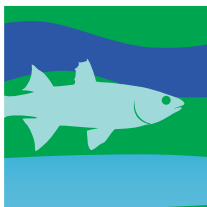
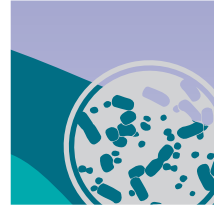


COUNTRY REPORTS



THE STATE OF **DENMARK'S**
BIODIVERSITY FOR FOOD AND
AGRICULTURE

This country report has been prepared by the national authorities as a contribution to the FAO publication, *The State of the World's Biodiversity for Food and Agriculture*. The report is being made available by the Food and Agriculture Organization of the United Nations (FAO) as requested by the Commission on Genetic Resources for Food and Agriculture. The information in this report has not been verified by FAO, and the content of this document is entirely the responsibility of the authors, and does not necessarily represent the views of FAO, or its Members. The designations employed and the presentation of material do not imply the expression of any opinion whatsoever on the part of FAO concerning legal or development status of any country, territory, city or area or of its authorities or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed by FAO in preference to others of a similar nature that are not mentioned.



**Ministry of Environment
and Food of Denmark**
The Danish Agrifish Agency

Denmark's Report for the State of the World's Biodiversity for Food and Agriculture

December 2016

Background

In 2007, the Food and Agriculture Organization of the United Nations (FAO) initiated the preparation of the first global report on *The State of the World's Biodiversity for Food and Agriculture* as requested by the FAO Commission on Genetic Resources for Food and Agriculture. The report on *The State of the World's Biodiversity for Food and Agriculture* is to provide an integrated description on the state of plant, animal, forest and aquatic genetic resources for food and agriculture.

In 2013 FAO invited the countries to prepare a new Country Report on their state of biodiversity for food and agriculture as a contribution to the preparation of *The State of the World's Biodiversity for Food and Agriculture Report* to be presented in 2017.

Description of the chosen report form

The electronic questionnaire that was prepared by FAO to collect national data as each country's contribution to *The State of the World's Biodiversity for Food and Agriculture Report* is only filled out regarding identified production systems in Denmark. Whereas the present report refers to these production systems throughout the report representing information on the status and trends of biodiversity for food and agriculture, including animals and plants and partial of forest, aquaculture and fisheries. The report is thus based on the questions in the electronic questionnaire and the annex refer to the recommended scope of the Country Report set up in the Guidelines for the preparation on the Country Reports for *The State of the World's Biodiversity for Food and Agriculture*.

The Danish Agrifish Agency under the Ministry of Environment and Food has been the national focal point coordinating the preparation of Denmark's country report.

Denmark, December 2016.

Graphics: The Danish Agrifish Agency

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1. Introduction to Denmark and the role of biodiversity for food and agriculture

1.1 General overview of the country

1.1.1 Land area

Denmark is a Nordic country in Europe and a member state of the European Union. Denmark consists of the peninsula, Jutland, and many islands, most notably Zealand, Funen, Lolland, Falster and Bornholm, as well as more than 400 minor islands. Denmark covers a total area of 43,100 km² (43,100,000 ha), with about 7,500 km coastline. Denmark is a relatively flat and low-lying country, and the highest point in the country is no more than 173 m above sea level.

The Faroe Islands in the North Atlantic and Greenland, which is part of the North American continent, is also a part of the Kingdom of Denmark. But they are not included in this country report of Denmark as they both have autonomous self-rule (extensive home rule), and the two countries are not members of the European Union.

1.1.2 Climate

Denmark has a mild and temperate climate (See definition in Annex 1, Table 1). The country falls into two biogeographical zones, the Continental to the east and the Atlantic to the west. Denmark has four seasons which means warm summer days, colorful autumns, green springs and cold, snowy winters. It rains or snows every second day (during the wintertime it snows seven days a month). Within the year, the average temperature ranges from 0°C in January to 16°C in August with considerable variation. The average annual rainfall, measured between 1961 to 1990, is 712 mm, ranging from 500 to 900 mm.

1.1.3 Human population

The total population is 5.6 million inhabitants and approximately 130 inhabitants per km². This means that it is densely populated. About 30 % of the population lives in rural areas (European Commission, 2015). Life expectancy of women are 81.9 years and of men 78.0 years (Danmarks Statistik, 2014). Especially the areas far away from the biggest cities (more than 45,000 inhabitants) and the smaller islands have had a negative population growth.

1.1.4 Land use

Denmark is among the most intensively cultivated countries in Europe. The agricultural land is covering approximately 62 % of the area (See Figure 1). Farms manage 2,632,947 ha of cultivated land (Danmarks Statistik, 2015). Over 90 % of this utilized agricultural area is arable land characterized by intensive and specialized production. The agricultural land consists of cultivated fields, permanent crops and permanent grassland.

The rest of the country consists of approximately 14 % forest, 9 % open semi-natural areas such as coastal and non-coastal cover (heaths, meadows and bogs), 2.5 % lakes and streams, 2.5 % small biotopes in the agricultural land (non-cultivated habitats, e.g. fences, boundaries, dykes, roadways, ditches and barrows), while cities, roads and other infrastructure pose approximately 10 % of the land (Figure 1).

The open semi-natural areas of which part of these areas have been protected for many years from active damage under the Nature Protection Act. This, however, does not prevent these areas from invasion by unpalatable grasses or scrub as a result of reduced management by grassing or cutting (Brink *et al.*, 2012).

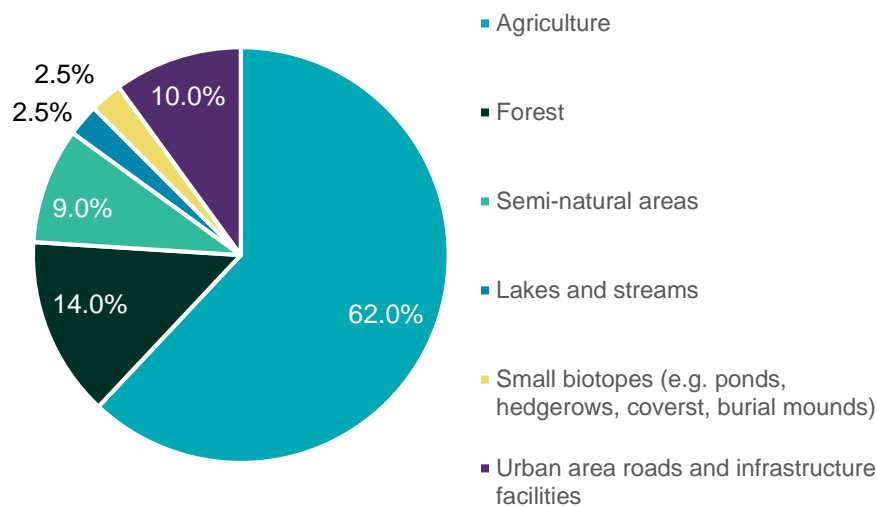


Figure 1: Land use in Denmark 2012 (%) (Lundsgaard *et al.*, 2016).

1.1.5 Agriculture

Between 1920 and 2015, the agricultural area has decreased from 3.2 million ha to 2.6 million ha (Danmarks Statistik, 2016).

The production in Danish agriculture is concentrated on fewer farms because of the structure development with a 3 % of decline of farms per year during the period 1990 to 2011 *i.e.* from 79,000 farms to 40,660. In 2015, the number of farms was 36,637. However, while the number of farms are decreasing the size of the remaining farms are increasing and becoming more specialized, *e.g.* only a few farms have mixed types of livestock. In 2014 only 1.8 % of the farms had both pigs and cattle.

The average size of farms has increased from 35 ha in 1990 to above 67 ha in 2013. However, the activity has not decreased correspondingly thus the production of cereals was 18 % higher in the period 2010 to 2014 compared to the period 1983 to 1987. Also the number of cattle decreased with 40 % but at the same time the production of milk from cows is doubled. Thereby, the production of milk is maintained at the same level.

Today 82 % of the agricultural area is cultivated with feed for livestock in the form of cereals, maize, beets, rape, whole crop and grass. 9.5 % of the area is used for growing food for humans like cereals, potatoes, sugar beets, vegetables, fruit and berries. The most important cereals in Danish agriculture are wheat, rye, barley and oats in that order. The rest 8.5 % is grown with rape for biodiesel, grass seeds, Christmas trees, industrial potatoes, flowers or uncultivated. In the horticultural sector the number of growers and the area with berries is declining. Whereas the area with outdoor vegetables is increasing (Figure 2).

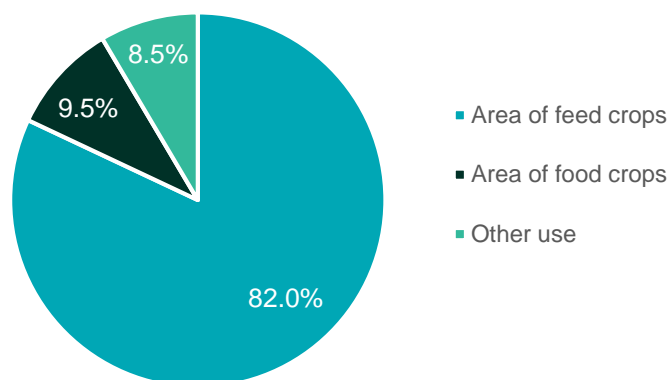


Figure 2: Distribution of agricultural area 2014 (%) (Lundsgaard *et al.*, 2016).

The economy within the Danish agricultural sector in general has been and still is under pressure these years. Generally, during the last decade the earning has decreased, the productivity is stagnant and the competitiveness is under pressure. In agriculture and horticulture the gross investment fell with 48 % from 2007 to 2012. Similarly, within the cattle and pig sector missing investments and stalled structure development are seen, which among other factors, are because of high debts on agricultural holdings (Miljø- og Fødevareministeriet, 2015 / 2016). Farmers are also facing difficulties in relation to the increasing requirements of environmental regulation that impinge the primary production as well as increasing level of costs (European Commission, 2015).

The main policies regulating the agricultural landscape in Denmark are based on European Union policies and national policies. The Danish Rural Development Programme (RDP) has recently been adopted by the European Commission for the period 2014 to 2020. The overarching objective of the Rural Development Programme is achieving green conversion and green jobs. Denmark has chosen to address this mainly via ensuring the sustainable management of natural resources and environment action. Denmark aims to improve biodiversity, water and soil management with environmental friendly management practices, by changing the use of land to more environmental and climate friendly practices, for example by increasing the area of organic farming. Also to foster competitiveness of the agriculture sector further, priority is given to investments contributing to environmental objectives. Additionally, support will be given to restructuring of the pig and cattle sectors, which have faced a low level of investment in recent years. Innovation as a cross-cutting objective is an integral part of the Rural Development Programme. It plays an important role in linking the highly prioritized environment objectives with the competitiveness of the agri-food sector, business in rural areas, and balanced territorial development contributing to the creation of 'green jobs'.

Often agriculture in Denmark is described as family farms, indicating that the farmer and one or more members of the family is taking part in the work at the farm. In 2013, 38 % had either the spouse of the farmer or another family member working at the farm. Especially on farms with poultry or pigs but also other livestock farms a member of the family of the farmer is employed.

Traditionally, men have dominated farming in Denmark. This is still the reality in 2013 with 73 % of men and 27 % of women working within agriculture. Half of the women are wives of the farmers, furthermore 80 % of this group of women work part time in agriculture. More than half of the men are working full time. Within pig production and nurseries more women are working fulltime

with respectively 55 % and 65 % (Danmarks Statistik, 2015). Only every seventh woman working within agriculture is an independent farmer or manager. In 2016 an increase of young people applying for education within agriculture has been observed. Almost no differences are observed between non-organic and organic farms when it comes to employment of a member of the family at the farm (Danmarks statistik, 2015). The average age of the Danish farmer has been increasing from 47 years in 2002 to 49 years in 2011.

Regarding beekeepers the number of female beekeepers are increasing from 11 % in 2006 to 18 % in 2011 and may still be increasing.

1.1.6 Forest

Many years ago, most of Denmark was covered with forest. However, around year 1800 only 2-3 % of Denmark was covered with forest after years of uncontrolled chopping and clearing areas for ship- and building materials, firewood and agriculture. In 1805 a forest legislation, was adopted and since then it has been illegal to clear forest areas in Denmark. Further, there has been an effort to plant more forest.

Thus the area with forest has increased in the period between 1920 and 2015 from 420,000 ha to 615,000 ha (Danmarks statistik, 2016). Compared with EU having a total forest area of about one billion ha in 2011, Denmark is among the minor forest countries. The forest area covers 14.3 % of Denmark, where most forest is found along the high ridges in Jutland, in the Northern Zealand and Bornholm (SVANA).

