to cultivation zones. Zone A is best suited for cultivation while zone D includes the natural limits for forest growth[20].

1.4 Natural hazards

The most common natural hazards for agricultural production are related to extreme weather conditions. An example of this is a 35% loss in the annual potato harvest in 2009, as the result of repeated night frosts in July and August[21]. Another famous example was April 16 1963 when temperature in Southern Iceland dropped almost 20 degrees within a day causing widespread and permanent damage on *Populus* trees in large part of the country[22]. In any case, temperatures below zero can be expected in most summer months every few years[23] and have repeatedly caused damage to vegetables, potatoes and barley.

Extreme wind is quite common in Iceland. Table 3 shows examples of wind measurements in the capital region. Wind speed of more than 30 m/s is to be expected in most winters and in many places wind speed of more than 60 m/s is not uncommon. Strong winds in autumn can be particularly hazardous for grain production causing sizable losses prior to harvest.

Table 3. Wind measurements in Kjalarnes (2001-2006) and Reykjavik airport (2006-2007).

Month	Kjalarnes[24]		Reykjavik airport[25]	
	Percentage of obs. with wind burst > 30 m/s	Highest wind burst (m/s)	Average wind speed (m/s)	Highest wind burst (m/s)
Jan	5,1%	49,7	5,3	25,9
Jul	0,05%	31,5	3,9	20,7

Floods in certain rivers can be expected on a regular basis, but the effects are usually limited to relatively few farms.

Volcanic eruptions and earthquakes are a real threat for agriculture in Iceland, as clearly demonstrated in the recent eruptions of Eyjafjallajokull 2010. Direct threat from volcanoes includes ash, lava and flooding in glacial rivers but indirect effects can be transportation problems, high building cost and general insecurity. The eruption in Eyjafjallajokull resulted in direct damage of agricultural land and holdings of €1.900.000[26]. It should be noted, that weather conditions were exceptionally favourable as most of the ash was blown direct South of the country. Different weather conditions would have had severe effects on productive agricultural areas in S-Iceland.

In 2008 a earthquake of 6,3 on the Richter scale hit the southern lowland and resulted in a total loss of €35 mill. and another slightly smaller earthquake took place in 2000. In historical times volcanic eruptions and earthquakes have repeatedly caused great damage but the worst example is the eruption of Laki in 1783-1785 which left 80% of Icelandic livestock and 20% of the human population in vain[27].

2 Icelandic Agriculture

2.1 Historical overview

Iceland was settled between 800 and 1000 AD[28], mostly by Norwegians that brought with them the culture of Scandinavian farming. Helgadottir and Sveinsson[29] offer concise historical review of Icelandic agriculture from settlement to the 20th century:

> *The development of agriculture in Iceland from the time of the settlement in the late ninth century to the present day can be divided into five distinct phases which are reflected in the production of farm produce … :*
>
> *I: 900-1900 Self-sufficiency*
>
> *For centuries sheep husbandry was the main farming activity in Iceland and productivity was very low. Hay was made up of indigenous species obtained from wild pastures and bog lands. It has been estimated that the country could carry 360 thousand sheep by*

utilizing grazing all year round and hay obtained from bogs in more difficult years. This was sufficient to maintain a population of 60 thousand (see Guðbergsson 1996).

II. 1900-1945. Cultivation begins

The growing urban population created a market for agricultural products. Food security was the major political driver for agriculture. Farmers adopted new but primitive technology in hay production and in improvements of hay fields. Artificial fertilizers arrived on the scene.

III. 1945-1980. Technological advances, increased production

After the end of World War II the rural population decreased rapidly and a subsidy system was set up to reward increased production. Advanced machinery was imported to reclaim new agricultural land. Agriculture was driven towards extensive cultivation of grassland seeded with introduced non-adapted grass cultivars and greater intensification with the use of artificial fertilizer and concentrates. Unfavourable climatic conditions in the 1960's caused severe winter kill in cultivated grasslands in many parts of the country.

IV. 1980-1995. Production restrictions

Overproduction, particularly in the sheep sector, called for revision of the extensive subsidy system. A quota system was introduced and farmers had to adapt to production limitations. A complete revision of the legal framework for agricultural policies was carried out in 1985. The main objectives were "to promote structural adjustment and increase efficiency in agricultural production and processing for the benefit of producers and consumers and to adjust the level of production to domestic demand and secure sufficient supply of agricultural products as far as practicable at all times" (Thorgeirsson 1996).

[it should be added that in 1992 all export support in agriculture was abolished][30]

IV. 1995-2006. Improved efficiency

Food habits are changing and the proportion of local agricultural products in the total food budget becomes progressively lower. The drive is now towards maintaining margins by reducing inputs as well as by increasing outputs. Dairy and sheep production is steady but the number of "traditional" farms is declining, especially in the dairy sector. Increasing urban demand for rural estates is causing a significant rise in farmland prices. Farmers and other landowners are looking to alternative land uses in addition to food production and agriculture becomes progressively more multifunctional.

What is of special interest is the prolonged period of self-sufficiency and how late farmers were to start cultivating their land. Several factors can explain this; lack of iron for tool making, low population density, modest foreign trade and generally harsh natural conditions. Iceland did, however, manage to maintain self sufficiency of animal products at most times, although the population has always been dependent on imported grain.

2.2 Livestock production

Agricultural production in Iceland is almost entirely animal based (except for horticulture which will be dealt with in a special chapter). Limited amounts of barley are grown, but mostly for animal fodder and still, most grain for fodder is imported.

Iceland has only a single breed of dairy cows, a single breed of sheep (and goats) and a single breed of horses. These are all breeds that have remained almost completely isolated since the settlement of the island approximately 1100 years ago.

Structural statistics Table 4 shows the total number of livestock in Iceland and most EU-27 countries. Iceland stands for only 0.5% of the total sheep population in the EU and 0.1% of the total number of dairy cows.

Table 4. Number of dairy cows, sheep and pigs in EU countries and Iceland. Numbers from the years 2007 and 2008 and all numbers are in thousands.

Country	Dairy cows[31]	Sheep[32]	Pigs[33]
Germany	4.229	1.920	27.113
France	3.794	7.715	14.969
Poland	2.697	270	17.621
United Kingdom	1.903	21.856	4.671
Italy	1.831	8.175	9.273
Netherlands	1.587	1.545	11.710
Romania	1.483	8.882	6.565
Ireland	1.105	3.423	1.575
Spain	888	19.952	26.061
Denmark	566	90	13.170
Austria	530	333	3.286
Belgium	518	:	6.200
Czech Republic	400	183	2.662
Lithuania	395	48	923
Sweden	366	521	1.728
Bulgaria	315	1.475	889
Portugal	301	3.145	2.374
Finland	288	94	1.427
Hungary	263	1.236	3.871
Croatia	213	643	1.348
Slovakia	174	362	952
Latvia	170	67	414
Greece	154	8.994	1.038
Slovenia	113	139	543
Estonia	100	62	375
Luxembourg	46	8	86
Iceland[34]	26	462	4
Cyprus	24	267	467
Malta	7	13	77

Only Cyprus and Malta have fewer dairy cows than Iceland but many countries have fewer sheep, even though Iceland lies well below the average. The number of pigs in Iceland, however, is exceptionally low; little more than 4000, while the corresponding number for Malta is 77.000.

Since the mid 1980's agricultural policy in Iceland has aimed at meeting domestic demand for animal products as production prices are generally too high for large scale export. This has been accomplished with import restrictions, tariffs, quota system in dairy and sheep production and direct payments to farmers. This system, despite its limitations, has indeed succeeded in keeping production in relation to domestic sales (Figure 5 and Figure 6).

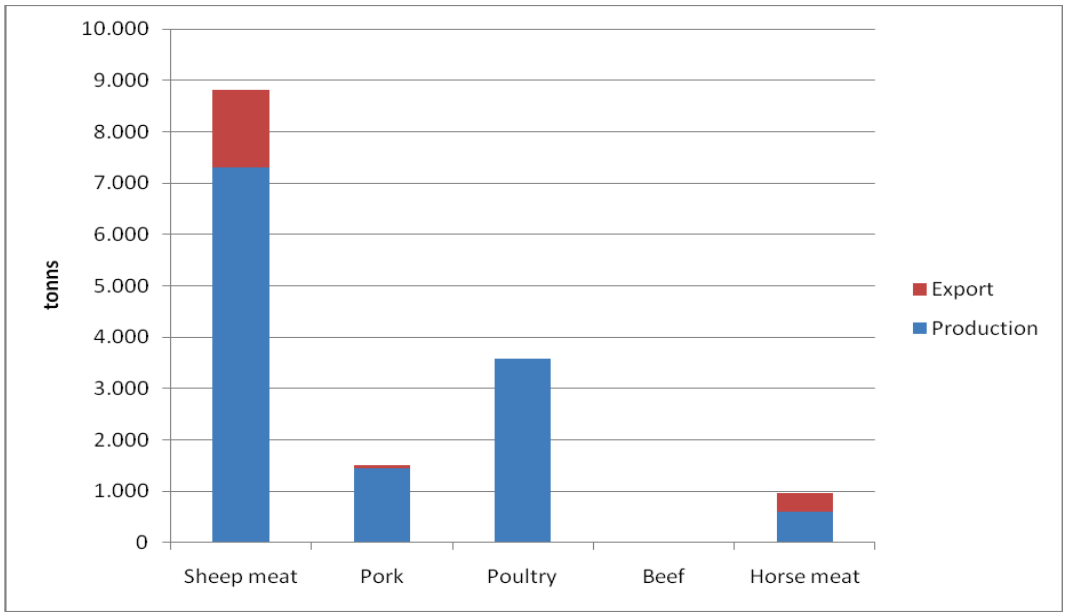

Figure 5. Production and export of meat in Iceland (average numbers 1999-2008)[35].

