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Ministry of Economic Affairs

Country Report for The State of the World's Biodiversity for Food and Agriculture – The Netherlands

Ministry of Economic Affairs, the Hague

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Centre for Genetic Resources, the Netherlands (CGN)

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Centre for Genetic Resources, The Netherlands (CGN), Wageningen
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Table of contents

Foreword

Humans have always adapted their environment to their needs. One of the consequences has been a decline in biological diversity. In a densely populated country like the Netherlands, in particular, centuries of human intervention have taken their toll on nature.

Once we realised what the cost of urbanisation and modern farming was, we took action to protect our natural heritage. As a result, the biodiversity of forests and dunes has stabilised or even improved. Unfortunately, the biodiversity of heaths, semi-natural grasslands and agriculture has continued to decline.

Biodiversity remains one of our priorities: we are fully aware that we need to take measures to improve the current situation. People are happier when they can enjoy the abundance of nature. And genetic diversity of animals, plants and micro-organisms, as well as the processes that support the functioning of ecosystems, are also key to human survival. They determine our ability to grow food and influence our economic development. This is true for the Netherlands, which is one of the world's largest agricultural exporters, but equally so for other nations. So, if we are to eradicate hunger and feed an additional two billion people over the next 30 years, we need to safeguard our planet's biodiversity.

Our country report on biodiversity for food and agriculture, which was drawn up by Wageningen University, shows what we are doing to secure our nation's biodiversity for food and agriculture. We are aiming to make natural areas more robust by focusing on larger natural systems instead of specific species and habitats. And we are working with farmers to make environmental conservation part of their day-to-day farm work, for example to protect the population of cherished meadow birds like oyster catchers and godwits.

The Netherlands will also continue to support the conservation of biological diversity and sustainable use of its components worldwide. Our actions will be guided by the EU Biodiversity Strategy and the international biodiversity treaties to which we are a signatory. We will endeavour to increase sales of timber from sustainably managed forests on the Dutch market, conclude fair agreements about the use of plant genetic material and tackle plastics at sea.

We are pleased that the FAO will publish an overview of all available country reports. By sharing best practices, we can better understand biodiversity for food and agriculture and protect our natural heritage for the future.

Martijn van Dam
Minister for Agriculture

Executive summary

The Netherlands Country Report for The State of the World's Biodiversity for Food and Agriculture forms, together with country reports from other countries, thematic studies, reports from international organizations and inputs from other relevant stakeholders, the basis for the report on the State of the World's Biodiversity for Food and Agriculture (SoWBFA report). The structure of the Country report follows the FAO's guidelines, to provide baseline information, highlight knowledge gaps and to facilitate the regional and global synthesis of the information from different countries. The report focuses on developments in the area of Biodiversity for Food and Agriculture (BFA) observed in the last 10 years.

In this report, the definitions of BFA and associated biodiversity as given in Annex 1 of the Guidelines for the preparation of the Country Reports have been followed. Biodiversity for Food and Agriculture is considered to include the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the structure, functions and processes of production systems, and that provide food and non-food agriculture products. Associated biodiversity refers to the biological diversity associated with supporting and regulating ecosystem services within production systems or of importance to them. It comprises species of importance to ecosystem function, for example through pollination, control of plant, animal and aquatic pests, soil formation and health, and water provision and quality.

Country profile
The Netherlands is a country with a temperate climate, with approximately 67% of the total land area used for agricultural purposes. With approximately 500 people per km^2 of land, the country is densely populated. The total area of cultivated land in the Netherlands is 1.85 million ha, of which 983,000 ha is grassland, 532,000 ha is used for arable crops, 236,000 ha for fodder and feed crops, and 96,000 ha for horticultural crops (of which 10,000 ha under glass). Between 1995 and 2013, the area of cultivated land decreased with 6% and the number of farms with 40% (to about 67,500), thus the average farm size has increased. The following production systems were identified as the most relevant for the Netherlands: 1. livestock grassland-based systems; 2. livestock landless systems; 3. planted forests; 4. self-recruiting capture fisheries; 5. culture-based fisheries; 6. fed aquaculture; 7. non-fed aquaculture; 8. rainfed crops; and 9. horticulture under glass. Of these production systems, the main contributors to the agricultural sector economy are Horticulture under glass, Rainfed crops and the two Livestock systems, while the contribution of the aquatic production systems is very limited.

Drivers of change in associated biodiversity
Important drivers causing changes in associated biodiversity in and around production systems in the Netherlands are the high inputs of nutrients, low groundwater tables, the use of chemical crop protection products, and changed landscape configuration in the livestock and rainfed crop systems. During the last 30 years, these factors have resulted in a decline of biodiversity in Dutch agricultural landscapes. For some of these drivers of change, the trend in the past 10 years has become more favourable for associated biodiversity, when compared with the decades before. The nitrogen and phosphorus balances of agricultural soils have become more even, but supply still exceeded removal in every year of the last decade, which means that the overall amounts of nitrogen and phosphorus in these soils have further increased. Calculated ammonia emissions into the air have declined, but measured ammonia concentrations in the atmosphere have nevertheless remained at the same level since 1993. The use of plant protection products in agriculture has declined from 1985 until 2000, but showed a slight increase again from 2000 onwards. Continuous improvements in production management practices are needed as still too much nutrients and pesticides are leaching into the ground and surface water. Although the effects of climate change on associated biodiversity and ecosystem services in the Netherlands seem to have been limited so far, they may become more pronounced in the future. Increasing temperatures lead to longer growing seasons and shifts in distribution areas and life cycles of species, including organisms causing pests and diseases.

Countermeasures to reduce adverse consequences of these drivers of change include the establishment of the 'National Nature Network' (NNN), an interconnected network of nature reserves and conservation areas, which also includes production forests and farmlands. ‘Natura 2000’ is the network of nature areas in the European Union. Natura 2000-areas in the Netherlands are mostly part of the NNN. In the ‘Integrated Approach to Nitrogen’ (PAS), the national government and regional authorities cooperate to halt the loss of biodiversity due to nitrogen deposition, and to ensure ecosystem recovery. The EU Common Agricultural Policy (CAP) provides for the support of agri-environment schemes and organic farming. The EU has also obliged all European farmers to have implemented the principles of Integrated Pest Management (IPM) by 2014. Countermeasures to reduce biodiversity loss in the fisheries sector include the establishment of Marine Protected Areas in the Dutch part of the North Sea, the lifting of physical migration barriers for fish, and the promotion of innovative fishing gear to mitigate collateral damage to the ecosystem.

Trends in biodiversity and regulating and supporting ecosystem services
During the 20th century, species biodiversity in the Netherlands has strongly decreased. Since 2000, the loss of biodiversity has been slowing down, but with large differences between ecosystems: the biodiversity of heath lands, semi natural grasslands and agriculture is still declining, whereas the biodiversity in forests and dunes has stabilised and even showed local improvements.

Regarding plant genetic resources for food and agriculture, generally a large number of varieties for a substantial number of different crops are available for farmers, and no indications exist that the diversity of crop varieties in the market is decreasing. With regard to animal genetic resources, livestock kept in the Netherlands largely consists of a few highly productive, globally used breeds. However, a large diversity of rare, local livestock breeds is still maintained by farmers and hobby breeders, and an increasing diversity of local breeds is employed in nature and landscape management. With respect to forest genetic resources, the proportion of native deciduous species has increased over the past decades at the expense of exotic conifers. Regarding aquatic genetic resources, fishing pressure has been reduced over the last decade, and positive trends in species richness were observed. Exploited fish species now mature at a younger age and smaller size, likely due to fisheries-induced evolution.

With respect to the associated biodiversity in and around production systems, and the regulating and supporting ecosystem services provided by associated biodiversity in these production systems, there are insufficient data available to make a quantitative assessment of the developments in the past 10-20 years in all production systems. As for the terrestrial production systems, the habitat provisioning role in rainfed crops systems has declined due to the more intensive management, changes in cropping patterns, and more large-scale farming, leading to the disappearance of many small landscape elements. The decrease in natural habitats in agricultural areas has probably led to a decrease in natural pest regulation. In addition, the use of pesticides has had negative effects on the species diversity of plants, insects and birds, and on the potential for biological pest control. At the same time, the introduction of agri-environment schemes and the growth of organic farming positively affected the species diversity of plants and insects, but not bird species diversity. In livestock grassland-based systems, the trends in the associated biodiversity and the regulating and supporting ecosystem services provided are generally negative, due to pastures being mown more often, earlier in the season and more rapidly, high inputs of nutrients, and low groundwater tables, resulting in a decline in the habitat provisioning role of these systems. The populations of the most common meadow bird species (the black-tailed godwit, the oystercatcher and the lapwing) still continue to decline. In planted forest systems, changed forest management objectives (from the purpose of wood production towards multi-purpose forest management) has led to increases in the numbers of birds, bats, invertebrates and mushrooms. In livestock landless systems and horticulture under glass the importance of associated biodiversity and regulating and supporting ecosystem services has remained limited. With regard to the aquatic production systems, the species richness in the self-recruiting capture fisheries system is increasing, likely in response to the increase in temperature and the appearance of invasive species. Some practices (bottom trawl fisheries) disturb sea bed habitats and reduce biodiversity, while others (construction of oil/gas platforms and wind farms) add habitat. Invasive species such as the Pacific oyster threaten existing functions of coastal waters, but can also provide a habitat for certain species. In the non-fed aquaculture system, the collection of mussel seed has reduced the surface area of mussel beds that provide a habitat for a variety of invertebrate species as well as food for waders. For culture-based fisheries insufficient information on the developments was available, while in fed aquaculture systems the importance of associated biodiversity and regulating and supporting ecosystem services has remained limited.