39 % of the total forest area in Denmark is conifers, where 42 % consists of broadleaves and the rest are mixed plantation, unplanted areas or areas where the trees are not identified yet (Figure 3). Conifers were imported to Denmark for about 200 to 300 years ago, where broadleaves are a local species.

Forestry contributes to the Danish economy with 2.1 billion DKK.

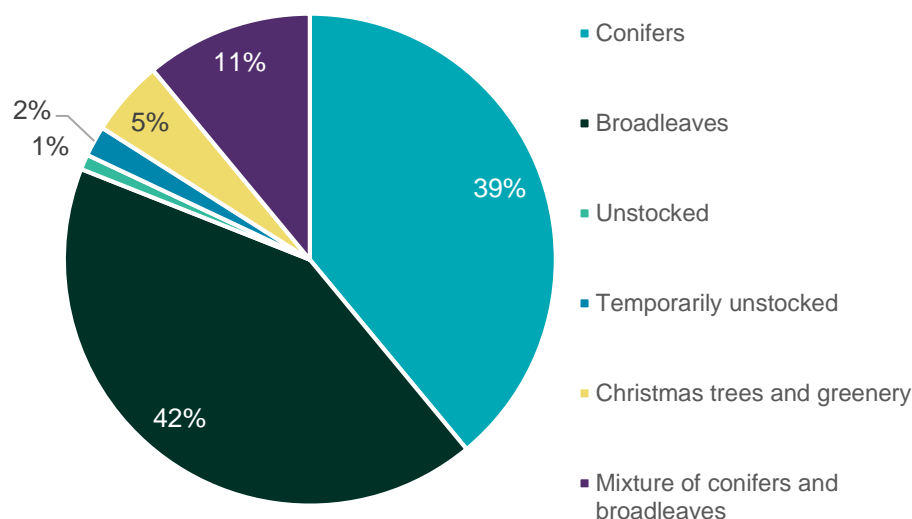


Figure 3: Distribution of forest area in 2014 (Nord-Larsen *et al.*, 2015).

1.1.7 Aquaculture and Fisheries

Denmark has a coastline of 7,314 km and a total water area of 700 km², where protected lakes of an area above 100 m² are constituting 64,524 ha. Further, there are 69,000 km of streams.

The marine waters are both part of the North-East Atlantic Ocean and the Baltic Sea regions. There are almost 200 species of marine fish in Denmark. Many species are captured by sustainable methods, but there are still some challenges to ensure that all fish are captured by sustainable methods and to secure a profitable business in the long term.

In 2011, the Danish fishery fleet consisted of 2,787 registered vessels which captured around 716,000 t fish equivalent to a turnover of around 3.2 billion DKK.

The Danish aquaculture production mainly includes rainbow trout kept in freshwater. In 2013, Denmark represented 12 % of the EU's total volume of fishery and aquaculture production. The Danish aquacultural sector is leading in use of recirculating technologies that contribute to a reduction of nitrate, phosphor and organic material emission per produced fish.

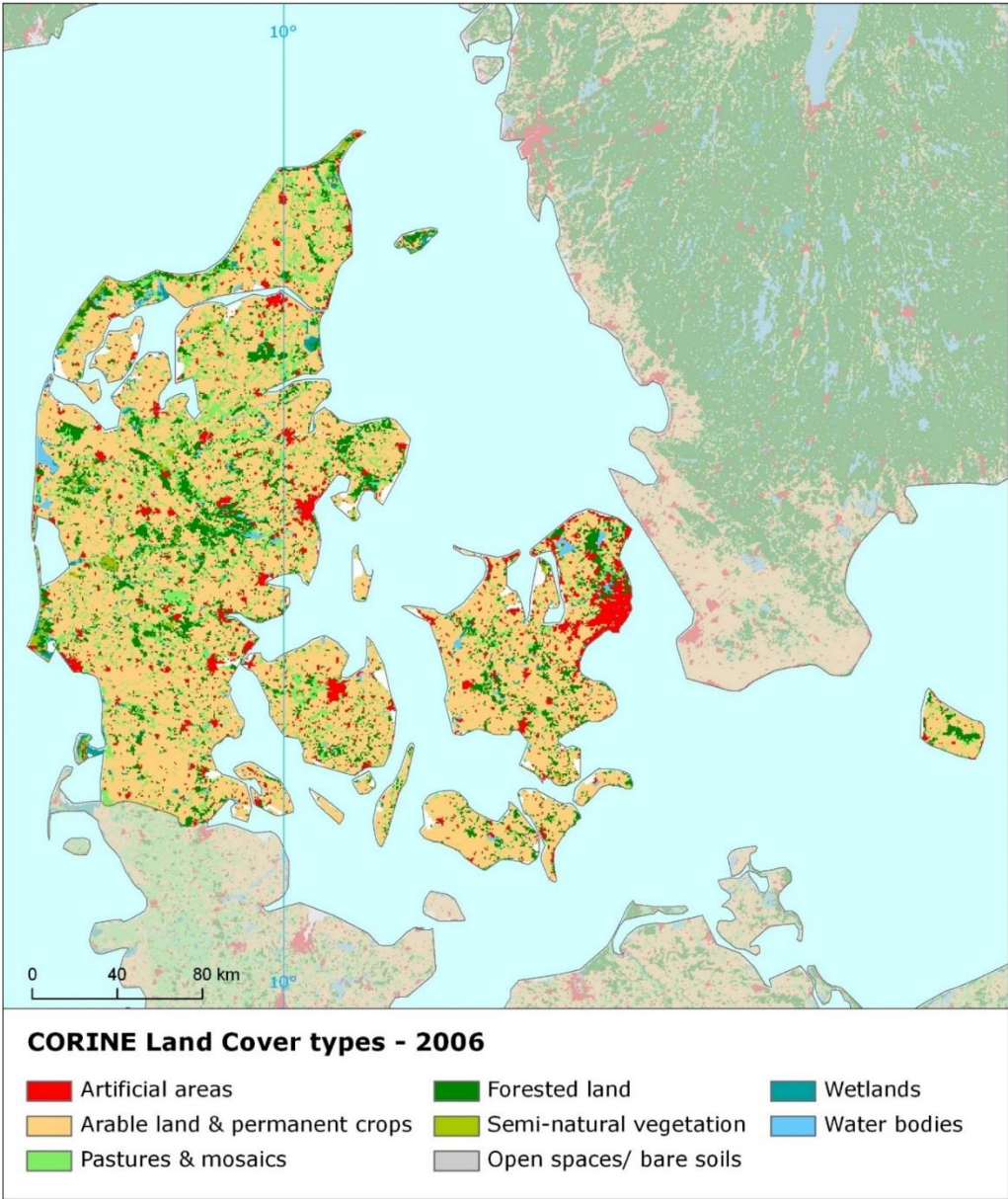


Figure 4: Land use (European Environment Agency 2006, <http://www.eea.europa.eu/da>).

1.2 Production systems in Denmark

1.2.1 Description of production systems in Denmark

Table 1: A brief description for each of the production systems identified as occurring in Denmark as described in Annex 1.

Sector	Code	Name of Production system	Description
Livestock	L3	Livestock grass-land-based system	Organic production and production systems where animals have access to outdoor areas. Pigs/porks Cattle Beef cattle Poultry Sheep Goats Horses
	L7	Livestock Land-less systems	Livestock production are separated from areas where forages are produced. Pigs/porks Cattle Fattening calf Poultry Fur animals
Forest	F3	Naturally regenerated forests	Naturally regenerated forests both includes primary, modified natural and semi-natural forests.
	F7	Planted forests	Planted forests both includes semi-natural forests and plantations that are productive and protective.
Aquaculture and Fisheries	A3	Self-recruiting capture fisheries	Capturing fish in marine, coastal and inland areas.
	A7	Culture-based fisheries	Fish are released into lakes and streams to increase population. Carp
	A11	Fed aquaculture	Trout Eel Salmon Perch Pike perch
	A15	Non-fed aquaculture	Fish that does not need to be fed (Blue mussels, oyster).
Crops	C 7	Irrigated crops (other)	Specific agricultural areas may purposely be provided with water in the growing season during dry years.
	C11	Rainfed crops	Agriculture practice relying exclusively on rainfall as its source of water. Arable crops for agriculture (Cereals, potatoes, sugar- & fodder beets, grass & green fodder silage, <i>i.e.</i> maize) Arable crops for horticulture (vegetables, fruit, berries)
Mixed	M3	Mixed systems	Production systems that are a combination of livestock, crops, aquaculture and/or forest.
Others	O1	Other	Horticulture under glass: vegetables and flowers Production of honey

1.2.2 Livestock

In Denmark livestock grassland-based systems include pigs, cattle, horses, sheep, goats and poultry (Danmarks Statistik), which are kept on outdoor areas. Part of the animals are for organic production, others are kept at indoor systems with access to outdoor area. Livestock landless systems includes pigs, cattle, sheep, goats, poultry and mink. Landless systems mainly keep the animals at indoor systems and are separated from areas where forages are produced.

Most of the livestock is raised in Jutland (Figure 5).

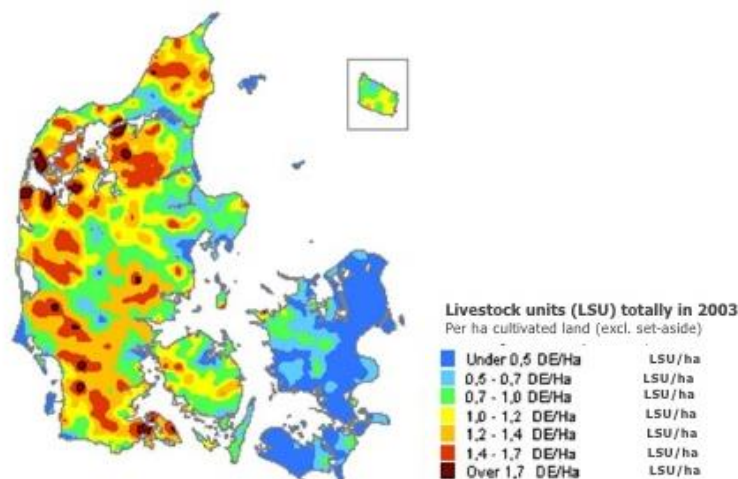


Figure 5: Distribution of livestock units in 2003 (Aarhus Universitet, 2011).

Today farmers are obliged to have land for spreading manure. However, future environmental regulation aims at targeting regulation according to how much the livestock production systems are putting on pressure on the surrounding environment. Most of the animals are kept at indoor systems, but over the last ten years, more systems have included seasonal outdoor areas. The animals are fed on forages, which might be produced at the farm or obtained from larger feed companies.

1.2.3 Forest

The forest area in Denmark includes both naturally regenerated and planted forests.

1.2.4 Aquaculture and fisheries

The Danish aquaculture and fishery are generally based on self-recruiting capture fisheries and fed aquaculture. Within fed aquaculture Denmark produces trout, eel, salmon, perch, pike-perch and carps. Also culture-based fisheries are used to increase population and further non-fed fisheries are used to generally produce blue mussels.

1.2.5 Irrigated crops

In the Western part of Denmark, in Jutland, sandy soils may be irrigated during extremely dry periods. 9,000 farms have access to irrigating which is equal to around 17 % or around 450,000 ha of the agricultural land (Miljø- og Fødevareministeriet, 2015 / 2016). Traditionally, seen from an economic point of view potatoes have been able to pay for investment in an irrigation system while a stable production of roughage and horticulture (vegetables) access to irrigation is also essential.

1.2.6 Rainfed crops

In general in the Danish climate the amount of rainfall suffices the crops to reach their potential maximum growth during the growing seasons.

1.2.7 Mixed systems

A minor number of Danish production systems consists of a combination of livestock, crops and forest land, i.e. in mixed systems. This is mainly found at manors or castles.

1.2.8 Others

In Denmark, some vegetables and flowers are produced within horticulture under glass.

1.3 Importance of production systems

In Table 2 numbers are taken from Denmark's statistic.