Approximately 15-20% of the lamb meat production has though been exported annually for the last 10-15 years[36] but often as a surplus production, giving reduced payback to producers. Small amounts of horse meet have also been exported, mostly to Europe[37].

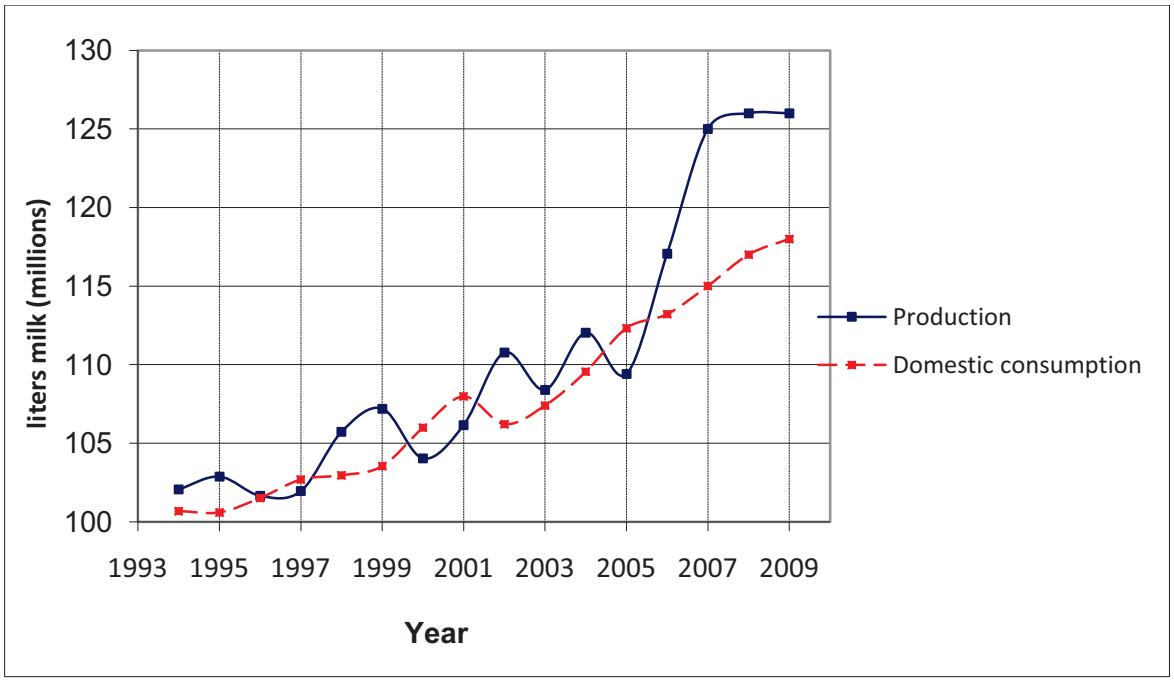

Figure 6. Production and domestic consumption of milk in Iceland 1994-2008[38].

On average 3% of the annual dairy production 2006-2009 was exported[39]; mostly[2] to Europe[40]. Despite several attempts, no long term market access has been established for Icelandic milk products. The export is mainly in the form of butter (544 t in 2009) and milk powder (528 t)[41].

Geographically, the animal production is concentrated in few regions in south, west and north Iceland, as can be seen in Figure 7 and Figure 8. The figures show the distribution of direct payments, which are based on annually produced litres. It should be noted though that the

[2] 67% were exported to Europe on average 2006-2009, based on fob-price.

correspondence between production and direct payments is not 100% but nonetheless, the figures offer acceptable outline of the production distribution.

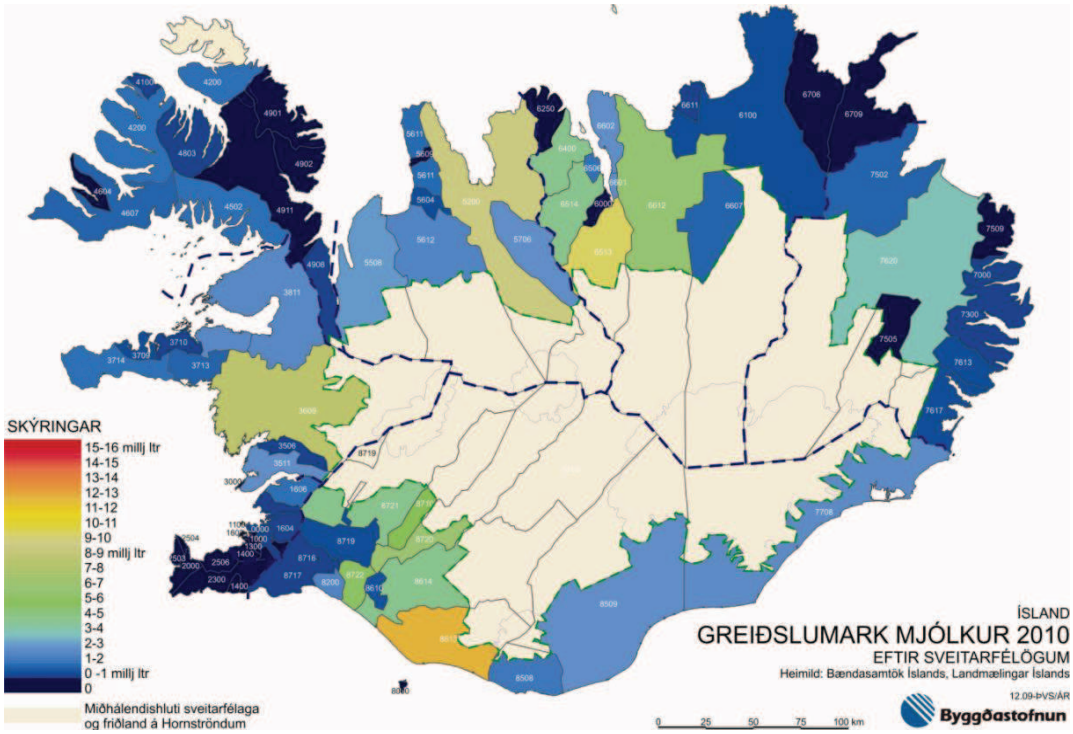

Figure 7. Distribution of direct payments to dairy farmers (numbers indicate million litres)[42].

The milk production is concentrated around the urban areas in South and West Iceland as well as in Akureyri region in Northern Iceland. This distribution is probably related to distance to the markets and general farming conditions. The North-West and the East of Iceland have very limited milk production.

The total number of milk producers 2008 was close to 760 but in 1993 the number was 1.700[43] giving an annual decline of 62 farms on average. The average farm size is 34,4 dairy cows (2008 numbers), compared to 17,6 in 1993. These structural changes reflect the technological progress and a liberal market with quota and farm land.