The number of alien species settling in the Netherlands has strongly increased in the past 20 years. On the one hand, the introduction of new species increases biodiversity, but, on the other hand, the introduction of new species can also form a threat to existing biodiversity, as some alien species have negative effects on indigenous flora and fauna, because they compete for food or space, or because they attack indigenous species or transmit diseases. Traders and private persons import large quantities of plants and other materials from abroad, which may carry exotic species, including harmful organisms.

Management practices
The most important management practices favouring the maintenance and use of biodiversity for food and agriculture and applied in the terrestrial production systems, are Integrated Plant Nutrient Management, Integrated Pest Management, Pollination management, Landscape management and Organic agriculture. In the aquatic production systems, the main practices with a positive effect fall into the category Ecosystem approach to capture fisheries. The major practices that negatively impact associated biodiversity in terrestrial production systems are over-fertilization with nitrogen in agricultural soils, the use of pesticides, and groundwater levels being kept low. In marine and inland fishing, overharvesting has been a problem, but fishing pressure has been reduced over the last decade. A major gap in information and knowledge is the lack of thorough evaluation of practices intended to favour associated biodiversity and the provision of regulating and supporting ecosystem services, such as the establishment of field boundaries. Actions required include proper and more in-depth evaluation of the effectiveness of management practices intended to favour biodiversity for food and agriculture. Gaps in information and knowledge also exist with respect to the sustainability or unsustainability of certain practices in using biodiversity for food and agriculture, such as bottom trawling and the use of neonicotinoid chemical crop protection products.

Interventions
Dutch biodiversity policies in the past decade contained measures focused on species as well as measures focused on areas. The core of the species-specific legislation was formed by the Flora- en faunawet ('Flora and fauna Act') and by fisheries regulations. The new Nature Conservation Act (Wet Natuurbescherming) will integrate the Flora and Fauna Act, the Nature Conservation Act of 1998 and the Forest Act. The core of the area-focused measures is the National Nature Network. Dutch forest policies are promoting multifunctional management (nature conservation, recreation, landscape values and timber production), sustainable management of the forests, and expansion of the forested area. At the EU-level, the reform of the Common Agricultural Policy (CAP) in 1992 envisaged the reduction of the negative consequences of agricultural intensification by financially supporting agri-environment schemes. The EU not only supports agri-environment schemes, but also organic farming. Furthermore it has obliged all European growers to implement the principles of Integrated Pest Management by 2014. North Sea fisheries have almost completely been regulated by European legislation, which has set, among other things, the total allowable catch for various species, and the maximum number of fishing days. As for fisheries in the Dutch coastal waters, fishing methods and fish sizes have been regulated. Marine Protected Areas have been established in the Dutch part of the North Sea. In the inland fishery sector, fishing activities are regulated through licenses and restrictions with respect to fishing gear, fishing areas and fishing seasons.

Future agendas
A shift in nature policy is currently taking place. In 2013, the national government and provincial authorities have drawn up the 'Pact for Nature', in which they have defined their ambitions regarding the development and management of nature in the Netherlands. The policy document 'The Natural Way Forward - Government Vision 2014' has outlined how the government wants to shape its nature policy over the next 15-20 years. There will be more attention for natural systems on a landscape scale, and the focus on specific species and habitats will be reduced, in order to increase the opportunities for the development of more robust natural areas. An important notion reflected in the vision is 'nature-inclusive agriculture', which means that attention for nature forms an integral part of farm management. Examples of nature-inclusive agriculture are the deployment of insects for pest control purposes in the horticulture sector and the creation of improved conditions in dairy farms to attract meadow birds by combining cattle-grazing with practices favouring high soil biodiversity. Considerable parts of the gamma of Dutch nature policies (including responsibility for the management and further development of the National Nature Network, the Natura 2000 areas and the agri-environment schemes) have been transferred to provincial authorities. The new agri-environment schemes are being placed in the hands of area-based collectives. At the EU-level, the Common

Agricultural Policy (CAP) and EU biodiversity strategy are important policies for the Dutch agriculture-related biodiversity. For the period to 2020, the target is to maximise areas that are covered by biodiversity-related measures under the CAP, to ensure and improve the conservation status of species and habitats that depend on or are affected by agriculture, and to ensure that agricultural lands can better provide ecosystem services, thus contributing to sustainable agricultural management. The CAP and the EU biodiversity strategy both aim at promoting the provision of environmental public goods by farmers. From the CAP perspective, the objective is not only to contribute to climate and environmental policy goals, but also to increase legitimacy for CAP payments by remunerating farmers for the collective services they provide to society. The policies and measures referred to above are expected to facilitate a further increase in BFA and associated biodiversity in the Netherlands.

General introduction

Background

In 2007, the Food and Agriculture Organization of the United Nations (FAO) received the request from the FAO Commission on Genetic Resources for Food and Agriculture requested FAO to prepare a report on the State of the World's Biodiversity for Food and Agriculture (SoWBFA report). The SoWBFA report is to provide an integrated description of the state of plant, animal, forest and aquatic genetic resources, and to reflect available baseline information on the state of diversity of micro-organisms, invertebrates, amphibians, reptiles, birds, plants and mammals found in and around production systems and often providing important ecosystem services supporting food and agricultural production.

The SoWBFA report should be ready and presented to the Commission in 2017, and is to be based on information from Country Reports, with additional information from thematic studies, reports from international organizations and inputs from other relevant stakeholders. Therefore, in 2013, the FAO invited countries to prepare a Country Report on their state of biodiversity for food and agriculture as a contribution to the preparation of the SoWBFA report.

The structure of the Country report follows the FAO's guidelines (FAO, 2013), to provide baseline information, highlight knowledge gaps and to facilitate the regional and global synthesis of the information from different countries. The report focuses on developments observed in the last 10 years.

Preparation of the Country Report

Work on this report started in August 2014, with the preparation of a draft Chapter 1. The National Committee was established in September 2014, and during the first meeting of this Committee, in October 2014, the draft of Chapter 1 was discussed, with special attention for the identification of the relevant production systems. Furthermore, the Committee brainstormed over Chapters 2 and 3 during this meeting. In the period October-December 2014, drafts were prepared of Chapters 2 and 3. In January 2015, the second meeting of the National Committee was held, in which the draft Chapters 2 and 3 and the set-up of the rest of the report were discussed. In February 2015, information on the aquatic production systems for Chapters 1-5 was assembled by Prof. dr. Adriaan Rijnsdorp of the Institute for Marine Resources and Ecosystem Studies (IMARES). From February to May 2015 drafts of Chapters 4 and 5 were prepared. In June-July 2015, the revised Chapters 1-5 were combined into a first draft report, which was sent to a number of experts for their comments. In August-September 2015 the draft report was revised and Chapter 6 was drafted. Subsequently, the report was sent to the members of the National Committee for their written comments. In October-November 2015 the report was finalized.

During the preparation of the report, it became clear that it was impossible to make quantitative assessments of the effects of the drivers and trends for all types of associated biodiversity and all regulating and supporting ecosystem services in each production system over the past 10 years. Therefore, it was decided to only show those rows in tables for which relevant information could be found.

The reader may notice that information is sometimes repeated, for instance in Chapter 3. This is understandable when you take into account that guidelines for the preparation of this report state that: "For the scope of this report, associated biodiversity comprises those species of importance to ecosystem function, for example, through pollination, control of plant, animal and aquatic pests, soil formation and health, water provision and quality, etc. (...)" (FAO, 2013). Thus, any factor that influences associated diversity, also influences ecosystem services.

Important definitions

In this report, the definitions of Biodiversity for Food and Agriculture (BFA) and associated biodiversity as given in Annex 1 of the Guidelines for the preparation of the Country Reports (FAO, 2013) have been followed.

Thus, Biodiversity for Food and Agriculture is considered to include the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the structure, functions and processes of production systems, and that provide food and non-food agriculture products.

Associated biodiversity is considered to refer to the biological diversity associated with supporting and regulating ecosystem services within production systems or of importance to them. It comprises species of importance to ecosystem function, for example through pollination, control of plant, animal and aquatic pests, soil formation and health, water provision and quality, and includes:

a. Micro-organisms and fungi, such as mycorrhizal fungi, soil microbes, planktonic microbes, and rumen microbes;
b. Insects, spiders, worms and other invertebrates functioning as decomposers, pests, pollinators, predators, etc.;
c. Vertebrates (including amphibians, reptiles, birds, and mammals) functioning as pests, predators, pollinators, etc.;
d. Wild and cultivated terrestrial and aquatic plants other than crops and CWR, such as hedge plants, weeds, and species present in riparian corridors, rivers, lakes and coastal marine waters that contribute indirectly to production.

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

1.1 General overview of the country

The Netherlands is situated in Western Europe, in the delta of the Rhine and Meuse rivers. It borders Belgium to the south, Germany to the east, and the North Sea to the west and north. It has a temperate climate as a result of the influence of the Gulf Stream, with even rainfall throughout the year (approximately 800 mm per year). Climate change predictions forecast higher temperatures and wetter summers in Western Europe (Visser, 2008).

The total area of the Netherlands is 41,543 km^2 (2010). About 19% of this area is water. Of the total land area (33,687 km^2), 67.2% is used for agricultural purposes (including not only cultivated land, but also gardens, scattered buildings and water courses less than 6 m wide), 10.3% is occupied by forest and 4.2% by natural terrain, while 15.0% is used for buildings and infrastructure, 2.9% for recreation an 0.4% for other purposes (LEI & CBS, 2014; CBS, 2015). The Netherlands can be considered a green country, with more than 80% of its surface area used for agriculture, forest and natural terrain. Distinct clusters of urban land use functions are present in the west of the country (Figure 1.1).