Production system		Area (Value and Unit)	Production quantity (Value and Unit)	Contribution to the agricultural sector economy (%)	Refer- ence year
Sector	Code				
Livestock	L3		Milk and dairy products: 1,084,000 t Beef meat: 133,000 t Pork meat: 1,718,400 t Sheep meat: 1,500 t Poultry meat: 186,300 t Eggs: 62,400 t Fur from mink: 17.2 million furs From organic production: Milk, cheese and eggs: 156,406 t Beef meat: 2,034 t Pork meat: 1,099 t Poultry meat: 715 t Eggs: 10,315 t		All num- bers from 2012 (Mink from 2015) All num- bers from 2015
	L7				
Forest	F3 F7	Total forest area: 615,000 ha	Forest area consists of: Conifers: 240,577 ha Broadleaves: 258,046 ha Mix of conifers and broadleaves: 67,080 ha	2.1 billion DKK	2014
Aquaculture and Fisheries	A3		Fish, crustacean and bivalve: 700,128 t 44,199 tons of fish produced Blue mussels: 1,810 t	3.2 billion DKK (in 2011)	2015
	A7 A11				2013
	A15				2014
Crops	C7 C11	2,620,000 ha 35,000 ha	Cereals: 9,471 million kg Christmas Trees: 10 million trees per year	Export of 1.5 billion DKK	2015 2010
Mixed	M3				
Others	O1	440.7ha 1,051 ha	Salad: 561 t Tomatoes: 10,575 t Cucumber: 19,506 t Strawberries: 4,624 t, Honey	67 million DKK Around 1 billion DKK extra from pollination. 100 million DKK on honey.	Area from 2014 Others from 2015

1.3.1 Livestock: Animal genetic resources for food and agriculture

Farms with animal production in Denmark have changed from many small farms with different types of animals towards fewer but larger farms where farmers are mostly specialized within one type of animal (Danish Agriculture and Food Council, 2012).

High performance and modern livestock breeds have been introduced at the expense of traditional and national livestock breeds to enhance productivity and ensure supply the ever expanding food industry.

In 1920 the number of horses was 600,000 and has fallen with more than 90 % due to the replacement with tractors and other machines. The number of sheep were 188,000 and has decreased to around 70 % (144,418 heads in 2015). Today the number of cattle is 2.9 million reduced with almost 40 %. Cattle are more frequent in Jutland compared to the rest of the country.

In 1980 the majority of the dairy cattle was grassing in the summertime. This gave an average yield of 6 – 8,000 Feed units (grass-) roughage per ha. Today the majority of Danish dairy never leaves the stable and thus is fed with roughage as maize- and grass silage, with an average crop yield of 8 – 11,000 Feed units per ha. Thus the Danish dairy sector is steady growing in productivity.

Since 1920, the production of pigs has increased. Between 1995 and 2014 Danish farmers have increased the number of pigs with 1.2 million more pigs. The total number of pigs in Denmark was in 2015 12,645,000 (Danmarks Statistik, 2015). This give an output of 12 million piglets for export and 19 million pork for slaughter (Landbrug & Fødevarer, 2016). However, while the pig production has increased the amount of farms keeping pigs have decreased from 7,842 to 3,769 during the last 20 years. The pigs are mostly fed on barley or wheat and further supplemented with protein source from soya- and canola cake.

In 2014 120 million broilers were produced in Denmark (Danmarks Statistik, 2014). The production of broilers are kept in few systems. In all non-organic systems the line Ross 308 is used. The amount of non-organic farmers producing broilers has decreased from 227 farmers in 2012 to 217 farmers in 2015, where the organic farms producing broilers have increased from 16 farmers in 2012 to 19 farmers in 2015 (Det Danske Fjerkræraad, 2015).

Beside the production of broilers, turkeys and ducks are also kept in Denmark. In 2015 around 0.6 million turkeys were produced. The production of ducks in Denmark in 2015 were around 400,000 heads, where 180,000 ducks were from organic production.

The demand for cage eggs has been decreasing among Danish consumers while the interest for eggs from alternative production systems has increased. The amount of cage egg systems has therefore decreased from 39 farms in 2012 to 25 farms in 2015, together with the barn egg production that decreased from 47 farms in 2012 to 38 farms in 2015. Free range production has increased from 18 farms in 2012 to 19 farms in 2015 and the organic egg production has increased from 66 farms in 2012 to 82 farms in 2015 (Det Danske Fjerkræraad, 2015). In 2012 62,400 t of eggs were produced.

Denmark is the world leading country regarding production of mink fur. Fur from Denmark is among the most expensive on the market, which is because of their great quality (Kopenhagenfur homepage). In the last five years (2010 to 2015) the amount of farms keeping mink has been stable around 1,400 farms (Danmarks Statistik). In 2015, there were 3,388,367 minks in Denmark (Danmarks Statistik, 2015) and each year 17.2 million furs from mink are produced together with a small amount from fox, chinchilla and rabbits (Kopenhagenfur homepage).

In 2015 the total organic production area was on 179,808 ha. In Figure 6 the development in the organic production area is shown from 1989 till 2015. Today most of the organic area is primarily placed in the Southern, Middle and Western part of Jutland as well as in the Northern part of Zealand. The number of organic farms has during the last ten years been stable of about 2,600 farms. The number of organic livestock increased from 2,040,616 pieces of livestock in 2014 to 2,646,566 livestock in 2015, which is mostly caused by higher amount of organic poultry production. In 2015, organic systems included 157,527 cattle, 260,510 pigs and 2,216,589 poultry (Danmarks Statistik, 2015).

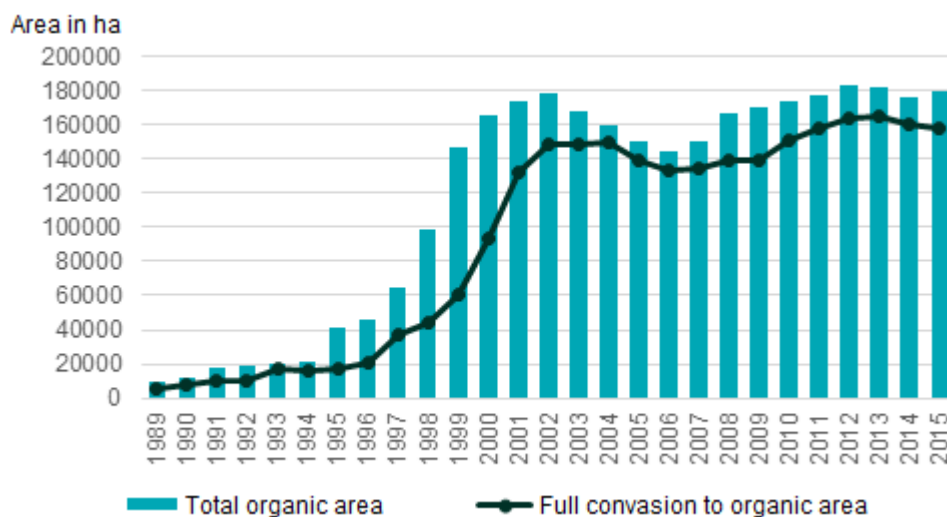


Figure 6. Development in the organic production area from 1989 to 2015 (NaturErhvervstyrelsen, 2016).

1.3.2 Crops: Plant genetic resources for food and agriculture

Today around 40 different species are cultivated as food and feed crops on the production area on 2.6 million ha.

Grasses, green fodder and fodder beets have declined in importance whereas a growing share of the land is cultivated with cereals and maize. From the mid 1980's the area with wheat increased significantly. The harvest of cereals per hectare has tripled from 1920 till today. The highest increase concerns rye. The harvest per hectare of potatoes and sugar beets has more than doubled in the same period. Fodder beets have almost disappeared in Danish agriculture and have been replaced by other fodder crops, especially maize. About 70 to 85 % of the cereals are used as fodder, until the 1950's also to horses to considerable extent. Thus, the composition of crops has changed during the years, which is essentially economically driven, *i.e.* shaped by the demand behavior of the commerce and consumers.

Cereals, *i.e.* wheat, barley, rye, oats and others like triticale and maize, are the most important cereals in Danish agriculture. The cereals cover 55 % of the agricultural area in 2015. The application for cereals has different purposes. A considerable amount of the cereals is exported, around 17 % of especially barley (for malt production) and wheat. Usually Denmark has a higher export than import of cereals. The remaining production of cereals is used for industrial purposes for food for consumption and as seeds for sowing in the coming year.

The area of maize has been increasing since 1980 from a few hundred ha to around 200,000 ha. The majority of maize harvested is used as silage and only a minor area is used for kernel harvest.

Primary root crops grown in Danish agriculture are potatoes, fodder beets and sugar beets. Today the area of root crops has decreased because the number of livestock has decreased and also because these crops have been replaced by e.g. maize and whole crops.

1.3.3 Horticulture

The number of farms within horticulture has since 2002 to 2011 decreased to around half. The total number of farms are in 2011 about 395 where more than half of these have green houses that are 20 years old or more (Danmarks Statistik 2011).

Most of the vegetables, fruit and flowers produced as horticulture under glass are found in the southern part of Jutland and Funen. More than half of the total area used for greenhouses is used for potted plants to ornamental use (Danmarks Statistik, 2014) (Figure 7).

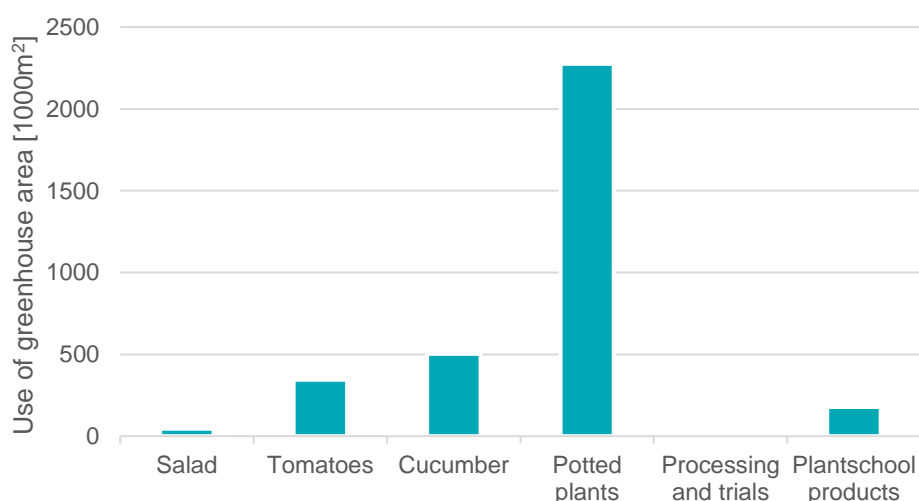


Figure 7: Use of greenhouse areas in Denmark 2014 (Danmarks Statistik, 2014).

The production of salad and tomatoes under glass has decreased from 2,808 t and 19,696 t in 2002 to 1,165 t and 13,241 t in 2011, where the production of cucumbers has increased from 14,962 t in 2002 to 18,237 t in 2011 (Danmarks Statistik).

1.3.4 Forest genetic resources

Denmark uses more tree than locally produced. Every year 4.3 million m³ of wood are used in Denmark, but only 2.4 million m³ are locally produced each year, where the remaining part are imported from especially neighbor countries (SVANA).

Chopping of trees in the Danish forest increased with 3 % from 2014 to 2015, which are caused by an increased production of energy wood, that are mostly used in power plants. The increase in production of energy wood over the last four years (2011 to 2015) can be explained by a political goal towards more energy coming from biomass. Therefore, the demand for Danish power plants on energy wood has increased (Danmarks Statistik).

Chopping of trees used for furniture and paper decreased with 6 % from 2014 to 2015. Since 1970 the employment within forestry has increased from 4,315 people to 5,890 people in 2014 (Danmarks Statistik).

1.3.5 Fisheries and Aquaculture genetic resources for food and agriculture

Denmark accounts for 12 %, equal to 700,128 t of EU's total volume of fishery and aquaculture production in 2013 (Danmarks Statistik, 2016). Fishing accounted for 95 % of the production and the remaining 5 % related to aquacultural production of fish etc. for human consumption

(Danmarks Statistik, 2016). The large volume of Danish fishery production emerges mainly from lower priced industrial fishery for fish meal. The Danish share of the EU total value was 6 %.

The employment within fishery has decreased from 10,991 in 1970 to 2,574 in 2014 (Danmarks Statistik). From 2003 to 2011, the total amount of vessels in Denmark was reduced with a number of 782, and among these 545 vessels were active.

In 2013, Denmark produced 44,199 t of fish, where the main produced species were trout. Rainbow trout have highest value of importance within Danish aqua culture (Figure 8). In 2012, Denmark produced 41,000 t of rainbow that had a value of 138 million euros (Fødevareerhvervet Danmark, 2015).