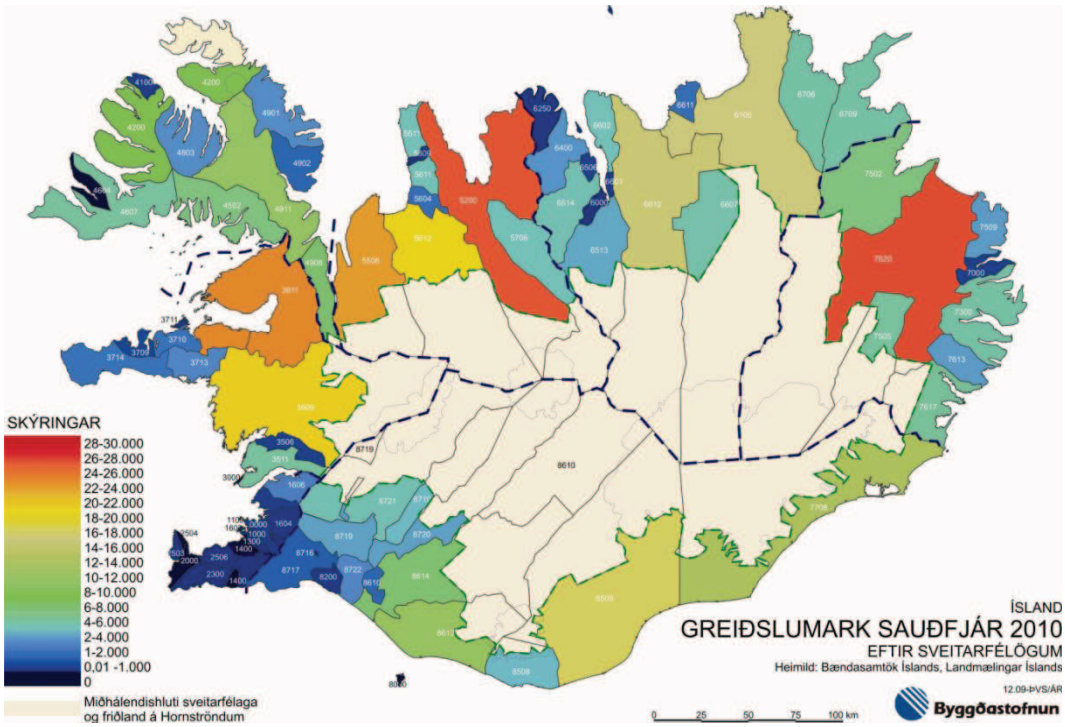

Figure 8. Distribution of direct payments to sheep farmers (numbers indicate slaughter weight)[44].

The distribution of the sheep production follows somewhat a different path with higher concentration in the more remote areas of North-West and North-East. Sheep production in Iceland requires considerable areas of extensive grassland for grazing and close to the urban areas, land price is too high.

The number of sheep farms is 2.785 (2008 numbers)[3] compared to 3.286 in 1993[37]. The annual decline is 33 farms; considerably less than the drop in number of dairy producers, but quite considerable, nonetheless. The difference can partly be explained by the fact that many sheep farms are small and contribute only to a part of the total farm income.

Figure 9 shows the changes in size distribution of sheep farms in Iceland the last 30 years. The most apparent change is the increase of very small farms and also increase in the share of large farms. The medium sized farms, on the other hand are losing ground.

[3] The numbers are based on the receivers of direct payments and might be a slight underestimate as some small hobby-producers are not registered.

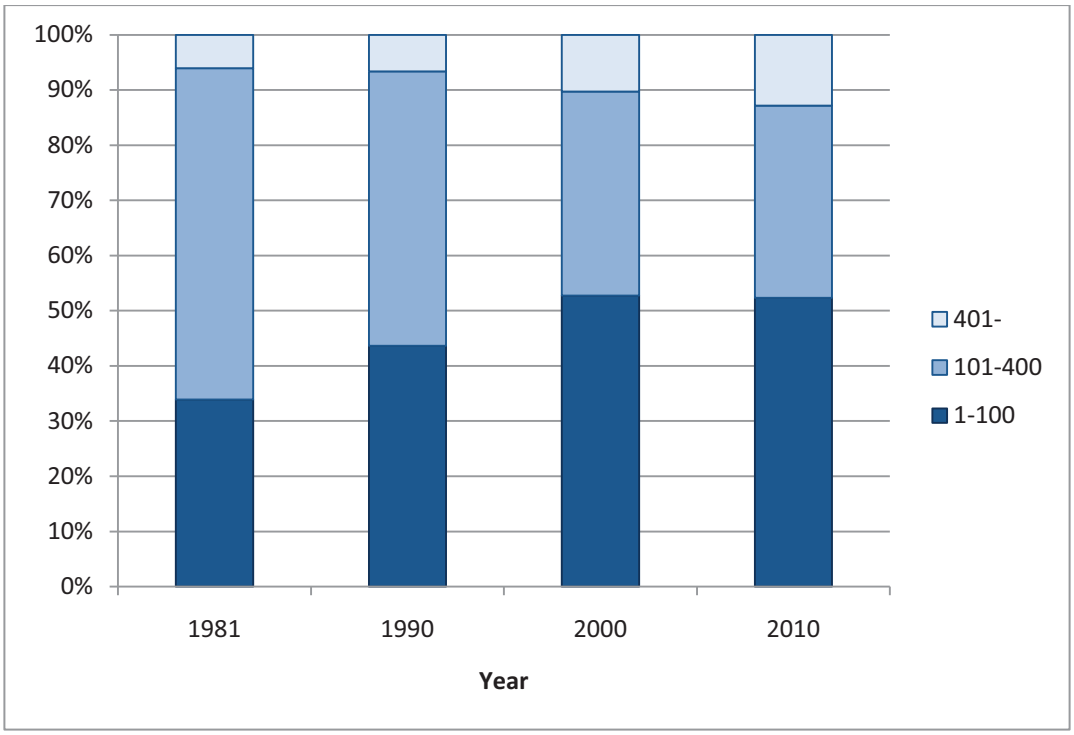

Figure 9. Changes in the size distribution of sheep farms. Categories indicate numbers of winterfed sheep[45].

Traditionally, lamb has been the most popular type of meat in Iceland but as shown in Figure 10, this has changed radically in recent decades. The annual consumption of lamb, pork and poultry is now more or less equal; 20-25 kg/capita but while the consumption of lamb and pork seems to have levelled off, the consumption of poultry is still rising.

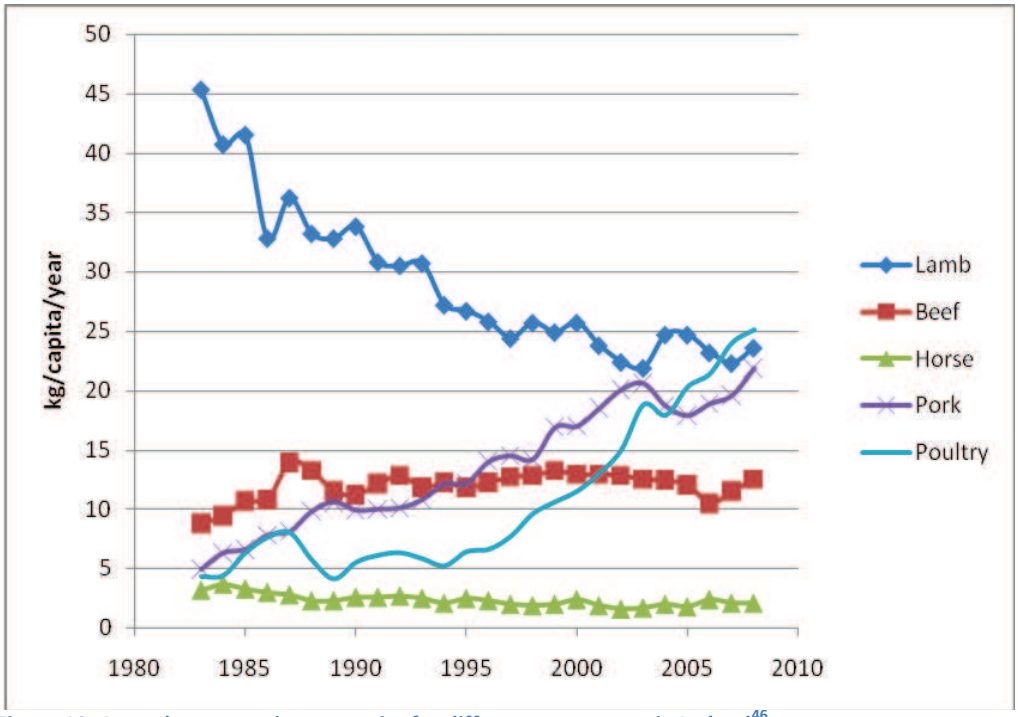

Figure 10. Annual consumption pr. capita for different meat types in Iceland[46].

The total meat consumption in Iceland is 85 kg/capita/year, which is similar to most European countries[47]. For more than 15 years ago, the corresponding number was only around 60 kg; the difference is probably the result of increased prosperity, tourism and guest workers. The market for beef in Iceland is stable and so is the consumption of horse meat, although small.

The special combination of the meat market in Iceland and restrained export possibilities means that the meat industry is very vulnerable against the import of processed meat. Domestic production of processed meat would quickly lose market share and the domino effect would raise the price of other meat products making them even less competitive than present.

2.2.1 Disease comparison

The long isolation of the Icelandic livestock breeds (dairy cows, sheep, goats and horses) makes them especially vulnerable to transmittable diseases. Iceland remains free for a long range of common animal diseases and as discussed in the following chapters, imports of genetic material have sometimes proved disastrous.

Table 5 shows a summary of comparison between Iceland and selected European countries in prevalence of animal diseases. A comprehensive comparison is available at the cited homepage.

Table 5. Results of WAHID country comparison of sanitary situation[48]

Screening results	Iceland	Germany	UK	Spain
Total diseases screened for:	121	121	121	121
Clinical	1	21	27	33
Never occurred	105	43	42	26
No information available	0	7	1	15

There is only one disease out of the total list of 121, which is classified as clinical disease in Icelandic livestock. This is Para tuberculosis but 86% of the screened diseases have never been found in Iceland. This important difference between Iceland and most other European countries explains to a large extent the strict restrictions on import of animals and all potentially disease transmitting materials.