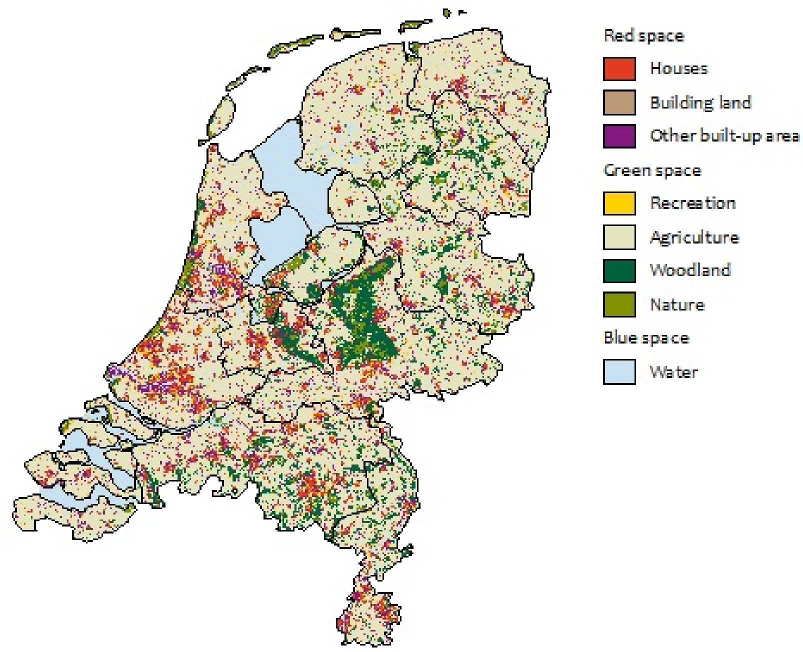

Figure 1.1 *Land use in the Netherlands, 2010 (source: CBS, PBL & Wageningen UR, 2015).*

The population has increased from 16.2 million in 2003 to 16.8 million in 2013, the population density from 479 to 498 people per km^2 of land in the same period (LEI & CBS, 2014). However, developments in population size have been uneven, with some regions having an increase in population, while others experienced a decrease (Figure 1.2). With about 500 people per km^2 of land, the Netherlands is a densely populated country.

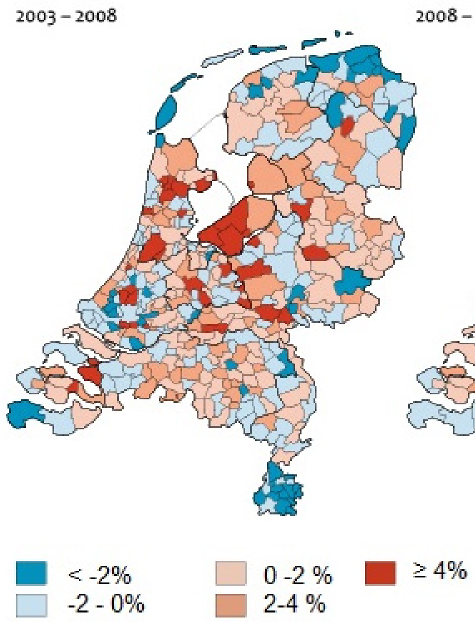

Figure 1.2. *Population size developments per municipality, 2003-2008 and 2008-2013 (source: CBS, PBL & Wageningen UR, 2014).*

Between 1995 and 2013, the area of cultivated land decreased with 6% (LEI & CBS, 2014). Of the more than 94,000 hectare agricultural land that disappeared between 2000 and 2010, 51% has been built upon, 22% has been turned into forest and nature, 10% into land for recreation, 9% into infrastructure, and 8% into water (CBS, PBL & Wageningen UR, 2014). The urban area has increased with 16% in the past 20 years (CBS, PBL & Wageningen UR, 2014). This increase is one of the factors in the decline of the area under agriculture ("habitat conversion'). In addition, a process of suburbanization of the countryside has taken place, with farms being converted into houses for people not depending on agriculture.

The gross domestic product of the Netherlands increased from € 505,833 million in 2003 to € 642,851 million in 2013. The combined value added of agriculture, forestry and fisheries increased from € 10,157 million to € 11,392 million, i.e. the relative contribution of agriculture, forestry and fisheries decreased from 2.01% in 2003 to 1.77% in 2013 (CBS, 2014). The sectors contributing most to the gross domestic product in 2011 were government and care (19.8%), trade, transport and food service industry (16.8%), industry (11.5%) and business services (9.9%) (LEI & CBS, 2015).

When processing activities are also taken into account, the gross value added of the Dutch agricultural sector rose from € 33,300 million in 1995 to € 45,600 million in 2005 and € 52,600 million in 2011. About half (€ 26,100 million) of the added value in 2011 is based on the domestic production and processing of agricultural raw materials, and the other half on the processing, delivery and distribution of foreign-grown agricultural raw materials such as cocoa and tobacco. The contribution of the agricultural complex to the total national value added declined from 12.3% in 1995 to 9.5% in 2005, after which it slightly increased to 9.8% in 2011 (Van Leeuwen *et al*, 2014).

The number of people working regularly in agriculture decreased from 276,000 in 1995, through 258,000 in 2005 to 193,000 in 2013 (CBS, 2014; LEI & CBS, 2014). Of the 193,000 people regularly working in agriculture in 2013, 68% can be classified as family labour and 32% as non-family labour, while 68% was male and 32% female (CBS, 2014; LEI & CBS, 2014).

The number of labour year units involved in agricultural production decreased from 188,000 in 2003 to 160,000 in 2013 (CBS, 2014; LEI & CBS, 2014). In 2013, 69,000 labour year units were involved in horticulture (of which 41,000 in horticulture under glass), 35,000 in dairy farms, 20,000 in farms with other grazing animals, 14,000 in intensive livestock farms, 16,000 in arable farming, and 7000 in mixed farms. About 58% of the labour year units in agricultural production consists of family labour (Berkhout *et al*, 2014).

1.2 Role of biodiversity for food and agriculture

1.2.1 Agriculture

In 2013, the total area of cultivated land in the Netherlands was 1.85 million ha, of which 983,000 ha was grassland, 532,000 ha was used for arable crops, 236,000 ha for fodder and feed crops, and 96,000 ha for horticultural crops (of which 10,000 ha under glass) (CBS, 2014; LEI & CBS, 2014; Berkhout *et al*, 2014). The total number of farms was 67,481 (LEI & CBS, 2014; Berkhout *et al*, 2014). While between 1995 and 2013 the area of cultivated land decreased with 6%, the number of farms decreased with 40%, resulting in an increase in average farm size (LEI & CBS, 2014).

Up to the 1970s, many mixed farms (with arable and livestock components) existed in the Netherlands, especially in the southern and eastern parts of the country. Since then, significant specialisation occurred, resulting in large, highly specialised pig and poultry farms. In contrast to most cattle farms, these are not soil-bound. The number of farms with cattle, pig and/or poultry as its core business has decreased over the last 50 years, while production per farm has increased (Hiemstra, 2002). The productivity per animal has also increased, in particular for dairy cattle, pigs, broilers and laying hens. For instance, the productivity per milking cow has increased by 10% over the last decade (Hiemstra, 2014). Since the 1990s, organic livestock farming has emerged (Hiemstra, 2002).

The transformation in the 20th century of small farms into large farms depending on high input and industrial management practices, led to the decimation of natural and semi-natural landscape elements, such as hedges, ditches and tree patches. These developments had a negative impact on associated biodiversity. To counteract the loss of biodiversity, some remaining areas of traditional agricultural production systems are protected as nature reserves. In addition, biodiversity and other environmental management schemes have been put in place. Notwithstanding biodiversity-supportive agro-environmental schemes, total biodiversity in Dutch agro-ecosystems has still been declining (Visser, 2008).

The number of organic farms increased from 439 in 1991, through 906 in 2000 and 1250 in 2010, to 1,440 in 2013, and their area increased from 9200 ha in 1991, through 26,900 ha in 2000 and 45,800 ha in 2010, to 49,400 ha (2.7% of total cultivated land) in 2013 (CBS, PBL & Wageningen UR, 2015). However, the Dutch organically managed area is still below the European average, which was 5.4% in 2011 (EC, 2013).

Although urban farming, oriented toward customers living close to the production locations (Van der Schans, 2010), is becoming more popular, its role in food production is still small, amounting to only 1-2% (De Knegt, 2014).

The main regulating and supporting ecosystem functions sustaining the production of agricultural systems are pollination, pest and disease regulation, protection of soil fertility and habitat provisioning. In general, the decline in the prevalence of natural and semi-natural landscape elements and agricultural intensification has led to decreased pollination, pest and disease regulation and habitat provisioning in agricultural areas (Geiger *et al*, 2010).

1.2.2 Forestry

The area under forest in the Netherlands is approximately 360,000 ha. From an economic point of view, the Dutch forestry sector is of minor importance. The number of jobs in the forest sector is estimated to be approximately 2,200 only, but when employment in supply companies and the wood processing industry is included, the total number is much higher, an estimated 42,500 (Buiteveld, 2012).

Production is mainly for the purpose of industrial roundwood. Industrial roundwood is used for pulpwood (46%), sawn timber and veneer (45%), and other purposes such as particle board and pallets (9%). Due to a change in forest management (nature-oriented forest management), the volume of roundwood removal has been decreasing since 1990. Harvesting is most often carried out by selective thinning. Firewood removal has risen slightly in recent years, mainly caused by an increase in the use of woodchips for energy production. Turnover in the forestry sector directly related to harvesting and processing of wood from Dutch forests is approximately € 230 million. However, forests play an important role in the recreation sector. Recreational activities in and around the forest are often essential for a tourist town or region and generate additional income for the local population. Non-wood forest products such as wild meat are of minor importance to the Dutch forest sector. Only the earnings from hunting licences provide a reasonable income for forest owners. None of the Netherlands' native trees and shrubs are used for food security (Buiteveld, 2012).