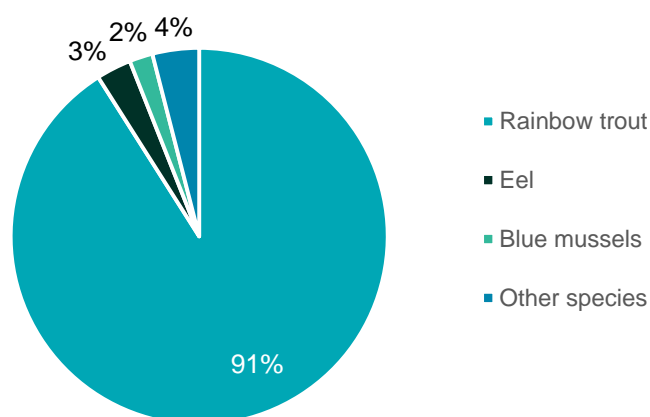


Figure 8: Production of fish in 2012. (Fødevareerhvervet Danmark, 2015)

Production systems within fed aquaculture includes fish farms and marine aquaculture, where mostly trout and salmon are produced. Fish farms are mostly placed in Jutland. In 2014, there were 177 fish farms, 21 marine aquaculture facilities and 11 facilities producing mussels. Production of blue mussels are an almost new type of production in Denmark. Normally they are harvested by scraping the ocean bottom at shallow water.

The Danish fishery are regulated through an EU common fishery policy and national legislation. A set of rules for the organic fish production in Denmark were agreed in 2004. In 2015 there were totally 23 aquaculture facilities which were converted to organic production, divided on 10 fresh water fish farms (produce about 850 t/year), 2 marine aquaculture facilities (produce about 225 t/year), 9 line mussel facilities (produce about 3000 t/year), 1 seaweed facility (produce about 1000 t/year) and 1 crayfish facility (Danish aquaculture homepage).

1.4 *Ex situ* and *in situ* conservation

1.4.1 Regional Work on Conservation and use of genetic resources

NordGen is a Nordic organization dedicated to the safeguarding and sustainable use of plants, farm animals and forests. The Nordic countries have been co-operating for more than 30 years on conservation of genetic resources. Until 2008, the Nordic Gene Bank was only active with the domain of plant genetic resources but since then NordGen was established as a result of a merger between the Nordic Gene Bank, the Nordic Gene Bank Farm Animals and the Nordic Council for Forest Reproductive Material.

1.4.2 NordGen Plants

NordGen Plants works with conservation and sustainable use of cultivated plants and their wild relatives. This includes both conserving the seeds *ex situ*, supplying researchers and others with seeds and their data as well as general information work about the value and importance

of plant genetic resources. In Denmark's country report from 2009 (Ministry of Agriculture and Fisheries, 2009) on the state of plant genetic resources for food and agriculture the close collaboration and coordination between the Nordic Genetic Resource Centre (NordGen) and the Danish plant genetic resources programme is presented as being essential to the national conservation and use of food and feed crops and their crop wild relatives. NordGen is thus responsible for the conservation of Danish seed propagated crops and potatoes. This includes the respective administration of documentation and database systems covering all Danish agricultural and horticultural crops, including material of vegetatively propagated material conserved in national field genebanks. The seed material in NordGen's collection is accessible to all, e.g. breeders, scientists, farmers and gardeners. Relevant material is included under the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture.

A survey of crop wild relatives growing *in situ* in Denmark has been elaborated (Bjørn *et al.*, 2011). Each species is described by its location and recommendations on management especially for the rare and endangered species and has been followed up by seed collections stored in NordGen's *ex situ* collection.

1.4.3 Activities in Denmark on Plant Genetic Resources

In Denmark the Danish Agrifish Agency under the Ministry of Environment and Food coordinates the work with the national programme on plant genetic resources for food and agriculture. Strategy and action plans have been implemented since 2000. A new strategy on plant genetic resources is launched in 2016. Denmark has committed itself internationally through the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture. A Danish Advisory Committee for Conservation of Plant Genetic Resources are in place to assist and advice the Danish AgriFish Agency on matters related to conservation, use and access to plant genetic resources within its territory.

The Ministry of Environment and Food of Denmark supports projects regarding plant genetic resources through national funds.

The Danish national vegetative collections of fruit and berries are maintained within public institutions as the University of Copenhagen, and the vegetatively propagated vegetables are maintained by the University of Aarhus. Conservation, maintenance and use of vegetatively propagated species of Danish origin is a task of the national programme on plant genetic resources.

Crop wild relatives (CWR): In Denmark a survey of crop wild relatives (CWR) were initiated in 2007 and around 450 species of CWR were identified (Plantedirektoratet, 2007). A prioritizing of the list resulted in around 100 species. The species have been localised in different places around the country. For each of the species recommendations to their future conservation have been given (Bjørn *et al.*, 2011). At the time being some of the identified CWR have no actual need for specific attention, *i.e.* as there is no actual significant risk of loss in their original environment, and may therefore continue only to be under *in situ* conservation, though the crop wild relative species it is not growing in protected areas. While other identified crop wild relative species needed backup in *ex situ* collection. Therefore seeds of such threatened species have been collected and stored in the *ex situ* seed collection of the common Nordic genebank, NordGen.

Breeding activities:

Ongoing commercial plant breeding programmes in Denmark today are in place for the following crops:

- Cereals: barley, wheat, oat, rye, and triticale.
- Grasses: bromegrass, cocksfoot, creeping bentgrass, blue fescue, hard fescue, meadow fescue, red fescue, tall fescue, festulolium, Italian ryegrass, Kentucky bluegrass, perennial ryegrass, and timothy.

- Fabaceae: alfalfa, faba beans pea, red clover, and white clover.
- Industrial crops: potato, and oil seed rape.

Micro breeding within agricultural crops, e.g. within oil crops is also in place. Earlier Denmark used to have commercial plant breeding programmes also within vegetables.

Crop Innovation Denmark - from Genes to Seeds (CID):

In Denmark a strengthened close collaboration between universities and industry was established in 2013 to obtain even more targeted research, and innovation within plant breeding. The initiative was taken to secure Danish competitiveness and ability to move forward on the market through innovation and research within plant breeding.

Public Private Partnership for Pre-breeding:

The Nordic countries represent some of the most northern agricultural areas on Earth. A long tradition of plant breeding exist within the countries, which has delivered new varieties and characteristics of crops, specifically adapted to the unique environmental conditions of the high north. Now, much of the global plant breeding is carried out by large multinational companies and a small, unique market like the Nordic countries, can easily be overlooked and neglected. Therefore, a regional Nordic Public Private Partnership for pre-breeding was established in 2011 to strengthen the Nordic collaboration in plant breeding. The goal is to secure the development of Nordic agricultural crops to meet the demands brought about by climate change and consumer expectations for healthy and tasty products, and to contribute to sustainable development of an environmental friendly agricultural sector. Funding is divided equally with 50 / 50 between national public sources and private industry (Nilsson *et al.*, 2016).

1.4.4 NordGen Farm Animals

NordGen Farm Animals is a service and knowledge center for sustainable management of farm animal genetic resources for the Nordic countries. NordGen Farm Animals' areas of activity are conservation of farm animal genetic resources (AnGR) relevant for food production and agriculture, sustainable use of AnGR information and networking as well as international activities. NordGen Farm Animals contributes to the Nordic countries' work by promoting the genetic, economic, cultural, historical and social values of farm animal diversity to meet the needs of future markets, production systems and climate change.

1.4.5 Activities in Denmark on Animal Genetic Resources

The Danish effort on preserving animal genetic resources for food and agriculture is coordinated by the Ministry of Environment and Food of Denmark. Denmark has committed itself internationally through the Convention on Biological Diversity and the Interlaken Declaration on Animal Genetic Resources. Since 1985, a Danish Committee for Conservation of Animal Genetic Resources has existed. A new Advisory Committee was formed in 2013 with a majority of breeders which assists and advises the ministry. The Danish conservation work is concentrated around original or locally adapted breeds, which are at risk of extinction (Generally those mentioned in Table 3). Those breeds are often kept by small-scale farmers.

The Advisory Committee has in 2016 developed a strategy for the period 2016 to 2020, which focus to contribute to preservation work on the long-term perspective (http://naturerhverv.dk/fileadmin/user_upload/NaturErhverv/Filer/Landbrug/Genetiske_ressourcer/Husdyr/Udvalg/Strategi_for_Bevaringsudvalgets_arbejde_med_husdyrgenetiske_ressourcer_2016-2020.pdf).

The Danish gene bank for animal genetic resources contains cryopreserved semen from cattle, pigs, sheep, horses and goats, and embryos from cattle, pigs and sheep. The bull semen are routinely used for breeding, though there are limits for doses on stock and veterinary re-

strictions for elder semen. The Ministry of Environment and Food of Denmark supports breeders, breeders' associations and projects in conservation work through national funds. The conservation work is mainly communicated by the Ministry through the Committee, a newsletter, a yearly meeting for breeders and the homepage for animal genetic resources.

Table 3. Old Danish adapted breeds.

Horses	The Jutland horse
	The Frederiksborg horse
	The Knabstrupper horse
Cattle	The Jutland cattle
	Danish Black and White Cattle, anno 1965
	Danish Red Cattle, anno 1970
	Old Danish Dairy Shorthorn
	Agersoe cattle
Pigs	Danish Black Pied Pig
	Danish Landrace, anno 1970
Sheep	Danish Landrace Sheep
	Marsh sheep
Goat	Danish Landrace Goat
Rabbit	Danish White Rabbit
Poultry	Danish Landrace Chicken
	Danish Landrace Goose
	Danish Landrace Duck
	Danish Jacobin Pigeon
	Danish Suabian Pigeon
	Old Danish Tumbler
Bee	The Nordic Brown Honey Bee
Dogs	Broholmer Dog
	Old Danish Pointing Dog
	Danish/Swedish Farm Dog
	Danish White Spitz

1.4.6 NordGen Forest

The mandate of NordGen Forest is to address conservation and sustainable use of forest genetic resources, by being a forum for researchers, practitioners and managers working on forest genetics, seeds, planting stock and methods for regeneration, and by facilitating the flow of scientific information and knowhow between these groups. The main goal is to contribute to the establishment of the best possible Nordic forests for the future. NordGen Forest serves as a Nordic meeting place to connect people on conferences, thematic days, seminars and meetings, as well as through information and public awareness work. For example a meeting in 2016 was about introduced species in Nordic forestry (NordGen, 2016).

NordGen Forest consists of two units, each with members from all the Nordic countries. One unit is the forest regeneration council for exchange of information on regeneration issues, for discussion on topics of interest for Nordic forestry, and for planning of future events. The other unit is the working group on genetic resources to ensure cooperation in conservation and use of forest genetic resources across the Nordic countries.

2. Drivers of change

Traditionally Denmark has been regarded as a country of agriculture as agriculture covers 62 % of the country area. The agricultural area is therefore of great importance for the production of food and feed and thus influence the different components of associated biodiversity in the environment. However, all production systems in Denmark including crop, livestock, forest, fisheries and aquaculture, expose associated biodiversity to a number of different factors, some of which are shortly described in the following.

2.1 Main drivers of change affecting plant, animal, forest, and aquatic genetic resources for food and agriculture

2.1.1 Changes in land use management

Today farms manage 2.6 million ha of cultivated land a decline from 3.2 million ha in 1920 (See further in chapter 1.1.5).

2.1.2 Pollution and external inputs

Water quality and the status of the Danish water ways are generally quite good and improving. The emissions to the surrounding water environment of nitrogen and phosphorus have been markedly reduced since the beginning of the 1990'ies (Miljø- og Fødevarerministeriet, 2015 / 2016). However, it is necessary to reduce emissions from fertilizers and also from pesticides in order to maintain and further improve the situation. It is a challenge to reduce pressures on nature from intensive agriculture, including the use of pesticides and nutrients. The EU water directive commits Denmark to secure water ways in Denmark with a framework for Community action in the field of water policy.

In a new study the aim has been to improve understanding of and be able to quantify and predict the effects of glyphosate and nitrogen and their interaction on small terrestrial biotopes in the agricultural landscape, *e.g.* hedgerows and field margins. For both vegetation and soil fauna, the effects were assessed at the ecosystem level by measuring biodiversity and functional traits (Damgaard, *et al.*, 2016).

The project has led to an increased understanding of the causal relationship between plant communities and the soil fauna at the ecosystem level and increased knowledge on how and by what mechanisms important drivers that are known to affect plant communities may affect pollination and the soil fauna. The combined use of plant trait and soil fauna trait data in a full-factorial field experiment of glyphosate and nitrogen has never been explored before. The focus on plant soil fauna traits rather than species will enable a more robust description of the ecological processes at the functional level (Damgaard, *et al.*, 2016).