2.2.2 Dairy and beef production

2.2.2.1 Genetics and production statistics

Iceland has only one dairy breed, which is original for Iceland and not found elsewhere[49]. The breed is related to North Scandinavian Cattle Breeds but genetic studies indicate that the divergence has happened some 1000 years ago[50] which is coherent with historical data. Since then, practically no import of foreign dairy breeds has occurred. The total number of Icelandic dairy cows is approximately 26.000[51] and the number is relatively stable. In terms of biodiversity, the Icelandic dairy breed is unique as it has survived as an isolated population for such a long time.[52]

The average milk yield is 5.300 kg/cow[53] which is considerably less than in most common milk breeds in Europe (Table 6).

Table 6. Production and lifespan of different breeds of dairy cows[54].

Parameter	NRF	SRB	SLB	NZF	Icelandic
Milk prod. (kg)	6750	8599	9555	4766	5388
Protein (%)	3,33	3,50	3,33	3,54	3,41
Fat (%)	4,2	4,34	4,20	4,41	4,04
Prod. lifespan (years)	2,8	-	-	4,9	2,7

NRF: Norwegian Dairy Cattle; SRB: Swedish Red Cattle; SLB: Swedish Friesian Cattle; NZF: New Zealand Friesian Cattle

The genetic improvement of the Icelandic breed is rather slow (0,53%[55]) due to the small population and will always lag behind the more populous dairy breeds in the world.

Comparative research has indicated that a dairy breed like the Norwegian NRF would produce 27% more milk under Icelandic conditions[56; 57]. Despite this fact and comprehensive debate in the farming community, farmers have decided not to import genetic material for improvement of the Icelandic breed. This decision is supported by the majority of the population in Iceland according to a 2007 poll[58].

The reasons for this are many but few of the most cited are linked to the ambition to protect the Icelandic dairy breed and its unique genetic traits but also the potential risk of disease distribution. Three genetic traits have been described as especially valuable for the Icelandic dairy breed:

1. The milk from the Icelandic dairy breed has unique combinations of a protein called beta-casein. Scientific research have suggested a link between this trait and the risk for diabetes-I in children.[59; 60; 61] Additionally, the utilization for cheese production is higher than expected[62].
2. The colour combinations of the Icelandic breed are diverse and in many ways unique, as it has never been subject to breeding on the basis of colour[61].
3. Adaption to harsh climate, rough fodder and uneven terrain (although this has not been proven in scientific research).

Beef production in Iceland is primarily a side production from the milk production. The Icelandic dairy breed has not been bred for meat production and is not particularly well suited for that purpose. Many dairy farmers, however, raise the male calves as a side production. The growth potential is relatively low; according to a recent study the average growth rate is 321 g/day (carcass weight)[63].

Therefore, beef breeds have been imported to provide farmers with the option of establishing beef production and the total number of beef cows in 2008 was 1.614[64]. Sporadic import of Galloway in early 20 century did not prove successful due to disease outbreaks. Import was tried again in 1976 with frozen Galloway semen. The semen was not used directly on Icelandic cows, but used to establish a small population of blended animals in quarantine on an island out of the north coast. After 4-6 generations the population was close to 90% pure bred and semen from these animals could be transported to the mainland. The process was repeated in 1978 and 1987. Frozen embryos from Aberdeen Angus and Limousine were imported in 1994 but still, only semen was transported to the mainland. Since then, no import has taken place[65].

The strict import limitations mean that farmers would need 5 generations of animals to obtain a roughly purebred herd (and with a generation interval of two years this would take at least 10 years). Additionally, the limited stock of genetic material increases the risk for inbreeding problems and finally it must be noted that the most recent genetic material is basically 20 years old in terms of genetic progress.

Therefore, the Icelandic beef production cannot be expected ever to be fully competitive to the production in mainland Europe.

2.2.2.2 Production conditions

The general conditions in Iceland for dairy farming are not particularly favourable. One reason has already been mentioned; i.e. the Icelandic dairy-breed. Although a new breed could theoretically be introduced to the country, this is highly controversial amongst farmers and consumers as mentioned previously. As the Icelandic dairy breed only counts 26.000 cows, it would be difficult to maintain many separate breeds and the Icelandic breed, with its unique genetic makeup, would probably disappear. This would violate international obligations Iceland has undertaken through the UN Convention on Biological Diversity.

Harsh climate also puts severe strains on the dairy production. The combination of long winters and cold summers, and perhaps most importantly, the instability and sudden weather change results in low production security. Grazing periods can vary considerably from one year to the next and even in the middle of summer, cold storms can prevent outdoor grazing for days.

According to Icelandic regulations dairy cattle must have access to outdoor area at least 8 weeks every summer[66]. The grazing period, however, is normally from late May to early September, although some farmers choose a shorter period, especially farms with milking robots. The long housing period puts strain on the animals, making them more vulnerable to various production diseases[67].

As mentioned earlier, barley is the only grain produced in Iceland but there is no formal market for domestic grain due to the small volume of the production. Therefore, large part of concentrate for animal feed is imported and hence rather expensive. Common price for concentrate in Iceland is €360-420/ton[68], while comparable products cost €235/ton in Denmark[69]. High concentrate price means farmers use minimal amounts which again influences milk yield. Small milk yield along with expensive housing and long housing periods result in high production price.

No protein rich crop is cultivated in Iceland so farmers are mostly dependent on imported soya as a protein source. In addition, fish meal has been used as protein source for cows and sheep but to a lesser extend for pigs. Fish meal has proved to be an excellent protein source albeit an expensive one.

Limited supply of bedding imposes another problem for Icelandic dairy farmers. There is hardly any timber processing in Iceland, which means that sawdust for bedding must be imported at high prices. This means, of course, that sawdust use is kept to an absolute minimum. The other option for bedding is straw. But as barley production is limited and the harvesting period is in September, both supply and quality of straw are limited and insecure. The lack of adequate bedding can obviously lead to health problems and to increased production costs.

Dispersion of dairy farms imposes some important problems for dairy farmers. First, all transport cost is high, both on raw materials and the products. Secondly, service cost, e.g. veterinary cost, is expensive due to long distances and, thirdly, farmers have limited possibilities for partnership in ownership of the machinery. This last point leads to high capital cost on the farms as most farmers need to own a considerable amount of machinery.

2.2.2.3 Conclusion

Dairy farming in Iceland faces many special challenges. The dairy breed is not productive, most concentrate is imported, bedding material is expensive and short summers limit profitable grazing systems. Long distances between farms impose high transport costs and limit the possibilities for active cooperation between farms.

2.2.3 Sheep production

2.2.3.1 Genetics and production statistics

Iceland has only one[4] sheep breed and one goat breed. The number of goats is only 500-600 and they are mostly kept for recreational purposes. The number of sheep is much larger, 460.000 winterfed ewes[70] and sheep production has for long time been an important pillar for rural areas.

The Icelandic sheep breed originates from the time of the settlement and most attempts to import breeding animals from other countries have failed due to diseases[71]. Genetic studies show clear but distant relation to sheep breeds in Norway, and Faroe Islands[72].

[4] Some 1000 animals belong to a genetic group that has recently been classified as distinctive breed – so called „Leader sheep. See: Emma Eyþórsdóttir, et al., 2002.
http://landbunadur.is/landbunadur/wgsamvef.nsf/key2/index.html

It is difficult to compare production parameters across breeds and countries, both because of lacking data and because of different production systems. In Iceland, sheep are almost entirely kept for meat production. The lambing season is in May and after 3-5 weeks on lowland fields the flocks are moved to the highlands for 8-10 weeks. The slaughtering season is in September and October. Only a handful of farms use the sheep for milk production, and wool production, although part of the breeding program, has limited economical importance for farmers.

After 60 years of organized breeding (including AI) the Icelandic sheep breed is homogeneous, producing on average close to 1,9 lambs pr. ewe and the meat quality is renowned.

The last 10 years, the Icelandic sheep has shown on average 0.45% increase in meat production pr. ewe[73], which can be attributed to a combination of genetic and environmental improvement.

2.2.3.2 Diseases[5]

The Icelandic sheep breed is free from a long range of common diseases (see appendix xx), but this situation has meant great efforts on the behalf of Icelandic farmers. Attempts to import living animals for breeding purposes have repeatedly resulted in the outbreak of severe epidemics in Icelandic sheep.

In the 18th and 19th century, imported English and Spanish sheep brought with them the sheep scab mite (*Psoroptes ovis*) causing severe losses. In the former outbreak, up to 60% of Icelandic sheep were slaughtered but in the 19th century parasiticides were used to limit losses. The sheep scab mite is still found in Iceland, but very sporadically and may even be eliminated completely.[74].