Forests and their forest genetic resources provide numerous ecosystem services, including habitats for plants and animals, soil and water catchment protection, provision of reliable high-quality water supplies, options for recreational opportunities, and provision of carbon sinks (Buiteveld, 2012). From the estimated total of 1400 indigenous vascular plant species, at least 240 have economic value because of their relevance as progenitors or close relatives of human food plants, spices, feed and fodder crops, host plants of honey bees, medicinal plants, species for firewood and timber production, as providers of natural dyes, tannins, pesticides or perfumes, and for their ornamental value. Almost half of these 240 vascular plant species occur in forests and woodlands, i.e. in the tree layer or in the understorey layer (Visser, 2008).

In 1990, a policy to create the National Nature Network (NNN; formerly called 'National Ecological Network') was introduced in order to improve, interconnect and extend natural areas. It turned the nature loss into a slight nature gain, mostly by developing nature areas on former agricultural lands in order to connect up nature areas (Visser, 2008).

In a study aimed at quantifying the economic value of the ecosystem services supplied by the Hoge Veluwe forest, one of the largest and most well-known protected areas of the country, covering a forest and heather landscape of about 5500 ha, the economic benefits were estimated at around € 10.8 million per year (€ 2000 per ha per year), over three times the value generated by nearby agricultural land. Over 90% of this value is generated by only three services: recreation, groundwater infiltration, and air filtration (Hein, 2011).

1.2.3 Fisheries and aquaculture

From the national economic perspective, the fisheries and aquaculture sectors are of minor importance. The capture fisheries sector can be divided into marine and inland fishing, and the aquaculture sector into shellfish culture and fish culture.

Marine fisheries comprise fisheries for pelagic species with large deepfreeze trawlers (*grote zeevisserij*), fisheries for demersal fish and shrimps (*kleine zeevisserij*) and shellfish fishery. The number of active fishing vessels has decreased over the recent decade, due to restrictive fishing quota and a reduction of the overcapacity in the fleet. The pelagic fleet comprises 8 large deepfreeze trawlers targeting herring, horse mackerel, blue whiting, mackerel and sardines in the north-east Atlantic and the waters off West Africa. The landings of the pelagic fleet gradually decreased to 225 million kg in 2014. The number of people employed in 2012 was 547. The demersal fleet of 275 cutters are mainly targeting flatfish (sole and plaice) in the southern and central North Sea and brown shrimp in the shallow waters of the continental coast of the eastern North Sea. Demersal fish landings varied around 45 million kg and shrimp landings around 14 million tons (LEI, 2015a). The number of people employed in 2012 was 1055 (Rijnsdorp *et al*, 2014). Four vessels are allowed to fish for shellfish in the Dutch coastal waters. The target species varies in time due to the large fluctuations in species composition of the major stocks of shellfish. Currently these vessels target American razor clams (*Ensis directis*) and landed 2700 tonnes in 2012 (Rijnsdorp *et al*, 2014). In 2014, the number of companies involved in marine fisheries was 595, of which 405 with only one person involved (CBS, 2014).

Inland waters in the Netherlands measure some 270,000 hectares, of which the most important water body is the Lake IJssel. Competition between professional fishers and sports fishers has led to a system of division of fishing rights and licenses, with the exception of Lake IJssel where professional fishermen have priority. The most important species by value are European eel (*Anguilla anguilla*) and pike-perch (*Stizostedion lucioperca*) (FAO, 2005). In 2014, the number of companies involved in inland fisheries was 175, of which 120 with only one person involved (CBS, 2014).

The shellfish sub-sector consists of 50 companies growing blue mussels and 32 companies growing oysters. About 275 persons earn an income from shellfish culture activities (employment in processing and trade not included) (Van der Heijden, 2007). Shellfish culture takes place in the estuarine waters in the southwest Netherlands and in the shallow Wadden Sea in the North of the country.

The culture of fish for consumption purposes took off in the 1980s from almost nothing to a yearly production of 10,000 t, but in recent years the production has declined (Van Duijn *et al*, 2010). In the 2000s, there were approximately 90 companies growing fish for consumption in heated recirculation aquaculture systems, plus approximately five outdoor rainbow trout farms, and approximately 155 people worked on fish farms (Van der Heijden, 2007). In 2014, the number of companies involved in sea fish aquaculture was 80, of which 25 with only one person involved (CBS, 2014).

1.2.4 *Ex situ* and *in situ* conservation

With respect to *ex situ* conservation of biodiversity for food and agriculture, the Centre for Genetic Resources, the Netherlands (CGN), other public institutions, botanical gardens, NGOs, farmers and private companies manage plant, animal and forest genetic resources collections of major importance for food and agriculture at a global scale.

CGN, established in 1986 and administered by Wageningen University and Research centre (WUR), holds about 23,000 accessions of about 20 plant species, with a main focus on vegeTable crops and potatoes. In addition to the CGN national plant genetic resources collection in the public domain, other plant genetic resources collections have been established and maintained as well. These include collections established in the private sector (mainly plant breeding companies), collections maintained by botanical gardens and other public institutions (often associated with universities), and collections maintained by non-governmental organizations. These collections are not static, as material from elsewhere is regularly added to increase the diversity of the collections. Botanical gardens manage large collections including wild relatives, whereas NGOs have focussed on traditional crop diversity. Holdings of plant genetic resources managed in the private sector have increased considerably in size.

Until 1999, CGN was only active in the domain of plant genetic resources, but since then CGN has also acquired the mandate to contribute to the conservation of farm animal species and indigenous trees and shrubs (Visser, 2008). As for animal genetic resources, CGN is collecting genetic material and maintains *ex situ* gene bank collections of cattle, pigs, sheep, goats, horses, chickens, ducks, geese and dogs. Rare breeds as well as widely used, commercial breeds are represented in the gene bank (Hiemstra, 2014). The responsibility for *ex situ* conservation of Dutch autochthonous trees and shrubs is shared between CGN and the State Forest Service (*Staatsbosbeheer*, SBB). A living gene bank for trees and shrubs was established in 2006, and since then the number of accessions of trees and shrubs in this gene bank has been extended to about 3,735, belonging to 48 different species. Additionally, botanical gardens, arboretums, and NGOs manage several field collections of forest genetic resources of a wide range of native and non-native tree species (Buiteveld, 2012).

With respect to *in situ* conservation, only few traditional plant varieties, especially of potatoes and fruit species, are still produced by commercial growers, but substantial traditional diversity is maintained in homegardens, and in-garden maintenance of traditional varieties has been shown to represent a robust conservation system. Sales of traditional and regional products through farm shops and other niche markets increasingly contribute to the conservation and utilization of *in situ* managed crop genetic diversity. The Netherlands is home to only a limited number of genera that can be regarded as more direct wild relatives of our cultivated crops. No specific policy has been developed to protect the species involved, but based on scientific research most can be assumed to survive in national parks and nature reserves (Visser, 2008).

In the livestock sector, breeding associations and NGO networks are active in supporting the *in situ* conservation of locally adapted/native breeds. There is a strong collaboration between the Dutch rare breeds society (SZH), CGN and individual breed societies to support the complementary *in situ* and *ex situ* conservation of locally adapted/native Dutch livestock breeds (Hiemstra, 2014).

The opportunities for *in situ* conservation of forest genetic resources are limited, as forest remnants containing the original vegetation are often under heavy pressure, especially from urban expansion, road construction and clay and sand mining. The primary strategy for long-term conservation of Dutch biodiversity is to make use of an extensive network of protected areas that does not necessarily coincide with conservation of forest genetic resources. In 2011, however, 10 gene conservation units for 11 target species were established, together comprising an area of about 340 ha. These gene conservation units consist mainly of one or two stands of rare species (Buiteveld, 2012).

1.3 Production systems in the country

1.3.1 Identification of production systems

Table 1.1 shows which of the production systems defined in the Guidelines for the preparation of the Country Reports are relevant for the Netherlands.

In total, 9 main production systems are distinguished:
- Livestock grassland-based systems: Temperate (L3);
- Livestock landless systems: Temperate (L7);
- Planted forests: Temperate (F7);
- Self-recruiting capture fisheries: Temperate (A3);
- Culture-based fisheries: Temperate (A7);
- Fed aquaculture: Temperate (A11);
- Non-fed aquaculture: Temperate (A15);
- Rainfed crops: Temperate (C11);
- Others: horticulture under glass (O1).

Table 1.1. Production systems present in the country.

Sector	Code	Production system names	Present (Y/N)
Livestock	L1	Livestock grassland-based systems: Tropics	
	L2	Livestock grassland-based systems: Subtropics	
	L3	Livestock grassland-based systems: Temperate	Y
	L4	Livestock grassland-based systems: Boreal and /or highlands	
	L5	Livestock landless systems: Tropics	
	L6	Livestock landless systems: Subtropics	
	L7	Livestock landless systems: Temperate	Y
	L8	Livestock landless systems: Boreal and /or highlands	
Forests	F1	Naturally regenerated forests: Tropics	
	F2	Naturally regenerated forests: Subtropics	
	F3	Naturally regenerated forests: Temperate	
	F4	Naturally regenerated forests: Boreal and /or highlands	
	F5	Planted forests: Tropics	
	F6	Planted forests: Subtropics	
	F7	Planted forests: Temperate	Y*
	F8	Planted forests: Boreal and /or highlands	
Aquaculture and Fisheries	A1	Self-recruiting capture fisheries: Tropics	
	A2	Self-recruiting capture fisheries: Subtropics	
	A3	Self-recruiting capture fisheries: Temperate	Y
	A4	Self-recruiting capture fisheries: Boreal and /or highlands	
	A5	Culture-based fisheries: Tropics	
	A6	Culture-based fisheries: Subtropics	
	A7	Culture-based fisheries: Temperate	Y
	A8	Culture-based fisheries: Boreal and /or highlands	
	A9	Fed aquaculture: Tropics	
	A10	Fed aquaculture: Subtropics	
	A11	Fed aquaculture: Temperate	Y**
	A12	Fed aquaculture: Boreal and /or highlands	
	A13	Non-fed aquaculture: Tropics	
	A14	Non-fed aquaculture: Subtropics	
	A15	Non-fed aquaculture: Temperate	Y
	A16	Non-fed aquaculture: Boreal and /or highlands	
Crops	C1	Irrigated crops (rice) : Tropics	
	C2	Irrigated crops (rice) : Subtropics	
	C3	Irrigated crops (rice) : Temperate	
	C4	Irrigated crops (rice) : Boreal and /or highlands	
	C5	Irrigated crops (other) : Tropics	
	C6	Irrigated crops (other) : Subtropics	
	C7	Irrigated crops (other) : Temperate	
	C8	Irrigated crops (other) : Boreal and /or highlands	
	C9	Rainfed crops : Tropics	
	C10	Rainfed crops : Subtropics	
	C11	Rainfed crops : Temperate	Y
	C12	Rainfed crops : Boreal and /or highlands	