2.1.3 Climate change

Climate change has not yet been observed to have an impact in Danish agriculture, except in a trend of more mais growing. Danish agriculture has an impact on climate gas emission as the sector accounts for 16 % of the country Green House Gas (GHG) emission, such as carbon dioxide, methane and nitrous oxide. Danish farmers are in need of new practical tools to address these emissions stemming from crop and livestock production. The previous Danish Rural Development Programme 2007 to 2013 has supported considerable initiatives to reduce the negative impact of Danish agriculture on nature, climate and environment. The new Danish Rural Development Programme (European Commission, 2015) for the period 2014 to 2020 is putting investments among others in GHG-emission reduction from *e.g.* crop and livestock production

and renewable energy production on farms. Therefore, farm investments of the pig and cattle sectors aim to restructure and improve 3,300 farms, while simultaneously targeting environment, climate and animal welfare. Non-productive investments and changes in land use from arable land to extensive farming areas, as well as environmental efforts in forestry will also be supported. Thus, agriculture and forestry have a considerable role to play for restoring, conserving and improving ecosystems.

2.1.4 Invasive alien species

Invasive alien species is a growing threat to biodiversity for food and agriculture on land and in water, due to their ability to disperse and cause negative effects on native species and the environment. In 2009 an action plan was prepared for invasive species in Denmark which is planned to be revised in 2016 (Miljøministeriet, 2009). The action plan describes problems of invasive alien species and lists a number of recommendations on how to take action against the actual species. The Danish Agency for Water and Nature Management is monitoring and maintaining lists of invasive species in Denmark and giving recommendations on how to combat them (SVANA). Regulation is set up for some species and a number of guidelines has been developed on how to combat specific invasive species.

To enhance public awareness on the impact of invasive species targeted awareness raising activities are set up these years focusing on national efforts to inform the public in general. Among the latest initiatives is an available mobile application for the public to report on geographic observations of any invasive species in Denmark (www.invasive-arter.dk).

In 2008 a number of 2,655 species were registered to be introduced into Denmark, of these 2,068 species were plants, 566 were species of animals and 21 were species of algae and fungi. Of these introduced species only a minor number of species happens to be invasive. Thus in 2009, a total of 63 species were counted to be invasive of these 34 are plants, 25 animals, and 4 algae and fungi. However, these lists are dynamic as are the presence of the species and therefore such lists need regularly updating. Also, a list of monitored “doorknockers” is in place.

Denmark is part of the European Network on Invasive Alien Species (NOBANIS), which is a collaboration between 15 countries. NOBANIS is a gateway holding information on alien and invasive species in North and Central Europe including registration of invasive species in Denmark.

In a recent report (TemaNord, 2015), collaboration between ten participating countries and territories (the Nordic region: Denmark, Finland, Norway, Svalbard, and Sweden, the Baltic region: Estonia, Latvia and Lithuania, and the Island of the North Atlantic Ocean represented by Iceland, and the Faroe Islands) contains a pathway analysis and a horizon scanning. The pathway analysis examines the pathways of introduction for alien species in the Nordic region, the Baltic region and the islands of the North Atlantic Ocean. The horizon scanning identifies species that may potentially become invasive in the participating countries or territories. Furthermore, the report presents guidelines and general recommendations on measures to control pathways of interest and advice on development of an early warning system for invasive alien species.

2.1.5 Market, trade and the private sector

The choice of crops grown in Denmark is essential economically driven, *i.e.* shaped by the demand behavior of commerce and consumers. Within Danish agriculture a well-known owner structure as the cooperatives exist. This is known within abattoir, feed, seed and feeding stuff companies and dairy production. This means that the farmers own the processors.

In these years, the focus on organic farming is growing. The demand of consumers for Danish organic products are increasing both within and outside Denmark. Especially export to Germany and Sweden of Danish organic produce have increased. As a consequence, more farmers want to convert from non-organic to organic farming.

2.1.6 Policies

The Common Agricultural Policy has been the framework for the European Union, including Danish production of food and feed for the last fifty years. Denmark wants the Common Agricultural Policy to accomplish a number of things: Create jobs, ensure economic growth, deliver environmental benefits, generate export revenue and ensure high quality food. Denmark is working for a Common Agricultural Policy that is not setting up heavy administrative burdens or a heavy regulation of the market. The Danish Rural Development Programme adopted by the European Commission addresses economic, environmental and social priorities and contains clear targets for what is to be achieved (European Commission, 2015).

Farmers in Denmark are facing difficulties in relation to the increasing requirements of environmental regulation impinging the primary production. Therefore, in the Danish Rural Development Programme during the period 2014 to 2020 it is envisaged to support a number of highly target agri-environmental climate measures prioritising the most vulnerable areas, and water management. Almost 3,000 environment and climate friendly as well as resource efficient farm investments are envisaged. Non-productive investments, such as creation or recreation of wetlands and natural waterways on farmland, as well as investments and compensations improving the environmental and public amenity value of the Danish forests will be supported. Designated Natura 2000 and High Nature Value areas are prioritised in this regard.

2.1.7 Population growth and urbanization

The population moving from rural areas to urban areas has increased and most of the population about 70 % live in urban areas close to towns and cities and thus about 30 % live in rural areas. Especially the rural areas and the smaller islands have had a negative population growth as observed between 2007 and 2013 (European Commission, 2015).

2.1.8 Advancements and innovation in science and technology

Denmark is pointing at the importance of programmes for research, development and innovation within the EU framework to be well suited to develop the food chain. New skills, new technology and new products with commercial value are crucial for all farmers with big as well as small farms. For example the agricultural production is the supplier of renewable resources that can be processed and substitute other non-renewable resources. Resources from agricultural production that once were left-overs and waste can now and even more in the future in combination with research, development and innovation give rise to added value. The bio-economy and circular economy may provide achieving added value. This includes technologies that can refine and exploit biomass more effectively and improve methods of using material that is already produced and harvested. Such technologies both yield environmental benefits, and they can also generate new earnings for the farmers.

Where Denmark is a leader on environmental implementation, innovative approaches could be shared more widely with other countries, e.g. the special focus of national research on innovation policy on green innovation in the areas of energy, agriculture and environment.

2.2 Effect of drivers of change on traditional knowledge

The main driver of change affecting the maintenance and use of traditional knowledge relating to biodiversity for food and agriculture is the increased interest among the public population to obtain genetic resources for food and agriculture regarded as niche and quality products.

This is because local genetic resources for food are regarded as niche products of high quality. Often these resources are also followed with a good story telling behind.

3. The state and trends of biodiversity for food and agriculture

The Ministry of Environment and Food is the national authority in Denmark responsible for animal and plant genetic resources for food and agriculture including fish, wild plants and forest trees. In the Ministry, different agencies are responsible for the different sectors. The Danish Agrifish Agency hosts the Centre of Genetic Resources for Food and Agriculture. The agency is thus the secretariat of the two advisory boards for respectively animal and plant genetic resources for food and agriculture. For animals, the so called Conservation Committee was established in 1985 and the National Advisory Board for Plant Genetic Resources for Food and Agriculture was established around 2000. Both boards are represented by various stakeholders including universities, breeders, and organisations of farmers, museums, non-governmental organisations, and different relevant authorities. The overall aim in the areas of the genetic resources for food and agriculture is to secure conservation, strengthen sustainable use, secure access and fair benefit sharing, to raise and increase awareness of their importance and strengthen relevant knowledge research and development. Strategic plans or action plans have been elaborated and are reviewed and updated at appropriate time intervals, often every three or four year (Ministry of Food, Agriculture and Fisheries 2004; 2008; 2009).

3.1 Associated biodiversity and ecosystem services: state, trend, risk of loss, and conservation

Agriculture and forestry play a central role for restoring, conserving and improving ecosystems among these a number of nature and environmental values in the open land and in agricultural and horticultural production systems are potential important in relation to conservation and development of landscapes and recreational areas.

Agriculture has through decades increased pressure on nature. Thus today nature has become fragmented. Fields are becoming larger and hedges, boundaries and small ponds have been removed. However, new allocations are invested in projects for restoring, preserving and enhancing ecosystems.

Agricultural intensification is characterised by mechanization and use of heavy machinery, use of fertiliser and pesticides, and modifications in the natural systems such as land drainage, closing of small ponds and ditches, removal of hedges and field boundaries. Therefore, the rural development programme for Denmark is focused on support for better management of natural resources of ecosystem services such as replanting hedges, field boundaries and restoring small lakes. However, semi-natural nature is occupying about 9 % of Denmarks land area such as meadows, marsh, bog, commons, moorland. Such areas have declined around 25 % during the last 50 years. The remaining area is highly fragmented with many smaller plots less than 5 ha in size (Miljø- og Fødevarerministeriet. 2015 / 2016).

Furthermore, extensively managed areas are declining in Denmark as the number of grassing livestock is declining, which have a negative effect on the number of semi nature areas having high nature value. Therefore, subsidies are allocated to focus efforts on such farmland areas to maintain and attract favorable farming practices and hereby preserve biodiversity as well ecosystem services provided by e.g. extensive farming. In January 2016 a total of 83,000 ha of

such areas were approved for subsidies. The aim is to target means of biodiversity in the most cost effective way, especially rural development support for grassing or cutting semi natural areas outside Natura 2000.

Another instrument is restoration within agricultural land which imposes an obvious challenge for the farmer who is dependent on cultivating that particular piece of land. However, in Denmark a tool is available to tackle such challenges smoothly and effectively for the benefit of both the farmer and for the ecosystem and the biodiversity it supports. It is called land consolidation. A special legal framework is established in the so called Land Consolidation Act having its roots in the land reforms launched more than two hundred years ago in the 1780's. Up until 1990, land consolidation was used as an instrument primarily for agricultural development aiming at reduced fragmentation and increased holding sizes. In 1990 the objective was broadened and nowadays the law aims at contributing both to agricultural development and to the implementation of nature end environmental projects. A key instrument in the tool is "land banking" where buying and selling of several pieces of land involving several farmers simultaneously are facilitated. The multiple deals involved are sealed in one or few cost effective transactions. The tool has proven to be absolutely essential in the process of voluntary agreements with the landowners affected by nature projects. Some of the largest Danish nature restoration projects have been carried out this way involving many farms and restoration of some Denmark's most precious wetland ecosystems.

Forrest wild life. Many forests are cultivated intensively and this has derived consequences for biodiversity. In 2007 to 2013 it was concluded that the 10 internationally protected forest types in Denmark, which cover about 15 % of the total forest area, are adverse. About one-quarter of the Danish flora and fauna species examined are on the national Red List of endangered species. The forest is home to the largest number of these endangered species. Over half of Denmark's endangered species are related to forest.

Farmland wild life: In agricultural landscapes the total population of the 22 most common farmland birds have declined with around 36 % since 1990 a decline that started in the 1970'ies (Miljø- og Fødevareministeriet, 2015 / 2016). Typical farmland birds such like lapwing (*Vanellus vanellus*), grey partridge (*Perdix perdix*), skylark (*Alauda arvensis*), and linnet (*Linaria cannabina*) are more than halved in the period. Also another typical farm land animal such as the hare has declined in numbers since the 1970'ies. Until 1960 a number of 400,000 hares (*Lepus europaeus*) were hunted per year which has declined to 57,000 in 2007. The increase in intensive farming is thus having a negative trend on farmland birds and other farmland animals such as hares due to hard living conditions with loss of important micro-habitats for nesting and feeding.

3.1.1 Soil resources

With the purpose to protect soil resources across Europe different threats are of particular importance for Danish conditions which are likely to induce significant degradation of Danish soils (Schjønning *et al.*, 2009).

Soil compaction is considered a severe threat to Danish subsoils due to frequent traffic with heavy machinery in modern agriculture and forestry. Compaction of the subsoil layers is effectively persistent and affect important soil functions such as productivity, leaching of nutrients, and emission of greenhouse gases.

Soil organic matter decline: In former times, permanent grassland was a more common feature in the landscape, and the arable land included a more diversified crop rotation compared with today. In some parts of Denmark, most of the agricultural land has been grown with annual cash crops continuously for decades. Improved drainage of the fields and more intensive tillage systems may have enhanced decomposition of the inherent soil organic matter. Altogether, this means that the soil organic matter content has declined for most of the agricultural land, and

tilth problems ascribed to low soil organic matter content are frequently observed. An exception in the decline in the soil organic matter content is sandy soils dominated by intensive cattle production systems that have a high frequency of grass in their crop rotation. Danish research on soil use and management affecting the soil organic matter content points to a range of options to counteract the soil organic matter decline. These include recycling of plant residues, an expansion of the incorporation of straw, and a more frequent use of catch crops.

In 2003 it was estimated that 10 % of the Danish agricultural area was potentially exposed to soil erosion. Soil erosion is detrimental to soil quality because it truncates the soil and especially because it removes the fine material and nutrients. In addition, it contributes to eutrophication of the aquatic environment.

Soil water erosion: Spectacular soil water erosion events are rare, and erosion risk is generally perceived to be low. Nevertheless, water erosion occurs in most soil types typically in autumn and winter after prolonged periods of rainfall, in connection with snowmelt and with rainfall on frozen soil. In 2010 the soil water erosion rate in Denmark was 0.5 t per ha per year, well below EU-28 average (2.5 t).