Scrapie, a prion based disease, appeared in Iceland after the import of a single English ram, imported from Denmark in 1878. The disease did not spread significantly until after the middle of the 20th century but then it became a serious epidemic, probably due to more intensive production methods, longer housing period and increased herd size. Since 1978, scrapie has been fought systematically and since 1982 all outbreaks have been met with immediate whole-herd culling following disposal of culled animals and disinfection of the sheep barn and surroundings[75]. No sheep are then allowed at the farm for two subsequent years. As shown in Figure 11, this program has yielded very positive results, as the annual number of infections has gone from 40-45 in the 1980´s to less than 5 in last 10 years.

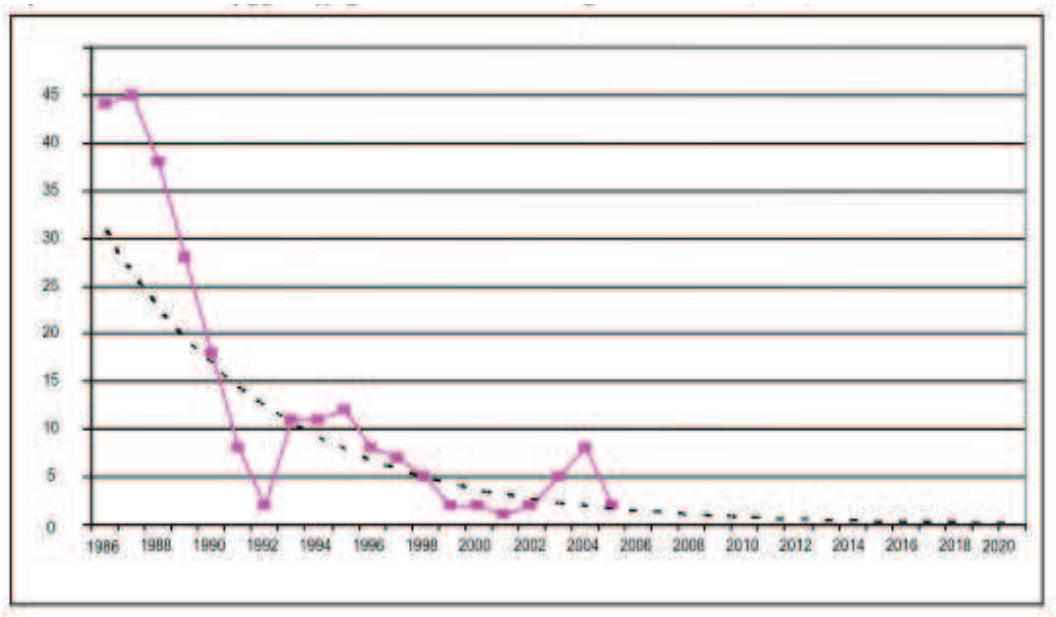

Figure 11. Annual occurrences of scrapie in Iceland (observed: solid line; calculated: broken line)[76].

[5] If not otherwise indicated this chapter is based on: http://www.sjavarutvegsraduneyti.is/media/Skyrslur/Skyrsla_nefndar_um_endurskodun_a_vornum_gegn_bufjarsjukdomum.pdf

In the 1930's import of sheep for breeding purposes resulted in three epidemics; Jaagsiekte (Ovine Pulmonary Adenomatosis), Maedi and *Para tuberculosis*[77]. The Maedi virus, described by Icelandic scientists in 1954, was the first *lentivirus* to be isolated[78]. The virus is often referred to by the names used by Icelandic farmers to describe its symptoms[6]. Interestingly, the imported sheep did not show any symptoms of the diseases – apparently due to long acquired immunity.

These epidemics were fought by massive slaughtering of sheep in the period 1941 to 1959 and restrictions on sheep transport within the country; many of which are still in place. The total direct cost of the operation is estimated to have reached € 67,7 mill. in 2009 values[79]. Neither Jaagsiekte nor Maedi have been detected in Iceland since 1960 but Para tuberculosis is still found on rare occasions[80; 81].

Since the outbreak of *Maedi-visna* and para tuberculosis no attempts have been made to import genetic material for the Icelandic sheep breed. Domestic breeding program have yielded satisfying results in meat production, fertility and meat quality so the interest for further genetic import has diminished. Additionally, the fear for diseases – even unknown diseases – has discouraged farmers, not only sheep farmers but also dairy and horse farmers.

2.2.3.3 Production conditions

For centuries, "farming" in Iceland equalled sheep farming. Pigs and poultry were rare or non-existing as these animals competed with people for food. Cattle production was only small scale 1-5 cows and then only at the bigger farms. Sheep produced the all important wool along with meat and milk and proved highly adaptable to the harsh environments of Iceland.

With the assistance of modern technology sheep production adapts well to the environment and climate of the country. The maritime climate, with cool summers and relatively mild autumns, allow for semi-extensive production methods although most farmers house their livestock from November to May. Large common grazing areas in the central highlands ensure good growth conditions for the lambs at low cost.

The sheep production in Iceland peeked in the late 1970's when the number of winterfed sheep reached almost 900.000 but since then the numbers have reduced significantly (Figure 12) and the last 15 years the total number has been relatively stable around 460.000 heads.

[6] Mæði=heavy breath; visna=wear off

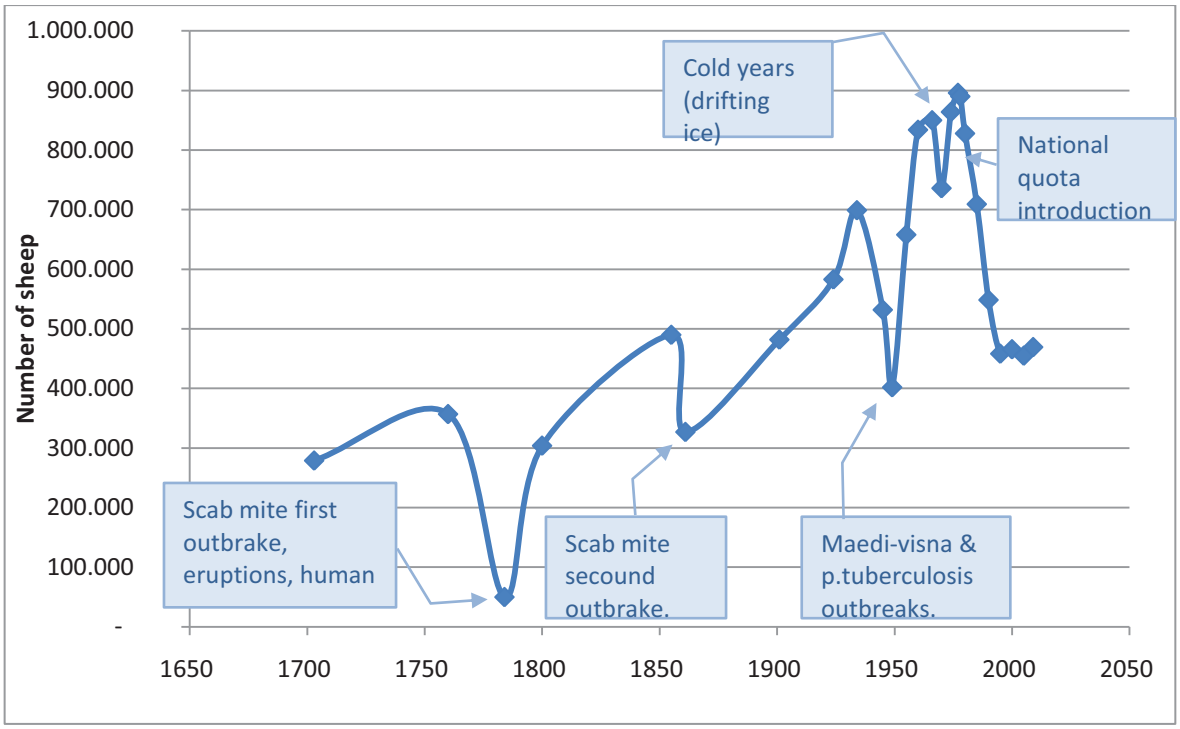

Figure 12. Development in number of sheep in Iceland[82; 83].

The Icelandic tradition of grazing on common land is very old and written into several laws and regulations. First, it should be mentioned that almost all farmers own their land. However, commonly only a fraction of the farm land is used for harvesting while the majority of the farm land is exclusively used for extensive grazing. The grazing area, belonging to the farm, may or may not be fenced and could even in some cases be undivided between two or more farms. In addition to the common use of farm land, most sheep are grazed in the central highland during summer. Most of this land is by now owned by the Icelandic state, but farmers have the intrinsic right to continue this grazing tradition. Relating this practice to EU-terminology, the term *Pastoralism*[7] would probably cover the summer grazing in the common areas of the highlands. *Transhumance*[8]on the other hand, is not common in modern times although it was frequently practiced before the 20th century.