Mixed	M1	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	
	M2	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	
	M3	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	N***
	M4	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	
Others	O1	Others [*please specify*]: Greenhouse horticulture	Y
* According to FOREST EUROPE et al (2011) there is 58,000 ha of naturally regenerated forest and 307,000 ha of planted forest. Buiteveld (2012) states, however, that there are some areas with naturally regenerated forests, for example on heathlands, but this area is relatively small, and no estimates of the number of hectares can be given. In the present report, all forest in the Netherlands is considered to be planted forest. ** Although this system is present in the temperate climate of the Netherlands, the temperatures for growing species such as catfish are kept artificially higher. *** Of minor importance, and therefore not treated in detail in the present report.			

1.3.2 Description of production systems

In Table 1.2 a brief description is given of each of the production systems that have been identified as occurring in the Netherlands.

The occurrence of the various types of production systems in the country is shown in Figure 1.3. The Figure shows that arable crops predominate in the south-western and north-eastern parts of the country, and in the relatively new polders in Lake IJssel. Horticulture is particularly important in the western part of the country, near the larger cities, while perennial crops (mainly fruit trees) are especially found near the large rivers in southern-central part. Grassland-based livestock keeping is practised almost throughout the country, but landless livestock systems are mainly found in the south-eastern and central parts. Mixed farms became less important in the past decades.

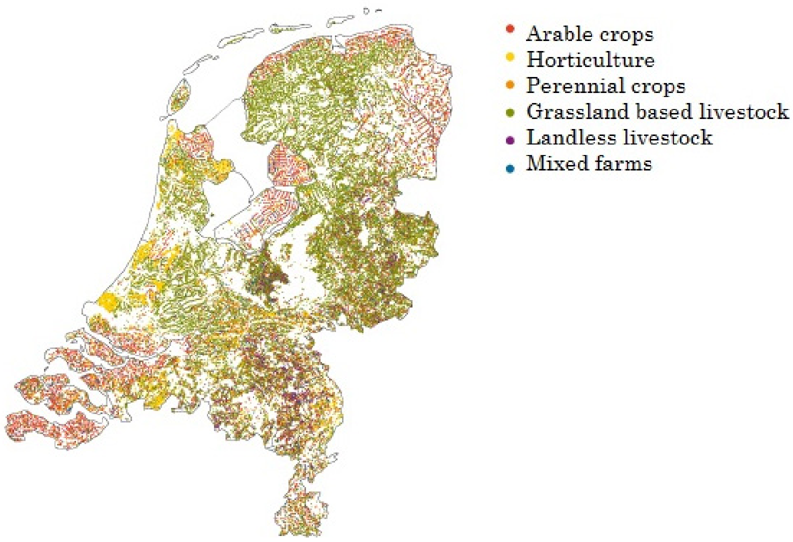

Figure 1.3. *Distribution of farms according to main farming activity, 2013 (source: CBS, PBL & Wageningen UR, 2014)*

Table 1.2. *Production systems present in the country.*

Code of production system	Name of production system	Description
L3	Livestock grassland-based systems: Temperate	Includes cattle (1.553 million heads in 2013), sheep (1.034 million heads), goats (413,000 heads) and horses and ponies (131,000 heads). About 54,500 labour year units (lye) involved in dairy farming in 2013, and about 11,200 lye in farms with other grazing animals. Unfertilized grasslands yield about 4-8 t dry matter per ha per year, and heavily fertilized grasslands 13-15 t. Common fertilizer rates on production grasslands are 200-300 kg N per ha per year on peat soils, and 300-400 kg on other soils. Grasslands are ploughed and renewed every 5-10 years. Occasionally, chemical weed and pest control are practised. The abolition of the European milk quota system in 2015 has encouraged many dairy farmers to increase their production capacity, by increasing average farm and herd sizes and adopting robotic milking systems. This has also been associated with a larger proportion of the dairy herd being kept indoors year-round. As a result, the dairy sector is gradually becoming more specialized and industrialized.
L7	Livestock landless systems: Temperate	Includes pigs (12.212 million heads in 2013), chickens (97.719 million heads) and calves for veal (925,000 heads). About 14,300 lye involved in 2013.
F7	Planted forests: Temperate	Focus on recreation and nature conservation, instead of on wood production. Area primarily assigned for wood production about 4000 ha, area managed for biodiversity conservation about 90,000 ha, and area with multi-use function about 266,000 ha. Number of jobs about 2,200.
A3	Self-recruiting capture fisheries: Temperate	Marine and inland fishing. In marine fisheries, less than 300 ships are involved, with about 1600 crew members.
A7	Culture-based fisheries: Temperate	Eels are set out in inland waters by professional fishermen and by the Dutch government ('restocking'). Young eels ("glass eels") are obtained from specialized French and British fishermen, and either set out immediately or first raised for some time in eel farms. Other fish species are also restocked, e.g. by anglers.
A11	Fed aquaculture: Temperate	Fish culture (mainly eel and catfish). In the 2000s about 95 companies, and about 155 people involved.
A15	Non-fed aquaculture: Temperate	Shellfish culture (mussels, oysters). About 50 companies growing mussels and 32 companies growing oysters. About 275 people involved.
C11	Rainfed crops: Temperate	Arable crops (cereals, potatoes, sugar beets, silage maize, others) + outdoor horticulture (vegetables, fruits, flower bulbs, tree nurseries). Predominantly rainfed; in extremely dry periods some watering. About 15,800 lye involved in arable farming in 2013, and about 28,300 lye in outdoor horticulture. The production system of arable crops is characterized by regular ploughing of the soil, the use of fertilizer (on average about 200 kg N per ha per year), chemical disease- and pest control products, and mechanical and/or chemical weed control.
O1	Others	Horticulture under glass (vegetables, flowers). About 40,900 lye in 2013.

Sources: Berkhout *et al*, 2014; Bos *et al*, 2013; Buiteveld, 2012; CBS, 2014; Melman & Van der Heide, 2011; Rijnsdorp *et al*, 2014; Van der Heijden, 2007.

1.3.3 Importance of production systems

Table 1.3 gives, where possible, information on the area under production, the production quantity, and the contribution to the agricultural sector economy in the Netherlands, for each of the production systems. It clearly shows that the main contributors to the agricultural sector economy are Horticulture under glass (O1), Rainfed crops (C11) and the two Livestock systems (L3 and L7), while the contribution of the aquatic production systems is very limited.

1.3.4 Importance of exports

The Dutch agricultural sector is highly focused on exports. Since 1995, exports have been generating about three quarters of the value added and employment of the agricultural complex. The reduced foreign demand for Dutch agricultural products, due to the financial crisis, has resulted in a lower export dependency from 2009 onwards (Van Leeuwen *et al*, 2014). In 2012, about 46% of the Dutch agricultural production was exported, and the export value of Dutch agricultural products was 63% higher than in 1995 (CBS, PBL & Wageningen UR, 2014).

The Netherlands ranks second worldwide in the value of agricultural exports behind the United States, with earnings amounting to € 78 billion in 2013, and agricultural exports forming 18% of total exports. When re-exportation (about 20% of agricultural exports) is taken into account, the Netherlands ranks third. The country's location gives it prime access to markets in the UK and Germany, with the port of Rotterdam being the largest in Europe. The main destination of Dutch agricultural exports is Germany (€ 20 billion) (ING, 2014).

In 2012, the economically most important product groups in Dutch agricultural exports were meat (€ 8.2 billion), ornamental products and plants (€ 8.1 billion), dairy products (€ 5.9 billion), animal feeds excluding cereals (€ 4.6 billion), vegetables (€ 4.4 billion) and fruits (€ 3.9 billion) (LEI & CBS, 2014). However, for some of these product groups large quantities were imported as well, especially meat (€ 4.3 billion), animal feeds excluding cereals (€ 3.8 billion), dairy products (€ 3.1 billion), and fruits (€ 4.6 billion). On the other hand, the import values of horticultural products and plants (€ 1.4 billion) and vegetables (€ 1.4 billion) were relatively low (LEI & CBS, 2014).

The import (for re-exportation) of large quantities of plants and other materials from abroad, may have effects on Dutch biodiversity. On the one hand, the introduction of new species increases biodiversity, while on the other hand, their introduction can also lead to decreased biodiversity, as some alien species have negative effects on indigenous flora and fauna (CBS, PBL & Wageningen UR, 2014; Noordijk *et al*, 2010; Smaal *et al*, 2009).

Table 1.3. Area under production, production quantity and contribution to the agricultural sector economy for production systems in the country.