Erosion by tillage is a process whereby spatial variations in the magnitude of soil movement during tillage along a hill slope cause net gain or loss of soil locally within fields. Next to land levelling, tillage erosion is the most severe process of soil redistribution in Denmark. The mouldboard plough is the primary tillage implement in Denmark and in general the most erosive. Tillage direction also exerts an important influence on erosivity. Tillage erosion must be considered a substantial long-term threat to soil productivity in Denmark. Researchers point at the most effective measure in reducing this type of soil degradation is to convert from non-organic to reduced tillage systems. However, there is a need to develop a practical, interactive tool for predicting and mapping tillage erosion for different tillage scenarios at the field scale.

Erosion by wind: In historical context wind erosion, has been a significant problem in Denmark. However, today the extensive use of hedges in regions with sandy soils and of winter crops has diminished the problem.

Thus none of these soil threats have had any general impact on the soil fertility in Denmark, when looking on yields.

3.2 Lakes and watercourses

Lakes, watercourses and wetlands are important habitat types in the Danish countryside (SVANA). They are heavily impacted by human activities such as water abstraction, discharges of waste water and straightening for drainage. Therefore many approaches are being taken in work to improve the environment in lakes and watercourses.

Watercourses connect the dry land and the sea, and apart from being habitats for a large number of plants and animals, watercourses act as dispersion channels in the landscape. This means that watercourses have a key role in relation to other habitat types.

There are about 69,000 km of watercourses in Denmark. The majority of these (about 75%) are small streams and ditches less than 2.5 meters wide at their bottom.

The Watercourse Act aims at ensuring that watercourses can be used to drain water with consideration for the natural and environmental quality of the watercourse according to other legislation. A total of 28,000 km of watercourses are also covered by the Nature Protection Act, which protects against changes in the condition of watercourses except for routine maintenance. The regulations on watercourses in the Act apply for open watercourses, as well as watercourses led through pipes and drains.

Watercourse condition: The majority of watercourses have been impacted by human activities such as water abstraction, discharges of waste water, straightening for drainage, pipe-laying and barrages. These impacts mean that many watercourses are not in optimal environmental condition. In order to ensure the ability of watercourses to drain water away, maintenance is carried out in almost all watercourses, including vegetation cutting to aid drainage of the riparian areas along watercourses.

In recent years the condition of nature and the environment in many watercourses has been improved considerably through more gentle vegetation cutting and restoration of watercourses. This means that watercourses which were previously straightened can develop more naturally again. Some watercourses have been returned to their old meandering course, and watercourses led through pipes have been opened to improve the living conditions of their plant and animal life.

Environmental targets for watercourses: The environmental quality of watercourses has been stipulated according to the provisions in the Danish Environmental Targets etc. Act Specific targets for watercourses are stated in the water management plans. Targets have been set specifically for about 22,000 km of Danish watercourses. The majority of these watercourses have the environmental target "good ecological status".

Lakes: Denmark has about 120,000 lakes larger than 100 m². These correspond to 1.4% of the land area. By far the majority are small lakes, and only about 2,700 (or just over 2%) are larger than 10,000 m² (1 hectare). In addition, there are about 75,000 ponds under 100 m². The lakes in Denmark are spread all over the country with most of them are in the hilly landscape in northern Zealand and central and east Jutland.

3.2.1 Pollination

Pollination is a very important ecosystem service and maintenance of pollination is essential for the diversity of both plants and insects. However, in recent decades a decline of pollination insects have been reported nationally. Among the approximately 1,500 plant species occurring in Denmark, almost 80 % are animal pollinated and insect pollination is by far the most common. Several insect groups are involved in pollination and bees are considered by far the most important, however, butterflies, flies, especially hoverflies, wasps, and moths also participate. Besides honey bees, the Danish bee fauna consists of about 275 species of wild bees which encompass 29 species of bumblebees and about 245 species of solitary bees (Strandberg *et al.*, 2011).

Pollination is an important ecosystem service in agriculture and horticulture to improve production in quantity and quality. In agriculture and horticulture pollinator dependent crops are primarily pollinated by managed honey bees (*Apis mellifera*). The economic valuation of their pollination is estimated to about 1 billion DKK yearly because of improved quality and increasing yield. Kept honey bees are rented out for pollination of agricultural fields to increase quantity and quality of production of, e.g. white clover, rape seeds, and also in horticulture to improve quantity as well as quality of fruit and berries, e.g. such as plantations of apples and in strawberry fields.

Beekeeping in Denmark is regulated by law to protect the managed bees against a broad range of parasites among these are american foulbrood (*Paenibacillus larvae*), stonebrood (*Aspergillus* fungi), small hive beetle (*Aethina tumida*), Tropilaelaps mites (*Tropilaelaps*) and European foulbrood (*Melissococcus plutonius*), and Aspergillus fungi. Another threat is the *Varroa* mite, which was introduced to Denmark in the beginning of the 1980'ies. Therefore, today honey bees must be managed to control the *Varroa* mite to secure the survival of the honey bees.

Also, other drivers are of threat such as intensive agriculture practices with large areas of monocultures of no forage value for bees and a surrounding landscape of low content of floral resources.

A strategy for honeybees has been implemented in Denmark for the period 2016 to 2019 (Miljø- og Fødevareministeriet, 2016) replacing the previous strategy. The focus in the strategy is to secure future Danish beekeeping and pollination through maintenance of healthy honey bees and to work for enhancing the availability of floral resources in the agricultural and surrounding landscapes, e.g. by planting catch crops, green crops, and hedgerows containing pollinator friendly plant species and flower strips within the fields.

3.2.1.1 The Nordic brown bee

The brown bee (*Apis mellifera mellifera*) is a native bee species of the Nordic countries including in Denmark. In Denmark the brown honeybee is managed as an important genetic resource threatened by extinction and is therefore regulated in a specific executive order for the brown bee managed on the island Læsø. Furthermore, the traditional knowledge on the management of the native brown bee is today kept by a minor group of beekeepers and almost only kept among beekeepers on Læsø. It is therefore essential to maintain this knowledge and the importance of passing it on to the next generation is recognized. However, it is a challenge to recruit new beekeepers on Læsø and to pass on the education through 'learning by doing' while the specific knowledge on management and breeding is still around.

In the Nordic context an action plan has been prepared to coordinate Nordic activities to promote conservation and utilization of the Nordic Brown Bee and to avoid losing traditional knowledge.

3.2.2 Habitat provisioning

Planting of hedgerows, has been a long tradition in Danish landscapes. Originally for sheltering purposes on sandy soils, now rather to increase biodiversity and create wildlife corridors in landscape (Brink *et al.*, 2012).

4. The state of use of biodiversity for food and agriculture

The most frequently reported management practices or actions that involve use of biodiversity for food and agriculture in Denmark are described for agriculture, forest and fisheries. Such management practices applied are generally favoring the maintenance of the conservation and sustainable use of biodiversity for food and agriculture. Furthermore, impacts of the production systems on the ecosystem may also be mentioned.

In Denmark production systems in the sectors of relevance for food and agriculture are adopting an ecosystem approach. This means that within agriculture, forest and areas of marine and coastal waters, ecosystem approaches are generally management practices that favor the conservation and sustainable use of biodiversity for food and agriculture.

4.1 Agriculture

In general Denmark is following directives set out by the European Union. Most agricultural farms are applying Integrated Plant Nutrient Management (IPNM) and Integrated Pest Management (IPM) practices. Although the management practice applied depends on the agriculture production system whether it is non-organic or organic agriculture. However, for both non-organic and organic farming the same rules are applied regarding Integrated Plant Nutrient Management.

In Denmark an action programme describes the implementation of the Nitrates Directive during the years 2008 – 2015. The programme ensures that the objectives of the European Council Nitrates Directive is achieved to protect waters against pollution caused by nitrates from agricultural sources (91/676/ECC). The member states are therefore obligated to review and if necessary review their action programmes at least once every four year.

Integrated Plant Nutrient Management is thus regulated for all production systems in Denmark to avoid any negative impact on associated biodiversity, *e.g.* water provision and quality. In the EU-nitrate directive Denmark has been classified as a nitrate sensitive area. Therefore, to protect the environment within and outside the production areas such as water ways Danish rules are set up with regard to application of fertilisers such as nitrogen, phosphorus and potassium. Regarding nitrogen each farm is assigned a quota which is calculated according to the size of the farm, crop, climate, and soil. The relevant authorities control quantity allocation and use of nitrogen. Furthermore, guiding standards are set up for the application of phosphorus and potassium.

Biodiversity is taken into account in non-organic and organic agriculture. For example grant schemes for applying for several subsidies are in place for encouraging farmers to take on responsibility to increase biodiversity within the agricultural landscape and the surrounding nature. Today farmers are obliged to use environmentally friendly cultivation measures and to reserve 5 % of their areas to biodiversity to protect biodiversity.

4.1.1 Non-organic agriculture

Regarding Integrated Pest Management (IPM) Denmark has implemented a national action plan 2013 – 2016 according to the European Union's directive on sustainable use of pesticides,

making the application of IPM compulsory. In non-organic agriculture, only approved pesticides are allowed. However, it is recommended to apply non-chemical methods or only to apply such pesticides that have minor effect on environment and health. The action plan contains a number of different voluntary efforts to be applied during professional use of pesticides. However, the area is strictly regulated by the authorities and therefore a number of restrictions and requirements are to be fulfilled by the users.

4.1.2 Organic agriculture

Organic agriculture in Denmark had its own law in 1987 as the first country in the world. In Denmark organic farming is controlled and supported by the state. The organic farming in Denmark is regulated at EU level. During the Danish Rural Development Programme in the period 2007 – 2013 the effort has been to promote the spread of organic production through area support to change from non-organic to organic farming by covering the cost of farmers adopting environment and climate friendly land management practices.

Organic farming in Denmark was started up as a small niche production that was mainly sold locally and has today become a substantial supplement to non-organic food products within Denmark as well as on major neighbour markets. A national organic control label was launched in 1989. The organic control label has been successfully implemented as all consumers successfully recognize this in 2015, although today it may be used on a voluntary basis whereas is obligatory to use the EU-logo. At times production levels have struggled to meet the growing demand. This is because it takes two years to convert from non-organic to organic farming. Furthermore, farmers need to feel assured that the demand will remain high and preferably increase before they start the process of converting from non-organic to organic production. Medio 2015 the organic production farming area covered almost 180,000 ha, which is equal to 6.8 % of the Danish agricultural area.

Geographical Danish organic farms are most common in the Southern-, Middle- and Western-Jutland and in the Northern part of Zealand where also most of the livestock is produced (Figure 9). This may be due to the fact that organic farming mainly relies on fertilisers of organic origin such as compost and farmyard manures as artificial fertilisers are not allowed. Organic farming is improving biodiversity and at the same time it ensures high standards for animal welfare.

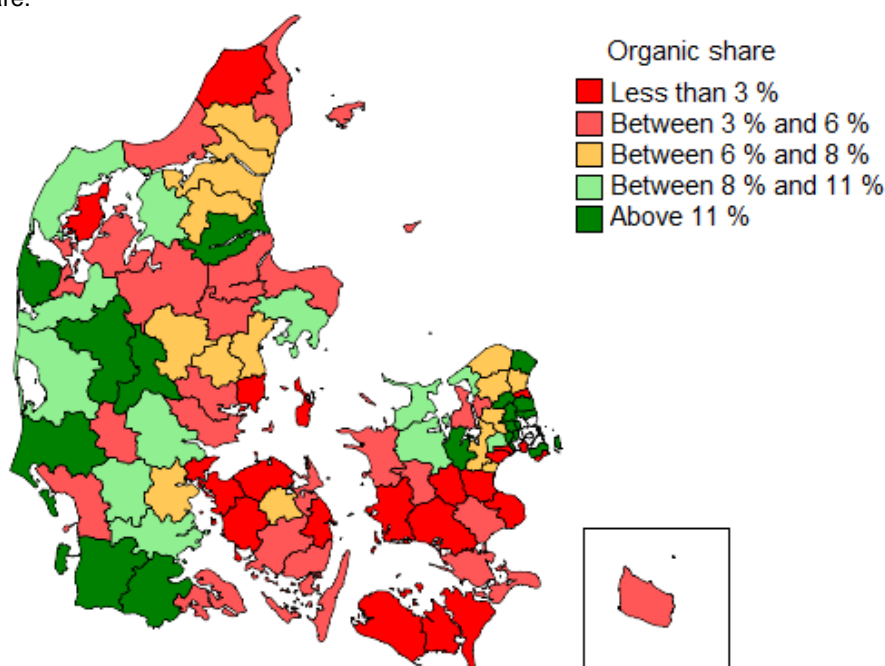


Figure 9. Organic areas in Denmark reported by the Agrifish Agency in 2015.