2.2.3.4 Conclusions

Although sheep production may not have profound macro-economical effect it is a most important element for traditional way of living in rural Iceland. The lamb meat is of high quality and is a popular choice locally. It can be concluded that disease prevention is a high priority for Icelandic sheep production, given the widespread effects of several epidemics in recent history.

2.2.4 Pigs and poultry

The local production for pork, chicken and eggs is sufficient to meet the domestic consumption but export is practically non-existing. Almost all feed is imported (80% in pig prod.) resulting in high production cost and the small market does not allow for any significant economy of scale. Due to small number of animals, domestic breeding is not applicable. Therefore, genetic material is imported on regular basis from Norwegian sources. Production systems are also comparable

[7] Pastoralism: „...periodic migration to reach the pastures ... seasonal grazing of domestic livestock at low densities in large open areas, often on common land dominated by semi-natural vegetation“

[8] Transhumance: „... the regular movement of herds between fixed points to exploit the seasonal availability of pasturelands ...Shepherds oive for this period with their herd in a hut or a secondary farm...“

with Norway as Iceland maintains strict limitations on the use of hormones, growth enhancers and feed-added medicines.

Pig production was negligible before the 20th century. Even as late as 1932, there were only 138 pigs in Iceland. Since then the production has increased considerably and now the total production is approximately 6000 tons[84]. The number of producers dropped rapidly from mid 1990's to 2002 but has since then stabilized around 20, although almost 50% of the production is soon expected to be controlled by the largest concern[85].

Regular import of pork semen started in 1995 after the construction of a quarantine facility in Hrísey (a small island close to Akureyri). From Hrísey, second generation breeding animals are transported to producers on the main-land. At the present moment, a new program is under development, where frozen semen is to be transported directly from Norway to individual farmers. Consequently, after year 2015 the time lag of genetic improvement between Icelandic pigs and Norwegian pigs will be down to 1-2 years. Still, the use of imported, frozen semen will always be expensive due to transport cost and extensive screening for potential diseases. Additionally, frozen semen results in considerably lower reproduction compared to fresh semen.

Poultry production was, similar to the production of pork, very limited during most of the 20th century mostly due to low quality genetic material and unsuitable production systems. Organized import of genetic material began in the early 1990's and in 1995 producers were allowed to send fresh meat to the market. Since then, chicken consumption has increased steadily (Figure 10).

Icelandic egg production fulfils the local demand and export is negligible. The total production has remained relatively stable (2500-3000 tons) since 1980 while the egg production pr. bird has increased by over 60%.[86]

In both the egg and poultry production eggs are imported to a quarantine facility and hatched chicken is then transported to specialized breeding stations, which then provide farmers with production animals[87]. This long process adds an extra cost on the production and delays genetic progress.

From the above mentioned circumstances it should be clear that the production of white meat and eggs has limited possibilities to maintain its market position in competition with unrestricted foreign import.

2.2.5 Other livestock production

Iceland has a considerable number of horses – close to 77.000 and approximately 40.000 mink[88]. There are almost no farmed foxes and only few hundred goats.

The Icelandic mink production has reached international standards and in 2010 autumn auction in Copenhagen the Icelandic skins received the second highest price – only Danish skins received higher prices.[89] The Icelandic mink production has recently attracted the interest of Danish and Dutch farmers as climate and access to high quality feed create good conditions for mink farming[90].

There are approximately 77.000 horses in Iceland and the number has remained relatively stable since early 1990's. All horses in Iceland are of one breed; the *Icelandic horse* but it is estimated that 2/3 of the total population of Icelandic horses are located abroad.[91] There has been no documented import of horses since the time of settlement and today import is practically unthinkable although legally not impossible.

Every year around 2000 horses are exported, mostly to EU-countries (82%) but most horses are still sold domestically.

A small part of the horse population in Iceland is kept entirely for meat production but this is rather the exception as most horse breeders aim for the production of riding horses.

Horse breeding produces important externalities with regard to horse rentals, horse shows and large scale exhibitions and is often coupled to farm tourism.

Goats in Iceland are almost entirely held for stock reservation and hobby farming. The population is very small and has only on few occasions exceeded 1000 animals. The Icelandic goat is the only animal breed in Iceland that is defined as endangered according to FAO standards[92].

Although not strictly agriculture, the production of eiderdown is growing in Iceland and offers valuable source of income for those who manage it correctly. In 2009, eiderdown export value was € 1,2 mill[93]. Salmon fishing might also deserve mentioning as most salmon rivers are owned by farmers and provide considerable revenue.

2.3 Crop production

Of Iceland's total landmass of 103.000 km^2 only 25% or 2.500.000 ha is below 200 meters. Above 200 meters, agricultural production is very limited due to unfavourable climate.

Cultivation in Iceland is mostly limited to permanent grass fields, sown with Timothy (*Phleum pratense*) and Smooth Meadow-grass (*Poa pratensis*). There is no commercial production of wheat, maize (corn), oats, sugar-beets or oil-seed (canola) in Iceland. Perennial ryegrass is gaining popularity but cannot be regarded as widespread.

Cultivated land in Iceland is close to 116.000 ha but estimates for potential area for cultivation range from 160.000 ha[94] to 615.000[95]. The lower number is based on requirements for large scale production (minimum patch size 30 ha) and must be regarded more realistic with regard to modern agriculture. Given that number, approximately 72% of the crop growing potential has already been utilized.

Table 7 shows the estimated size of cultivated land in Iceland (drainage, buildings and roads excluded). Most of the land is used for permanent grass but in recent years, barley production has increased rapidly and accounts now for 4,1% of cultivated land.

Table 7. Estimates for major crops and geographical distribution of cultivated land in Iceland[96]

Area	Permanent grassland (ha)	Barley (ha)	Total (ha)
South Iceland	37.000	2.500	39.500
West Iceland	21.000	520	21.520
North Iceland	42.000	1.550	43.550
East Iceland	11.000	200	11.200
Total	111.000	4.770	115.770

Permanent grasslands are used for silage harvesting in combination with sheep or dairy production. Few, if any farms have only crop production.

Barley production receives very limited governmental support (ca. 20 €/ha) and based on recent progress in breeding, cultivation and warmer climate, there is undoubtedly considerable potential for increased production[97] if support levels would reach EU standards.

Unstable weather conditions in Iceland means that comparison of crop yield can be difficult. Additionally, the only grain produced commercially in Iceland is barley and country comparison is therefore limited to this production. Most of Icelandic silage is harvested from permanent pasture where yield is negatively correlated with forage quality, which means that comparison between countries is not relevant. Permanent ryegrass has been grown in Iceland on research farms but on commercial farms it loses yield already on second year and has not proved successful[98].

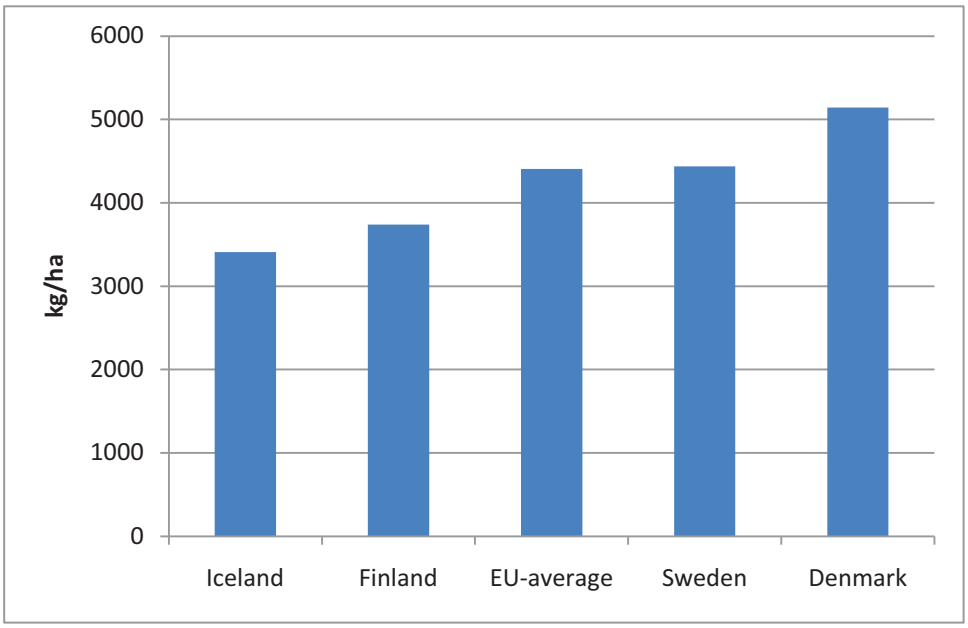

Figure 13. Barley yield in few Iceland[99;100;101], Finland, Sweden, Denmark and EU-average[102]. The numbers are calculated as mean annual yield 2007, 2008 and 2009.