Production system		Area	Production quantity	Contribution to the agricultural sector economy (%) *	Reference year
Code	**Name**				
L3	Livestock grassland-based systems: Temperate	987,000 ha	Milk: 11.9 million t Beef: 159,000 t Sheep and goat meat: 14,000 t	17.5% ** 29.9% ***	2012
L7	Livestock landless systems: Temperate	NA	Pork: 1.3 million t Poultry: 1.1 million t Veal: 220,000 t Eggs: 11,000 million (672,000 t)	6.3% ** 19.3% ***	2012
F7	Planted forests: Temperate	365,000 ha (available for wood supply: 295,000 ha)	Net annual increment in timber stock: 2.24 million m^3. Fellings: 1.55 million m^3. Roundwood removal: 1.1 million m^3. About 450 t of game meat.	NA	2005
A3	Self-recruiting capture fisheries: Temperate		Horse mackerel: 79,200 t Herring: 55,800 t Blue whiting: 35,000 t Plaice: 28,300 t Mackerel: 24,900 t Shrimp: 18,900 t Sole: 8,700 t Cod: 2.700 t	1.3% ** 0.9% ***	2010
A7	Culture-based fisheries: Temperate				
A11	Fed aquaculture: Temperate	NA	Catfish: 2100 t Eel: 2000 t		2011
A15	Non-fed aquaculture: Temperate	7361 ha (mussels: 5311 ha; oysters: 2050 ha)	Mussels: 32,000 t Oysters: 3500 t		2011
C11	Rainfed crops: Temperate	839,000 ha (including 232,000 ha silage maize and 86,000 ha outdoor horticulture)	Silage maize: 10.7 million t Potatoes: 6.8 million t Sugar beets: 5.7 million t Wheat: 1.3 million t Vegetables: 3.1 million t	33.4% ** (including 14.4% outdoor horticulture) 27.7% *** (including 7% outdoor horticulture)	2012
O1	Others (horticulture under glass)	10,000 ha	Vegetables: 1.7 million t	41.5% ** 22.2% ***	2012

* Forestry not included; data 2011
** Primary production
*** Including processing industry, suppliers and distribution ('agrocomplex') (Van Leeuwen *et al*, 2014)

(Sources: Berkhout *et al*, 2014; Blonk *et al*, 2014; Buiteveld, 2012; CBS, 2014; FOREST EUROPE et al, 2011; LEI & CBS, 2014; Van Leeuwen *et al*, 2014.)

2. Drivers of change

2.1 Effects of drivers of change on associated biodiversity

Important drivers causing changes in the extent and distribution of associated biodiversity in and around production systems in the Netherlands are 1. High inputs of nutrients; 2. Low groundwater tables; 3. Use of chemical crop protection products; and 4. Changed landscape configuration in the livestock and rainfed crop systems (Geiger et al, 2010; Noordijk *et al*, 2010; Notenboom *et al*, 2006; Oerlemans *et al*, 2015; Scheper *et al*, 2014). During the last 30 years, these factors have resulted in a decline of biodiversity in Dutch agricultural landscapes.

2.1.1 High inputs of nutrients

Over the past decades, the nitrogen balance of agricultural soils has become more even (Figure 2.1). In the period from 2003 to 2013, the nitrogen supply decreased from 353 kg/ha to 311 kg/ha, while the removal (mainly through crop products) increased from 181 kg/ha to 209 kg/ha. The total supply of nitrogen to agricultural soils decreased from 733 million kg to 605 million kg in 2003-2013, while the removal (mainly through crop products), increased from 387 million kg to 440 million kg (CBS, 2014).

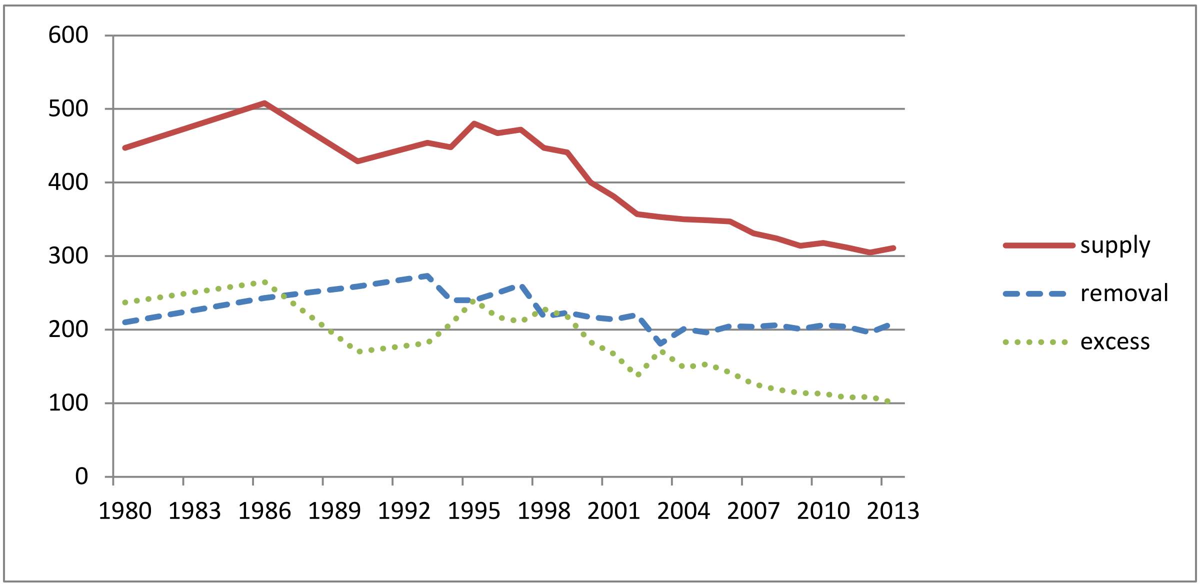

Figure 2.1. Nitrogen supply, removal and excess (supply minus removal) to/from agricultural soils, in kg N per ha (source: CBS, PBL & Wageningen UR, 2014).

The phosphorus balance has almost become even (Figure 2.2). In the period from 2003 to 2013, the total supply to agricultural soils decreased from 95 million kg to 64 million kg, while the removal increased from 52 million kg to 58 million kg (CBS, 2014).

It must be borne in mind, however, that the supply of both nitrogen and phosphorus was higher than removal in every year of the period 2003-2013, which means that the overall amounts of nitrogen and phosphorus in these soils have further increased in the period considered.

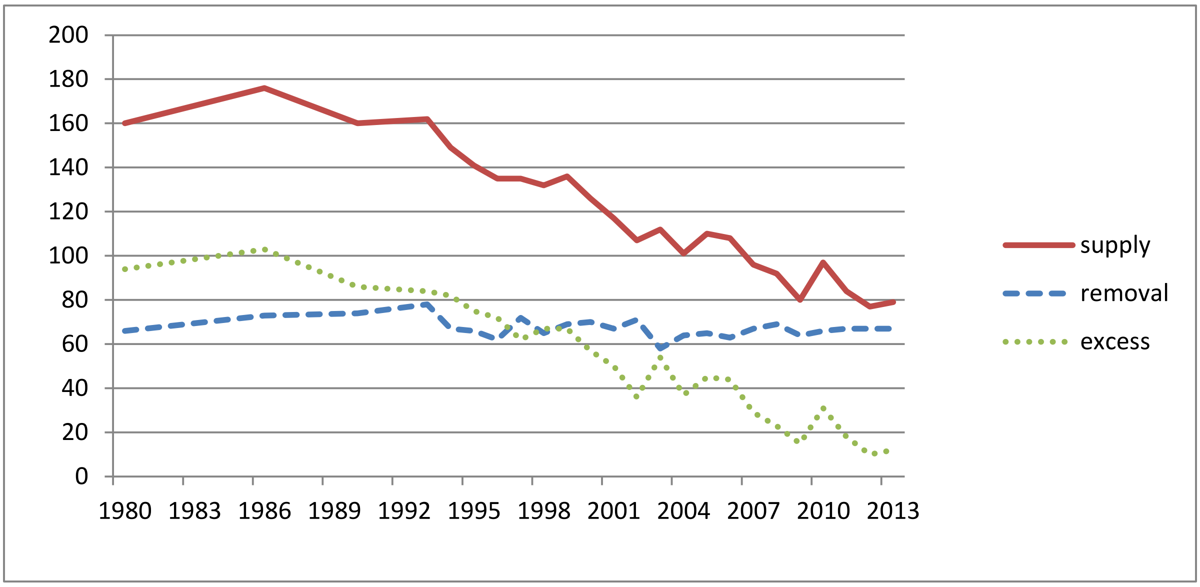

Figure 2.2. Phosphorus supply, removal and excess (supply minus removal) to/from agricultural soils, in kg P per ha (source: CBS, PBL & Wageningen UR, 2014).

The fact that nitrogen and phosphorus balances have become more even is largely due to government policies. Up to 1998, Dutch manure policies were mainly aimed at reducing the application of phosphorus. After the introduction of the Mineral Accounting System (*Mineralenaangiftesysteem*, MINAS) in 1998, focusing on nitrogen and phosphorus flows on individual farms and taxing farms where nutrient surpluses exceeded defined limits, the amounts of nitrogen also decreased. In 2006, the Mineral Accounting System was replaced by a system of application standards of nitrogen and phosphorus (CBS, PBL & Wageningen UR, 2014).

Ammonia (NH_3) emission into the air occurs from stables and manure storage facilities, and during grazing and manure spreading on the land. Ammonia emissions are calculated on the basis of, among other things, numbers of animals, nitrogen excretion, housing systems and manure spreading techniques. Calculated ammonia emissions from agriculture in the country have declined from 333 million kg in 1990, through 123 million kg in 2005, to 102 million kg in 2012. However, although calculated emissions have declined, measured ammonia concentrations in the atmosphere have remained at the same level since 1993 (CBS, PBL & Wageningen UR, 2015).

2.1.2 Low groundwater tables

In many areas, water management has been adapted to agriculture, meaning that groundwater levels are kept low. Because high groundwater tables are favourable for much natural vegetation, a lowered groundwater Table has profound impacts on the ecology of grasslands and wetlands (Notenboom *et al*, 2006; Oerlemans *et al*, 2015). Low water tables in agricultural areas also cause serious drought problems for adjacent nature reserves (Schrijver & Uetake, 2014).