A number of organic farmers are these years adapting to an even more advanced management method, which is biodynamic farming. The principles behind biodynamic farming is among others focused on sustainable soil management practices to obtain a soil of high quality. At the same time livestock plays an important role to maintain the production system of the farm at a sound balance. In 2016 a number of 45 farmers in Denmark are managing 2,900 ha biodynamically, among these are both small and big farms, *i.e.* of around 6 – 700 ha. Among the 45 farmers 38 are approved within the international biodynamic Demeter set of rules.

4.2 Forest

The Agency for Water and Nature Management, within the Ministry of Environment and Food of Denmark, drives the state forests after specific directives and green initiatives, such as all dead wood are kept in the forests to create life for birds, insects and mushrooms. Oak trees which are more than 300 years old and beech wood more than 200 years are not chopped. Some trees are preserved when chopping forest areas.

In this way especially landscape management are used as management practices to support the use and conservation of biodiversity for food and agriculture within the forests.

4.3 Fisheries

In Denmark, fish stocks are exploited sustainably, with the exception of a small number of stocks, *e.g.* of herring and cod in certain locations. The marine habitats have been investigated. These are negatively impacted by nutrient substances and, in some cases, by bottom trawling and rock fishing. A project to restore rocky reefs off the island of Læsø and the construction of offshore wind farms have locally created suitable habitats for many marine species.

In June 2013, the Danish mussel policy was adopted. The overall aim of the mussel policy is a reduced environmental impact from mussel fishing compared to the situation in 2013, when the policy was adopted. Focus is on ensuring the right balance between mussel fishery and nature conservation. With the policy more focus is thus given to a green transition of the way fishing for blue mussels is carried out in Danish waters. The industry is given incentives to develop other ways of producing mussels *e.g.* bottom cultures and long line production.

The North Sea is one of the busiest maritime areas, with exploitation of oil and gas reserves also occurring in parallel to the important maritime traffic. Two of the world's largest ports are situated on the North Sea coast, and the coastal zone is used intensively for recreation. In addition, overfishing and bottom-trawling might impact the biodiversity in that region. In the Baltic Sea, main risks for biodiversity relate to eutrophication, overfishing and bycatch, pollution by contaminants and oil, and introduction of non-indigenous species¹.

Of the 42 sites located in the coastal zone where only Danish fishermen have fishing rights – 32 sites are fully protected either through the Natura 2000 National Order (Executive order: 1048/2013) or through the National Order governing fishery with trawls in the coastal zone (Executive order 1588/2015). An additional 10 coastal sites will be included in the Natura 2000 National order later in 2016.

International track: 23 sites of the 65 sites are located in waters where other Member States have fishing rights. In 2014, Denmark launched a regional process with Sweden and Germany with the aim of protecting reef structures in 10 Danish Natura 2000 sites in the Kattegat area and Western Baltic Sea.

¹ European Environment Agency, 2016, [The Baltic Sea](#).

4.4 Wild resources: state, trends and use for food and agriculture

Associated biodiversity of relevance to food and agriculture is less systematically monitored than of genetic resources for food and agriculture.

Wild food resources in Denmark are primarily harvested and consumed on a recreational basis. Such terrestrial wild foods collected and hunted are of minor importance to their contribution to food security.

Wild species of plants, wild fruit and fungi such as, e.g. berries, mushrooms, and wild plants may be used in the new Nordic cooking.

Hunting has during the last 10 years, been an increasing and popular activity in Denmark. In 2015 almost 177,000 hunters were registered of which around 11,000 of the hunters, i.e. 6.1 %, were women. Part of the registration fee obtained from hunting licenses and hunters personal contribution are allocated for conservation and improvement of nature. Thus the hunters are setting up initiatives to establish hedges, waterholes, game stripes to form a landscape with biodiversity for the wild animals. Hunting is for deer (red deer, fallow deer, and roe deer), small games (hare, fox) and birds (pheasant, pigeon, ducks).

Fishing: Angling is a popular outdoor activity in Denmark. Recreational fishing in Denmark, requires a fishing license. These money are used to improve specific stocks mostly in streams, eg. trout and salmon. Much effort has been done to improve the quality of streams in Denmark and to improve the population of fish, some species have been released, mainly salmon and trout. (Ministry of Food and Agriculture, 2014).

4.5 Access, exchange and benefit sharing

4.5.1 The Convention on Biological Diversity

Denmark has been a contracting party to the Convention on Biological Diversity since 1993. As a supplementary agreement to the Convention on Biological Diversity is the Nagoya protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization (ABS).

4.5.2 The Nagoya protocol

Denmark ratified the Nagoya Protocol in 2014. Furthermore, Denmark was among the first countries in the world to implement the Nagoya protocol in Danish law in 2012 on benefit sharing, including measures on how to access the genetic resources and sharing of benefits arising from their utilisation.

Thus Denmark has taken measures with the aim of that access to its genetic resources is not subject to Prior Informed Consent but rules may be implemented if so decided by the Minister. However, other legislation, on for example species or habitat protection, may apply and access may not be free of obligations. In the Danish law genetic resources are described as the functional inherited properties of organisms and naturally occurring biochemical substances resulting from genetic expression or metabolism of the organisms. Utilisation is described as intended use to conduct research and development on the genetic and / or biochemical composition of genetic resources, including through the use of biotechnology. Utilisation is also understood to mean development and marketing of products based on genetic resources.

Generally speaking regarding utilization of genetic resources acquired in provider countries the following measures are in place: Genetic resources may not be utilised in Denmark, if they have been acquired in violation of the legislation on access to genetic resources, cf. Article 6 of the

Nagoya Protocol, in the country they have been accessed. This is applicable to genetic resources from countries that, as Parties to the Nagoya Protocol, have legislated in accordance with Article 6 of the Nagoya Protocol. Furthermore, traditional knowledge associated with genetic resources and held by indigenous and local communities must not be utilised in Denmark if this knowledge has been acquired in violation of relevant legislation cf. Article 7 of the Nagoya Protocol in the country where the traditional knowledge was accessed. This is applicable to traditional knowledge acquired from countries that, as Parties to the Nagoya Protocol, have legislated on this matter in accordance with article 7 of the Nagoya Protocol.

As a member state of the European Union Denmark also has the obligation to conform to the EU Regulation 511/2014 on compliance measures for users from the Nagoya protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilisation in the Union. This regulation entered into force in 2014.

4.5.3 The International Treaty on Plant Genetic Resources for Food and Agriculture

Regarding, plant genetic resources Denmark is also a contracting party to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). The Treaty was adopted in 2001 and entered into force in 2004. As a contracting party to the ITPGRFA means that plant genetic resources for food and agriculture are available within the framework of the Treaty's Multilateral system. Thus, Denmark's genetic resources are freely available to potential users for research, breeding and training for food and agriculture within the system. Those who access genetic materials through the Multilateral System agree to share any benefits from their use through the benefit-sharing mechanisms established by the Treaty. Parties wishing to provide and receive material under the Multilateral System therefore use the Standard Material Transfer Agreement. This Agreement is a private contract with standard terms and conditions that ensures that the relevant provisions on the International Treaty are followed by individual providers and recipients of plant genetic material.

4.5.4 Interlaken Declaration

Concerning animal genetic resources Denmark has joined the Interlaken Declaration to preserve and use animal genetic resources sustainably to secure global food safety and secure development of local communities. Further, the Declaration wishes to promote use of livestock for use on land and create opportunities for niche products generally with local breeds.

5. Policies, institutions and capacity

5.1 National policies, programmes and enabling frameworks

In Denmark there are a number of national policies, programmes and enabling frameworks that support or influence conservation and sustainable use of biodiversity for food and agriculture and the provision of ecosystem services.

Denmark has national strategies for its genetic resources for food and agriculture (<http://naturerhverv.dk/landbrug/genetiske-ressourcer>). Since 2000 a strategy and action plans have been in place for plant genetic resources for food and agriculture and a new strategy is to be launched in 2016. Also for animal genetic resources for food and agriculture a new strategy has been launched in 2016. These national programmes involve government agencies, universities, growers and farmers associations, Non-Governmental Organisations, the Nordic Genetic Resources Centre, the commercial breeding sectors as well as upcoming micro breeders, etc.

A new strategy is also in place in 2016 for honeybees to secure and enhance the delivery of ecosystem service within agriculture and horticulture production systems (http://naturerhverv.dk/fileadmin/user_upload/NaturErhverv/Filer/Landbrug/Genetiske_ressourcer/Biavl/Biavlsstrategi_2016-2019.pdf).

With respect to associated biodiversity, national commitments, policies and programmes are in place (<http://svana.dk/natur/biodiversitet/>). This implies e.g. commitments such as laws on nature protection, environmental protection, environmental objectives, livestock, forest, planning act, and national parks. Also policies for a Nature plan for Denmark was presented by the government in 2014 (<http://naturstyrelsen.dk/media/nst/12478455/naturplan-danmark.pdf>). In 2016 it has been followed up by a political agreement on a Nature Packet (http://mfvm.dk/fileadmin/user_upload/Naturpakke-2016.pdf) including different initiatives for forest biodiversity, continued efforts for improving biodiversity in nature, the farmer in the open country acting as nature manager, and a more effective management to obtain synergies between nature, and agriculture.

Being member of the European Union (EU) Danish policies and legal frameworks are aligned with the relevant EU policies such as regulations, directives and payment schemes. The national regulation in Denmark is therefore influenced by the different EU regulations. Thus the following to be mentioned is of importance for environmental regulation of agriculture and forestry in Denmark:

The environmental policy instruments in the agricultural sector in Denmark is formulated in the Rural Development Programme of the European Commission. Thus the Danish Rural Development programme is a result of support from the European Agriculture Foundation for Development of Rural areas, which are a part of the common agriculture politic, and are financed from EU and the Danish Government.

The Rural Development Programme for the period 2014 – 2020 is outlining Denmark's priorities for Green conversion and Green jobs.

5.2 Information systems on associated biodiversity

Denmark has several information systems in place providing data on associated biodiversity in some of which are reflected in Table 4.

Table 4. National information systems in Denmark.

National information system	Components of associated biodiversity	Description of information system
The Danish Red List	All	The Danish red list (Wind <i>et al.</i> , 2010) is a record of the Danish plant and animal species that is assessed according to the Red List Guidelines prepared by the International Union for Conservation of Nature (IUCN). The use of the IUCN guidelines adapted to Danish conditions is described by Moeslund <i>et al.</i> (2015).
Alien species in Denmark (including the Danish Black List)	All	Alien species in Denmark is registered in the database NOBANIS
NOVANA	Water and nature	National monitoring programme providing knowledge about the state of water environment and nature
Central Beehive Register	Honeybees	Honeybee families and their geographical location is registered on a voluntarily basis in an electronic Central Beehive Register in Denmark. The aim of the register is to support and secure bee health.
Statistics of Denmark	All	Responsible for the country's official statistics.

5.3 Stakeholder participation that support maintenance and use of biodiversity for food and agriculture

A broad range of different stakeholders contributes to the conservation and use of biodiversity for food and agriculture. Among others these include farmers, foresters, fishermen, beekeepers but also plant- and animal breeders and universities.

5.3.1 Farm animals

Many farmers are member of different breeding associations and societies, which exist for all the different breeds in Denmark, both locally and adapted breeds. These gather the farmers to network and share knowledge and experiences with each other. The breeding associations are an important stakeholder to connect different stakeholders such as farmers, breeding companies, The Ministry of Environment and Food of Denmark, SEGES and universities.

Viking Genetics are one of the largest leading breeding companies in providing artificial insemination from different cattle breeds. They also storage genetic material from old Danish cattle breeds (The Jutland Cattles, Danish Black and White Cattle anno 1965, Danish Red Cattle, and Old Danish Dairy Shorthorn) and are in cooperation with both Aarhus University and The Ministry of Environment and Food of Denmark to support the preservation of locally adapted breeds.

Danavl are an important stakeholder within breeding of modern pigs in Denmark. They develop and distribute breeding material from pigs and are owned and managed by the Danish Pig Research Centre.

The main activity for DanHatch Denmark A/S in Denmark, Finland and Poland are to run a hatchery together with a rearing- and hatchery production. It is one of the largest and most effective producers of day old chickens in Europe.

Honey bees are popular in Denmark these years. Five different associations exist and about 6,000 people are members of these associations located around the whole country. On the island Læsø a specific part of the island is assigned protected area for breeding and holding of the threatened subspecies of honeybees namely the Nordic brown bee (*Apis mellifera mellifera*). The Læsø brown bee population has its own association.