As seen in Figure 13, barley yield in Iceland is approximately 25% below the EU-average. This adds to the fact that harvest time in Iceland is from mid-September to beginning of October, which means large risk of harvest loss and problematic drying of straw.

2.3.1 Pesticides and fertilizer

Due to the nature of Icelandic agriculture, dominated by permanent grass fields, the use of fertilizer and pesticides[9] is very limited. Nitrogen or phosphorus pollution is unknown in Icelandic rivers and lakes and measurements of runoff from fields indicate that runoff is within natural range.[103] As salmon fishing is popular in Icelandic rivers, both farmers and fishers keep a good eye on potential signs for pollution. In general, Iceland has already adopted the Nitrogen Directive through Reg 804/1999[104], although the codes for GAEMS have not yet been constructed.

Table 8 compares the application of nitrogen and pesticides in a range of EU countries both in relation to Utilized Agricultural Area (UAA) and total land mass. For Iceland, "cultivated land" is used in the absence of defined UAA.

Table 8. Pesticide and N-use use in a range of EU countries[105].

Country[10]	Pesticides kg active ingr. /UAA	kg N/ha UAA
Belgium	7,11[a)]	-
Bulgaria	-	82
Czech Republic	-	95
Denmark	1,52[d)]	-
Germany	2,05 [a)]	60
Estonia	0,51[c)]	101
Ireland	0,69[b)]	-
Greece	-	8

[9] The term "pesticide" is here used according to the definition of FAO 2002: http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/Code/Download/code.pdf.
[10] Only countries with data from 2005-2008 were included.

Spain	-	27
France	2,81[c)]	46
Italy	6,39[b)]	31
Cyprus	-	-
Latvia	0,59[c)]	-
Lithuania	-	260
Luxembourg	-	-
Hungary	2,86[a)]	45
Malta	-	-
Netherlands	5,61[c)]	775
Austria	1,07[a)]	-
Poland	0,99[c)]	120
Portugal	4,91[a)]	19
Romania	-	69
Slovenia	2,62[b)]	-
Slovakia	-	114
Finland	0,72[b)]	99
Sweden	0,55[b)]	26
United Kingdom	1,31[b)]	25
Norway	0,70[c)]	454
Iceland	*0,05*[106 b)]	*132*[107]

a) Data from 2005; b) Data from 2006; c) Data from 2007; d) Data from 2008; d) Cultivated land – not including semi cultivated grazing areas.

As can be seen in the table, the pesticide use in Iceland is only one tenth of the use in the member states with lowest usage. Actually, the total pesticide use in Iceland is lower than the average use pr. ha in Belgium and the Netherlands.

Nitrogen use appears relatively high in Iceland but it must be noted that data is not comparable as UAA has not been defined for Iceland. The denominator is hectares of cultivated land, not including semi-cultivated grazing areas, which most likely would be included in UAA. If these areas were included the usage numbers would be approximately ten times lower.

2.3.2 Organic production

In Iceland a total of 36 producers are certified organic, most of them in horticulture[108]. Approximately 1% of the agricultural production in Iceland is certified compared with 4,1% in EU-27 and 4,8% in EU-15[109]. One of the main obstacles for organic production is the provision of nitrogen, as clover has been unreliable in cultivation. Limited supply (and low quality) of straw and saw dust for bedding material proposes another important problem and finally, being very extensive, conventional production is so close to the organic prescriptions that it is difficult for organic producers to demonstrate a sufficient distinction to justify higher product price.

2.3.3 Conclusion

Iceland still has relatively large unutilized potential for crop production, although large part of it can only be used for silage production. Production of barley has been increasing but is still very small compared to imported grain. Icelandic agriculture is mostly pesticide free and the low level of land utilization ensures no fertilizer pollution. However, due to the lack of nitrogen fixating plants (like clover) and some other natural and structural factors, organic farming is not widespread.

2.4 Horticulture

Short growing season and cold climate imposes considerable limitations on horticulture in Iceland. There is no domestic production of fruits, and berries are not grown for commercial purposes. The local production of potatoes is 12.500 tons and is covering 85% of the domestic consumption[110]. More than half of the imported potatoes are "baking-potatoes" as these are not easily grown locally. The vegetable production is primarily cabbage, tomatoes, cucumbers and peppers, of which the cabbage is grown outside but the latter in greenhouses heated with geothermal energy.

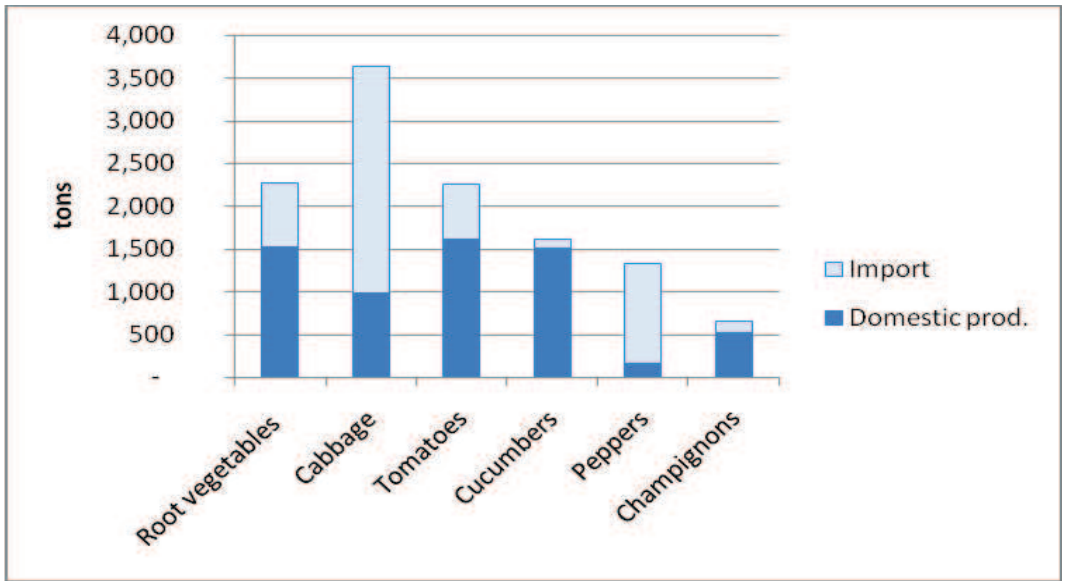

Figure 14. Local production[111] and import[112] of common vegetables. Onions and leeks are not included in these figures as those are entirely imported.

As seen in Figure 14, local production of tomatoes covers 70% of the consumption, cucumbers 95% but peppers only 13%. There is only one Icelandic producer of champignons but he covers 80% of the domestic market.

According to a new study, made by the *Institute of Economic Studies* the horticulture sector will suffer considerable losses if Iceland joins the EU, ranging from 9-21% of total income and the production of flowers would probably terminate.[113] However, according to the report, there are potential possibilities in selected production branches given continuation of governmental support and a period of adjustment.

2.5 Forestry

The Iceland Forest Service (IFS) is a governmental agency founded in 1908. There were no natural coniferous tree species in Iceland (except for Junipers) so "Icelandic forest" consisted almost entirely of low-growing and crooked native birch which, by the start of 20th century, covered less than 1% of the land area[114]. Most of the 20th century, the main tasks of IFS were to protect the remains of the birch woodlands, to search for and import suitable species and to establish new forest areas by plantations. This work has been carried out by the IFS and numerous local forestry societies. By law set first in 1984 and extended in 1991, more effort was put into afforestation on farms. Farm afforestation, supported by state grants under the management of Regional Afforestation Projects now represents 70-80% of the afforestation effort in Iceland. Some of those plantations are seen as important additions to the existing landscape, e.g. in reclamation of degraded and eroded land, while others might become the future resource for timber production. According to the CORINA land cover classification the total forest cover in Iceland accounts for 156.800 ha divided into birch scrub, birch forest, afforested area lower than 2 m (young plantations) and afforested area higher than 2 m (older plantations) (Figure 15). The total forested area covers 3,6% of the Icelandic land area below 400 meters.