The average groundwater level in the Netherlands decreased with 30 cm in the period 1950-1969, after which is stabilized. In the period 1990-1999, however, a further decrease seems to have occurred. In 2000 an area of

492.000 ha was dried, of which about 257.000 ha with nature as main function, and 235.000 ha with nature as secondary function (e.g. meadow bird areas and borders of ditches) (CBS, PBL & Wageningen UR, 2015).

The lowering of groundwater levels has not only affected biodiversity, but has also led to a reduced water holding capacity of agricultural land. Reduction of water holding capacity of agricultural land is also caused by soil compaction due to intensification of cultivation (Staps *et al*, 2015). At present, water boards are establishing covenants with farmers' organizations to increase the water holding capacity of polders.

Lowering of groundwater levels also leads to mineralization and decomposition of peat soils, resulting in an annual CO_2-emission of 4.2 Mt CO_2-equivalents, or 3-5% of the annual CO_2-emission of the Netherlands (De Knegt, 2014).

2.1.3 Use of chemical crop protection products

In a study in the Netherlands and various other European countries it was found that the use of pesticides, especially insecticides and fungicides, had consistently negative effects on the species diversity of plants, carabids and birds in agricultural fields, and on the potential for biological pest control (Geiger *et al*, 2010).

The sale of chemical crop protection products has declined since the 1980s, but in the past 10-15 years it has been fluctuating around an average level of 10 million kg of active matter (Figure 2.3). From 2000 to 2012, the total amount of chemical crop protection products used in Dutch agriculture increased slightly from 5454 t to 5606 t, and the use per ha from 6.6 kg to 6.9 kg (CBS, 2014).

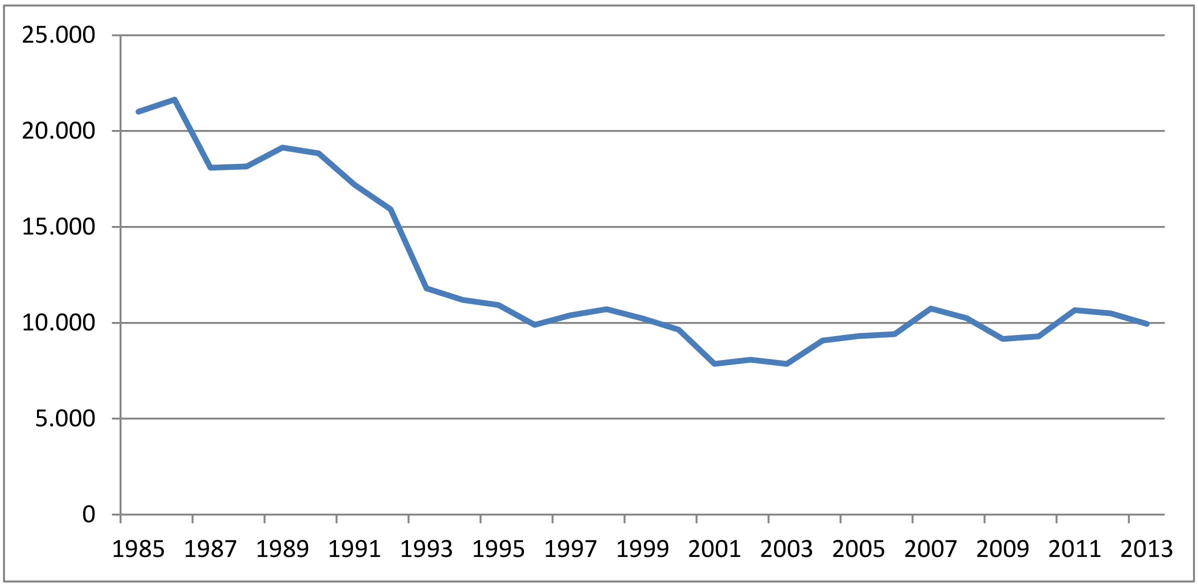

Figure 2.3. *Sale of chemical crop protection products in kg of active matter (source: CBS, PBL & Wageningen UR, 2014).*

In horticulture under glass, the use of insecticides has decreased. In the period 2000-2008, the use of insecticides in fruit vegetables, such as tomato and sweet pepper, decreased with 30%, and that in flowers with 35%. Factors which have contributed to this development are a ban on certain insecticides and an increase in the use of biological pest control in flowers (Mulder *et al*, 2011).

In the period 1998-2010, the use of plant protection products in agriculture has placed a considerably smaller burden on the environment. Two-thirds of the environmental benefits were found to be due to the implementation of emission reduction measures. However, it was concluded that surface waters still contain too many residues from plant protection products, adversely affecting aquatic organisms (Van Eerdt et al, 2012).

The use of certain chemical crop protection products (neonicotinoids) is suspected of playing a role in a decline in honeybee populations, important for pollination in Dutch agriculture. However, there is still no scientific consensus on the degree to which crop protection products contribute to this decline (CBS, PBL & Wageningen UR, 2014). In a recent study it was emphasized that the discussion should not be limited to honey bees, but should also take into account the effects of neonicotinoids on other pollinators, such as bumble bees, solitary bees, hoverflies, butterflies and moths, and it was concluded that there is an increasing body of evidence that the widespread prophylactic use of neonicotinoids has severe negative effects on non-target organisms that provide ecosystem services including pollination and natural pest control (EASAC, 2015).

2.1.4 Changed landscape configuration

The transformation in the 20th century of small farms into large farms depending on high input and industrial management practices had a negative impact on associated biodiversity (Visser, 2008). Between 1950 and 1980, for instance, many re-allotments (*ruilverkavelingen*) were carried out. This resulted in larger agricultural fields, the disappearance of landscape elements such as hedges, ditches and tree patches, and the straightening of brooks and roads (CBS, PBL & Wageningen UR, 2015; Notenboom *et al*, 2006; Oerlemans *et al*, 2015).

The trend of farming become more large-scale is continuing. The total area of cultivated land in the Netherlands decreased with 5% from 1.95 million ha in 2003 to 1.85 million ha in 2013, while the total number of farms declined with 21% from 85,400 to 67,500 in the same period, resulting in an increased average farm size (CBS, 2014; LEI & CBS, 2014).

2.2 Effects of climate change on associated biodiversity

During the past 100 years, the average annual temperature in the Netherlands has increased with 1,5 °C (Figure 2.4), the total annual rainfall with about 20%, and the heavy rainstorms have become more frequent (CBS, PBL & Wageningen UR, 2015; Oerlemans *et al*, 2015) Van Minnen & Ligtvoet, 2012). It is expected that these trends will continue. The past 20 years, the temperature increase has been about 0.03 °C per year (CBS, PBL & Wageningen UR, 2015).

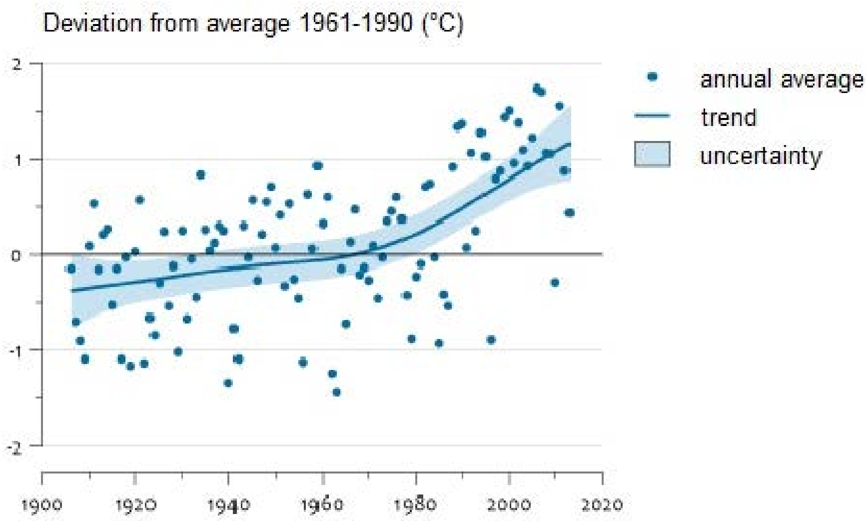

Figure 2.4. Temperature in the Netherlands (source: CBS, PBL & Wageningen UR, 2014).

The increased air temperature, together with the discharge of cooling water, has led to an increased water temperature in the main rivers (almost 3 °C in the past 100 years). The temperature of smaller inland waters has also increased (CBS, PBL & Wageningen UR, 2014). Sea surface temperatures in Dutch coastal waters have also increased since the 1980s (Van Aken, 2010). The rate of change since 1985 is nearly triple the global warming rate (MacKenzie & Schiedek, 2007).

In a study which included 60 animal species (45 bird, 12 insect, and 3 amphibian species), it was found that the number of individuals of thermophilic animal species increased during the past decades, whereas the number of individuals of cold-tolerant species decreased (Figure 2.5).

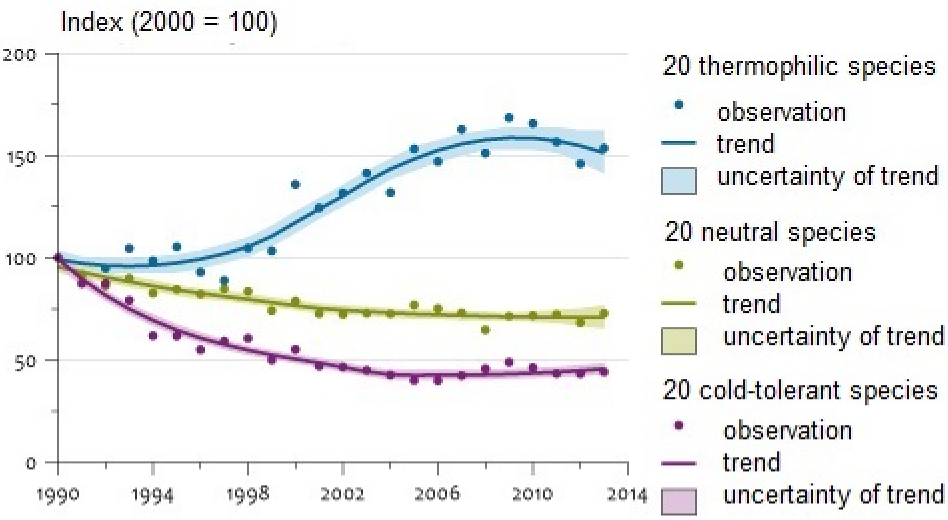

Figure 2.5. The influence of climate change on animal species (birds, insects, and amphibians) (source: CBS, PBL & Wageningen UR, 2014).