5.3.2 Plant genetic resources

Plant breeding: Within plant breeding in Denmark there are five commercial private plant breeding companies. These breeding companies are among others, responsible for providing Danish farmers with adapted plant varieties to Danish growing conditions.

Sejet Plant Breeding has breeding programmes in agricultural crops such as spring and winter barley, winter wheat, winter triticale and faba beans. Sejet Plant Breeding is partly owned by Carlsberg and thus has a close collaboration and thus the synergies between the two enhance the possibilities in developing new and improved malting barley varieties. Nordic Seed is breeding winter wheat, spring barley, peas and faba beans. DLF Seeds and Science is a global seed company, which among others runs breeding programmes across the world to produce varieties of grasses for forage. The agricultural fund of potatoes Vandel breeds potatoes for consumption and industrial purposes.

These years new upcoming micro breeders are also emerging.

Vegetative propagated Danish material of fruit, berries and vegetables are conserved as living plants in clonal archives in different geographic places in Denmark. The main clonal archive for fruit and berries is conserved at Pometet, by the University of Copenhagen (<http://pometet.dk/>). The main clonal archive for vegetables is conserved at Årslev, by the University of Aarhus (<http://dca.au.dk/om-dca/au-aarslev/>).

The non-governmental organisation, in Danish called Frøsamlere and in English "Seed savers", is active in collecting, multiplying and preserving *etc.* plant genetic resources for food and agriculture. Also other enthusiastic individuals as private persons care for certain crop varieties or research activities on plant genetic resources for food and agriculture.

The national programmes on plant genetic resources for food and agriculture support the activities and projects of any dedicated enthusiasts also for spreading knowledge of plant genetic resources for food and agriculture among public.

5.4 National, regional and international collaboration for the conservation and sustainable use of biodiversity for food and agriculture

5.4.1 National collaboration

The Danish Agrifish Agency is responsible for Danish genetic resources for food and agriculture such as plants, animals and fish. The Danish Agency for Water and Nature management is responsible for state forest. Concerning plant and animals there is a committee for each sector regularly participating in meetings to discuss matters of relevance to genetic resources for food and agriculture. Both committees are involved in providing advice on elaborating strategies and action plans within the sectors. Another important task of these committees are to give advice to the Agrifish Agency for allocating funds under application rounds for project funds.

5.4.2 Regional and international collaboration

The Nordic Council of Ministers, is an official cooperation forum of the Nordic governments, of which Denmark is member, jointly with Finland, Iceland, Norway, Sweden, the Faroe Islands,

Greenland and Åland. Among other things the Nordic Council of Ministers finances the Nordic Genetic Resource Center, NordGen. NordGen is our common Regional Nordic genebank for activities related to conservation and sustainable use of genetic resources for food and agriculture (see chapter 1.4.).

European Regional Focal Point of Animal Genetic Resources: The European Regional Focal Point for Animal Genetic Resources (ERFP) (<http://www.rfp-europe.org/>) is the regional platform to support the *in situ* and *ex situ* conservation and sustainable use of animal genetic resources and to facilitate the implementation of FAO's Global Plan of Action for Animal Genetic Resources in Europe. Denmark is a member of the programme.

European Cooperative Programme for Plant Genetic Resources (ECPGR): Denmark is member of the European Cooperative Programme for Plant Genetic Resources (ECPGR) (<http://www.ecpgr.cgiar.org/>). This is a collaborative programme among most European countries aimed at ensuring the long-term conservation and facilitating the increased utilisation of plant genetic resources for food and agriculture in Europe.

European Forest Genetic Programme (EUFORGEN) (<http://www.euforgen.org/>) is an international cooperation programme that promotes the conservation and sustainable use of forest genetic resources in Europe as an integral part of sustainable forest management. Denmark is a member of the programme.

The Bern Convention: Convention on the Conservation of European Wildlife and Natural Habitats is a binding international legal instrument in the field of nature conservation, covering most of the natural heritage of the European continent and extending to some States of Africa. Denmark is a party to the Convention (<http://www.coe.int/>).

Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) and the Convention on the Protection of the Marine Environment of the Baltic Sea (HELCOM): The Danish marine waters are part of two marine regions, the North-East Atlantic Ocean and the Baltic Sea. Denmark is therefore party to both the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) (<http://www.ospar.org/>) and the Convention on the Protection of the Marine Environment of the Baltic Sea (HELCOM) (<http://www.helcom.fi/>). Helcom Recommendation on sustainable aquaculture was adopted by the members of Helcom in 2016. The Delegated Act came into force on 1 January 2016.

5.4.3 Capacity development

An overview and knowledge of all research in Denmark on the conservation and sustainable use of associated biodiversity is impossible to collect because of the wide range.

Denmark has quite a number of experts on management and sustainable use of biodiversity for food and agriculture, within all sectors such as within the fields of plant, animal, forest and fish genetic resources. Knowledge is mostly found within the universities in Denmark, such as the Universities of Copenhagen and Aarhus. Breeders are also aware of the importance of long-term conservation to secure future needs for genetic resources for use in breeding programmes.

Active farmers are offered supplementary education on how to manage high nature value areas such as grassing or cutting of semi-natural areas outside Natura 2000 to maintain biodiversity.

6. Future agendas for conversation and sustainable use of biodiversity for food and agriculture

The agricultural sector is a key player in relation to sustainability. The Common Agricultural Policy and related policies in relation to biodiversity, animal welfare, environment and climate is a focus point in achieving a more sustainable sector. The Danish agri-food sector increasingly responds to the possibilities of the globalized world.

Policies in Denmark point at the EU Common Agricultural Policy to work in complementary with other policies and vice versa. The EU Common Agricultural Policy has been the framework for the production of food for the last fifty years. From a Danish political point of view the EU Common Agricultural Policy shall in the future accomplish the following: create jobs, ensure economic growth, deliver environmental benefits, generate export revenue and ensure high quality food.

Farmers and the agricultural labor force are a very small part of the total labor force in a modern Danish society, even in the rural areas. For creating jobs and economic growth the agricultural sector needs to be market oriented and competitive. Therefore, the agricultural sector needs to develop and modernize its production, and structure of farms, as well as to be open to use new technology. For example the agricultural production is the supplier of renewable resources that can be processed and substitute other non-renewable resources. Resources from agricultural production that once was left-overs and waste can now and even more in the future in combination with research, development and innovation give rise to added value. The bio-economy and circular economy may provide ways of achieving this. This includes technologies that can refine and exploit biomass more effectively and improve methods of using material that is already produced and harvested. Such technologies both environmental benefits, but can also generate new earnings for the farmers.

The competition on the world market for agricultural produce will be stronger but will also give big possibilities for the farmers if policy is designed to foster development and innovation for both big and small farms. In general, all farmers and the food chain shall be innovative. Innovation where knowledge, science and data are brought into play to acquiring new skills, new technology and new products with commercial value. This will also help farmers to face new challenges in relation to climate and environment.

Climate change: Agricultural production has always been influenced by weather and climate conditions. A stable production of food and fodder must be secured to deliver livestock, milk, and vegetables and other agricultural products to consumers. In the future there will be even more focus on climate. Expected climate changes in Denmark may lead to severe storms and more frequent and heavier precipitation either as rain or snow. The temperature increase will be close to the global mean temperature increase. However, the Nordic region is the only place on earth where climatic conditions allow productive agriculture, forestry and fisheries at high lati-

tudes with dark winters. Thus in agricultural terms in general the region will be favorably affected by modest climate change, therefore this puts this region at a relative advantage in relation to food production (Barua, *et al.*, 2014). Climate change is expected to be favorable with regard to grow protein-rich crops such as peas, rapeseeds and soybeans, which may replace the import of protein for the Danish livestock production.

The challenge in the Nordic region will be to ensure sustainable growth in agricultural production without negatively affecting the environment and natural resources. Predicted climate change in the Nordic region, together with a highly skilled farming industry will provide good opportunities for implementing new agricultural production systems with substantially higher productivity at lower environmental costs.

Farmers in Denmark have always been flexible in order to adapt to changing conditions, *e.g.* with the upcoming climate changes farmers may continually experiment with alternative crops as well as new cropping techniques. The most successful techniques quickly spread throughout the farming community, where agricultural advisors and researchers are ready to compile and disseminate new results. The future changes is generally believed to be good because in many cases changes may be favorable to production. Furthermore, the Nordic region has high research, educational and advisory capability. Changes are also putting pressure on breeders for rapid delivery of crops which can adapt to new and more extreme environments. At the same time, nutrients (*e.g.* phosphorus) comprise a limiting factor for production improvements in relation to the ongoing environmental changes influencing primary production. There may be obstacles to adaptation, not least posed by current agricultural and environmental policies, which may be taken into account to ensure effective adaptation.

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Annex 1. Production systems

Table 1. Climatic zones definitions

Climatic zone	Definition
Temperate	At least one month with monthly mean temperature, corrected sea level, below 5 °C and four or more months above 10 °C

Table 2. Production systems descriptions

Name of production system	Climatic zone	Description
Livestock grassland-based systems	Temperate	Systems in which the animals obtain a large proportion of their forage intake by grazing natural or sown pastures, includes: <ul style="list-style-type: none"> • Ranching: grassland-based systems in which livestock is kept on privately owned rangeland • Pastoralist: grassland-based systems which the livestock keepers move with their herds or flocks in an opportunistic way on communal land to find feed and water for their animals (either from or not from a fixed home base).
Livestock landless systems	Temperate	Systems in which livestock production is separated from the land where the feed given to the animals is produced. Only seen in Denmark within fur production.
Naturally regenerated forests	Temperate	Includes: <ul style="list-style-type: none"> • Primary: Forests of native species, where there are no clearly visible indications of human activities and ecological processes are not directly disturbed by humans • Modified natural: Forests of natural regenerated native species where there are clearly visible indications of significant human activities • Semi-natural (assisted natural regeneration): Silvicultural practices in natural forest by intensive management (weeding, fertilizing, thinning, selective logging)
Planted forests	Temperate	Includes following: <ul style="list-style-type: none"> • Semi-natural (planted component): Forests of native species, established through planting and seeding, intensively managed. • Productive plantations: Forests of introduced and/or native species established through planting or seeding mainly for production of wood or non-wood goods. • Protective plantations: Forests of introduced and/or native species, established through planting or seeding mainly for provision of services.
Self-recruiting capture fisheries	Temperate	Includes capture fisheries in marine, coastal and inland areas that can involve <ul style="list-style-type: none"> • Natural ecosystems • Modified ecosystems
Culture-based fisheries	Temperate	Fisheries on resources, the recruitment of which originates or is supplemented from cultured stocks raising total production beyond the level sustainable through natural processes.
Fed aquaculture	Temperate	The farming of aquatic organisms including fish, mollusks, crustaceans, aquatic plants, crocodiles, alligators, turtles and amphibians. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators etc. Farming also implies individual or corporate ownership of the stock being cultivated; i.e., the population chosen for culture and not a stock in the same sense as that term is used for capture fisheries. Fed aquaculture production utilizes or has the potential to utilize aquafeeds of any type in contrast with the farming of filter-feeding invertebrates and aquatic plants that relies exclusively on natural productivity. Also defined as "farming of aquatic organisms utilizing aquafeeds in contrast to that deriving nutrition directly from nature".
Non-fed aquaculture	Temperate	The farming of aquatic organisms including fish, mollusks, crustaceans, aquatic plants that do not need supplemental feeding. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators etc. Farming also implies individual or corporate ownership of the stock being cultivated; i.e., the population chosen for culture and not a stock in the same sense as that term is used for capture fisheries. In non-fed aquaculture systems culture is predominately dependent on the natural environment for food, e.g. aquatic plants and mollusks.
Irrigated crops (other)	Temperate	Irrigated crops other than rice refers to agricultural areas purposely provided with water, including land irrigated by controlled flooding.
Rainfed crops	Temperate	Agricultural practice relying exclusively on rainfall as its source of water.
Mixed system	Temperate	Production systems with multiple components. They include: <ul style="list-style-type: none"> • Crop-livestock: mixed systems in which livestock production is integrated with crop production. • Agro-pastoralist: livestock-oriented systems that involve some crop production in addition to keeping grazing livestock on rangelands; they may involve migration with the livestock away from the cropland for part of the year; in some areas, agropastoral systems emerged from pastoral systems. • Integrated aquaculture: mixed systems in which aquaculture is integrated with crop and livestock production. May involve ponds on farms, flooded fields, enrichment ponds with organic waste, etc. • Other combinations
Other	Temperate	Vegetables and flowers are produced as horticulture under glass.



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