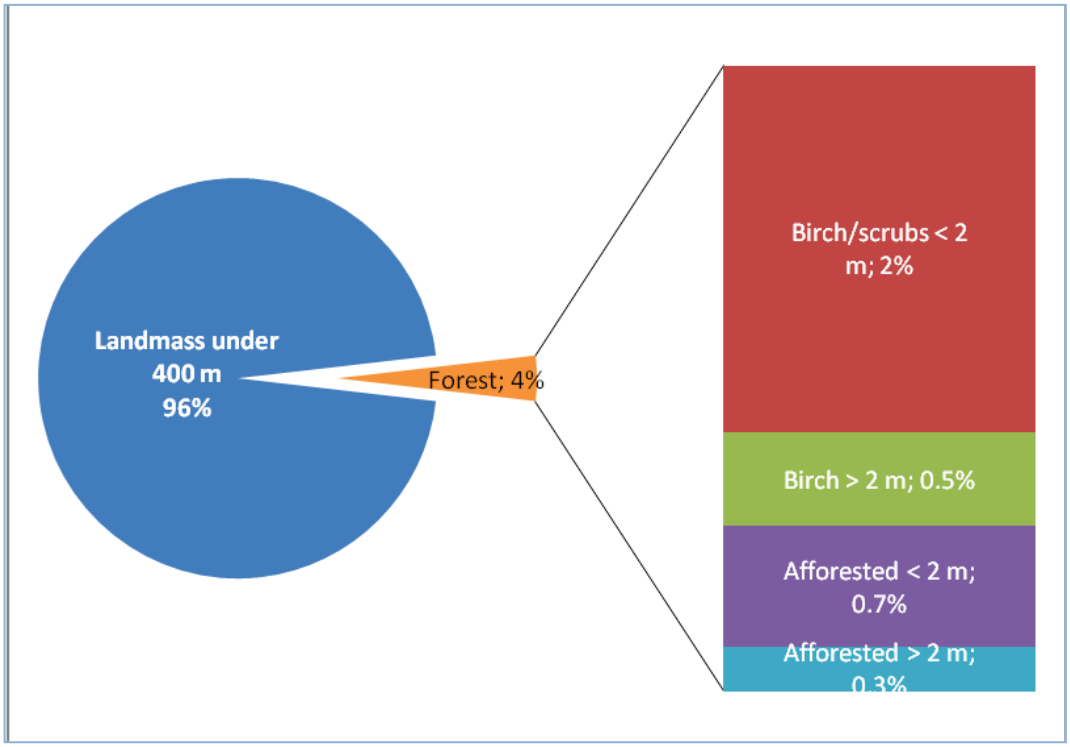

Figure 15. Forested area in Iceland (percentages of total land mass below 400 m; including lakes)[115].

The official goal for afforestation, set in the Regional Afforestation Projects Act of 2006, is to reach a forest cover of 5% below 400 m. At the present level of annual plantation this goal will be reached in approximately 50 years.

2.6 Aquaculture

Aquaculture in Iceland has mainly involved salmon and trout, although recently both cod and halibut have also contributed to the total production. After reaching almost 7000 tons in 2006, the production of salmon fell sharply but is now slowly recovering (Figure 16)

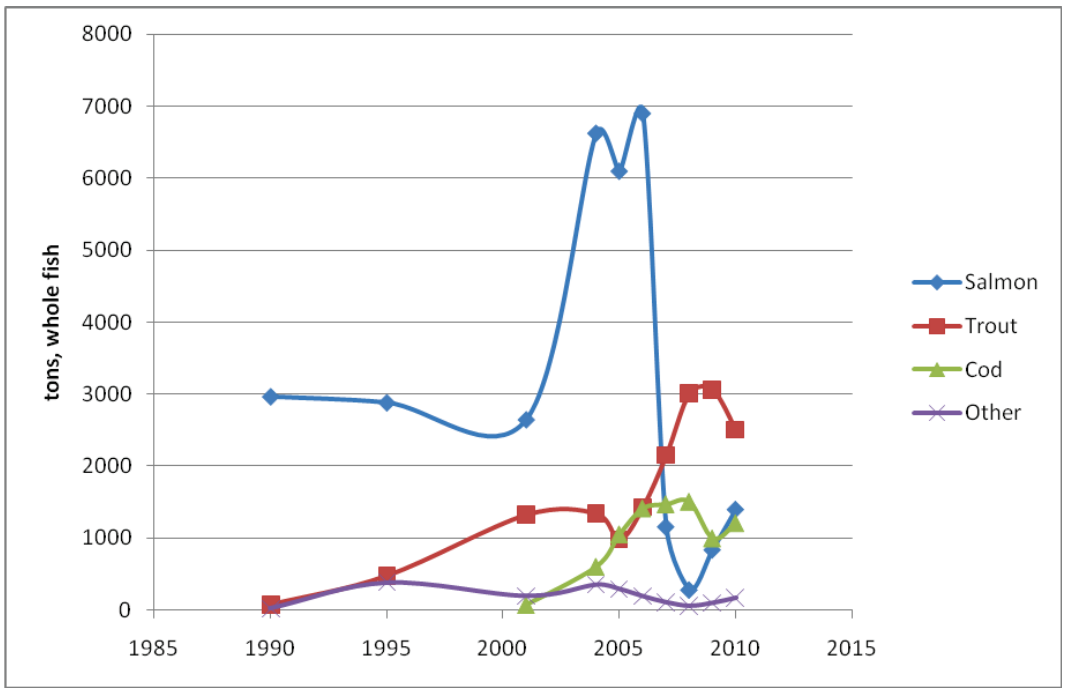

Figure 16. Aquaculture in Iceland (tons, whole fish) 1990-2010 (numbers for 2010 are estimates)[116;117].

Production of trout (*Arctic char*) has increased steadily since at the beginning of the 1990's but cod production is still in an experimental phase. Approximately 50% of both salmon and trout are exported to USA and EU[118].

Despite being relatively unknown in Europe and USA, the Arctic char is mostly exported as fresh fish, receiving high price on foreign markets. Given strategic investment in marketing, there should be a considerable growth potential in this production[119].

3 Final remarks

The general characteristics of climate and natural conditions in Iceland are essentially in line with other northern and mountainous regions in Europe. In Article 50 of Regulation (EC) 1698/2005[120] these regions are defined:

- *Mountain areas shall be those characterised by a considerable limitation of the possibilities for using the land and an appreciable increase in the cost of working it due:*
- *to the existence, because of altitude, of very difficult climatic conditions, the effect of which is substantially to shorten the growing season,*
- *at a lower altitude, to the presence over the greater part of the area in question of slopes too steep for the use of machinery or requiring the use of very expensive special equipment, or*
- *to a combination of these two factors, where the handicap resulting from each taken separately is less acute but the combination of the two gives rise to an equivalent handicap.*
- *Areas north of the 62nd Parallel and certain adjacent areas shall be treated in the same way as mountain areas.*

All of Iceland is north of 62nd parallel and would be categorized as a region with permanent handicap according to EU terminology. This fact – along with the geographical isolation of Iceland – is very important with respect to the competitiveness of the national agricultural production and food security. Table 9 shows the distribution of *LFA-Mountain* UAA in EU27. Only three member states have more than 50% share; Austria (55%), Finland (53%) and Slovenia (53%). This is in sharp contrast with Iceland's 100% share of LFA-Mountain area.

Table 9. LFA mountain area in the EU27 (FSS 2007)[121]

Member state	LFA mountain UAA	In % of total national UAA	In % of total EU area
	(x1.000.000 ha)		
Spain	7,40	30%	28%
Italy	4,30	34%	16%
France	3,99	15%	15%
Romania	2,71	20%	10%
Austria	1,74	55%	7%
Greece	1,53	38%	6%
Finland	1,21	53%	5%
Portugal	1,00	29%	4%
Slovakia	0,66	34%	2%
Czech Republic	0,63	18%	2%
Sweden	0,34	11%	1%

Germany	0,31	2%	1%
Poland	0,27	2%	1%
Slovenia	0,26	53%	1%
Bulgaria	0,24	8%	1%
Cyprus	n.a.	8%	1%
EU27	26,60	15%	100%
Iceland[11]	1,16	100%	4-5%

When all agricultural land is categorized with permanent handicap as LFA-Mountain, it follows that the production is in general less competitive than agriculture in more favourable natural conditions. The results presented in the present report support this general assumption. Icelandic agriculture faces many challenges, which do not have parallels in most other countries.

Icelandic typography and landscape result in extremely low population density and long distances. The range of potential natural hazards is long and in many ways unique and climate is extremely unstable and not particularly suitable for farming. Devastating epidemics in sheep – and disease transmission through import of cattle, leave Icelandic farmers and regulators extremely sceptical towards the import of live animals or any substances that might transmit diseases. This and a widespread interest in protecting the unique animal breeds of Iceland mean that all husbandry animals are less productive than most of the common breeds in other countries. In some cases the difference may equal a few years of genetic improvement but in other cases there might be a time lag of decades. Most of Icelandic farm land is used for silage production and barley is the only grain produced commercially. Barley yield is low and risk of harvest failure high.

As described above, Icelandic agriculture is formed and constrained by difficult natural conditions. Despite the fact its products are of high quality and agriculture is conducted with virtually no use of pesticides or herbicides, using mainly unique and vulnerable domestic breeds. The permanent handicaps will, however, always make agriculture difficult and less profitable than more industrialized agriculture in favourable production areas. It is therefore evident that in order to maintain agricultural production in Iceland, these handicaps will have to be taken into account when formulating an agricultural policy suitable for such a small scale arctic agriculture.

[11] UAA has not been defined for Iceland. The number used is based on size of cultivated land.

4 References

[1] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=reg_d2jan&lang=en
[2] http://en.wikipedia.org/wiki/List_of_countries_and_outlying_territories_by_total_area
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