Although the effects of climate change on associated biodiversity and ecosystem services have been limited so far, they may become more pronounced in the future. Increasing temperatures lead to longer growing seasons. Effects also include shifts in distribution areas and life cycles of species, including organisms causing pests and diseases (Van Minnen & Ligtvoet, 2012). Climate change induced changes in the life cycles of species usually mean that species start their development and activities earlier in the year. This may lead to mismatches between predators and preys, when the life cycle of one is more affected by increasing temperatures than that of the other (Noordijk *et al*, 2010). Climate change is also expected to lead to increased water problems due to peak rainfall (Van Minnen & Ligtvoet, 2012).

2.3 Effects of drivers of change on biodiversity for food and agriculture

Table 2.1 gives some information on the influence of various groups of drivers of change on biodiversity for food and agriculture during the past 10 years. Here, biodiversity for food and agriculture is considered to comprise "the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the ecosystem structures, functions and processes in and around production systems, and that provide food and non-food agriculture products" (FAO, 2013).

Because for many drivers it was impossible to assess their influence on a specific production system in the specific period, only those Table rows are shown where an assessment could be made.

Qualitative descriptions of the effects of various drivers in the different production systems are given beneath the table.

Table 2.1. *Effect of groups of drivers of change on sector biodiversity within production systems in the country in the past 10 years, by animal (AnGR), plant (PGR), aquatic (AqGR) and forest (FGR) genetic resources (effect strongly positive (+2), positive (+1), negative (-1), strongly negative (-2), no effect at all (0), or not known (nk)); for a description of the drivers, see Annex 2).*

Production systems	**Drivers of change**	**Effect of drivers of change on sector biodiversity for food and agriculture**			
		PGR	**FGR**	**AnGR**	**AqGR**
L3 (Livestock grassland-based systems: Temperate)	Changes in land and water use and management	-1			
	Markets, trade and the private sector			-1	
	Policies			-1	
	Changing economic, socio-political, and cultural factors			-1	
	Advancements and innovations in science and technology			-1/+1	
L7 (Livestock landless systems: Temperate)	Markets, trade and the private sector			-1	
	Policies			0	
	Changing economic, socio-political, and cultural factors			-1	
	Advancements and innovations in science and technology			-1/+1	
F7 (Planted forests: Temperate)	Changes in land and water use and management	+1	+1	+1	
	Pollution and external inputs		-1		
	Over-exploitation and overharvesting		-1		
	Pests, diseases, alien invasive species		-2		
	Policies		+1		
	Population growth and urbanization		-1		
A3 (Self-recruiting capture fisheries: Temperate)	Over-exploitation and overharvesting				0/-1
	Climate change				+1
	Pests, diseases, alien invasive species				+1
	Markets, trade and the private sector				+1
	Policies				+1
	Changing economic, socio-political, and cultural factors				+1
	Advancements and innovations in science and technology				+1
A7 (Culture-based fisheries: Temperate)	Over-exploitation and overharvesting				-1
A15 (Non-fed aquaculture: Temperate)	Pests, diseases, alien invasive species				+1
C11 (Rainfed crops: Temperate)	Changes in land and water use and management			0	
	Pollution and external inputs				-1
	Markets, trade and the private sector	+1			
	Policies	+1		+1	
	Changing economic, socio-political, and cultural factors	+1			
O1 (Others	Markets, trade and the private sector	+1			

Production systems	Drivers of change	Effect of drivers of change on sector biodiversity for food and agriculture			
		PGR	FGR	AnGR	AqGR
(horticulture under glass))					

L3 (Livestock grassland-based systems: Temperate)

- The average fertilization of grassland decreased from 351 kg N and 88 kg P per ha per year in 2006 to 322 kg N and 77 kg P per ha per year in 2012, but is still high (LEI, 2015b). According to Melman & Van der Heide (2011), the number of grass and herb species on unfertilized grasslands with relatively poor soils is 20-30, while in fertilized grassland the number of species is 5-15.
- During the second half of the 20th century, European and national agricultural and environmental policies, together with technological developments, resulted in increased use of a small number of specialized breeds in the animal production sector. In the dairy sector, for instance, the principal, mainstream dairy breed is the Holstein Friesian. Besides genetic diversity in terms of number of breeds, the monitoring and management of within-breed genetic diversity is relevant for both mainstream and rare breeds (Hiemstra, 2002; Hiemstra, 2014).
- The abolition of the European milk quota system in 2015 has encouraged many dairy farmers to increase their production capacity, by increasing average farm and herd sizes and adopting robotic milking systems. This has been associated with a larger proportion of the dairy herd being kept indoors year-round, and more grassland being mown instead of grazed (Bos *et al*, 2013). However, the effects of this development on biodiversity are not known.
- Demand for and supply of biological agricultural products has risen. In 2013, biologically managed pastures covered about 34,000 ha. There were 54,000 biologically managed cattle, and 50,000 sheep and goats (CBS, 2014). There is also an increasing interest in regional products, “local to local”, and typical, quality products. These developments may provide new opportunities to exploit farm animal genetic diversity, to support the conservation of animal biodiversity, and to promote diversification of breed and agro-ecosystem related food products and services (Hiemstra, 2014).
- The rapid developments in genomic and reproductive technologies provide new opportunities for breeding and conservation of genetic diversity. Although in particular commercial breeds and sufficiently large populations will benefit from genomic selection, local breeds and smaller populations size may also benefit, or may be used for the introgression of “lost” traits (Hiemstra, 2014).

L7 (Livestock landless systems: Temperate)

- During the second half of the 20th century, European and Dutch stimulation policies, together with technological developments, resulted in specialization and industrialization in the animal production sector. Currently, 99.98% of chicken are globally-used commercial breeding lines, with the remaining 0.02% consisting of about 20 native Dutch breeds (Van Veen *et al*, 2008). In the poultry sector, only a limited number of breeding organisations are active, and the major part of commercial production utilises a limited number of breeds or lines. A similar development is taking place within the pig sector, although there are currently more active breeding companies than in the poultry sector (Hiemstra, 2002; Hiemstra, 2014).
- Societal concerns about animal welfare are increasing, leading to consumers and retailers becoming more demanding (Hiemstra, 2014). The effect of this trend on biodiversity in livestock landless systems in the past 10 years is not known. However, demand for and supply of biological agricultural products has risen. In 2013, there were 64,000 biologically managed pigs and 2.2 million chickens (CBS, 2014). There is also an increasing interest in regional products, “local to local”, and typical, quality products. This may provide new opportunities to further exploit farm animal genetic diversity, to support the conservation of animal biodiversity, and to promote diversification of breed and agro-ecosystem related food products and services (Hiemstra, 2014).
- The rapid developments in genomic and reproductive technologies provide new opportunities for breeding and conservation of genetic diversity. Although in particular commercial breeds and sufficiently large populations

will benefit from genomic selection, local breeds and smaller populations size may also benefit, or may be used for the introgression of "lost" traits (Hiemstra, 2014).

F7 (Planted forests: Temperate)

- During the past decades, the objective of forest management has shifted from wood production to multi-purpose forest management with the focus on recreation and nature conservation. As a result, the forest area primarily assigned for wood production has declined, and the forest area managed for biodiversity conservation has increased. Management now focuses on increasing the amount of dead wood in the forest, increasing the number of large and thick trees, enhancing structural diversity, increasing the number of different age classes, and promoting native tree species (Buiteveld, 2012). The Dutch forest is increasingly mixed, mainly at the cost of mono species coniferous forest (Schelhaas *et al*, 2014). Changed forest management has led to increases in the numbers of certain forest birds, bats, invertebrates and mushrooms (Noordijk *et al*, 2010).
- Forest genetic resources are threatened by the use of herbicides and fertilizers that end up at forest edges (Buiteveld, 2012).
- They are also threatened by logging and inappropriate thinning in old woodlands and hedges (Buiteveld, 2012).
- Various diseases affect forest genetic resources. The Dutch elm disease (*Ophiostoma novo-ulmi*), for instance, is a major threat to the genetic diversity of native elm species (*Ulmus minor*, *Ulmus glabra*) in the Netherlands. Other examples in trees are watermark disease (*Brenneria salicis*) in willows (mainly *Salix alba*), oak wilt (*Ceratocystis fagacearum*), ash dieback (*Hymenoscyphus pseudoalbidus*), and poplar rust (*Melampsora medusae*). American black cherry (*Prunus serotina*) is an important invasive exotic species. It is abundantly present in half of the Dutch forests, complicating forest management and hindering the regeneration of native species (Buiteveld, 2012).
- The policy document 'Nature for People, People for Nature' (2000) stated that forests must be managed in an economically feasible, sustainable manner, and that long-term conservation of woodlands and further expansion of the forested area to more than 400,000 ha by 2020 will be continued (Buiteveld, 2012).

A3 (Self-recruiting capture fisheries: Temperate)

- Overexploitation has been a problem in the marine and inland fisheries sector. However, due to restrictions imposed by EU and national policies, exploitation practices in North Sea fisheries have become more sustainable. For example, since the 1990s, the amounts of herring, cod, plaice and sole caught have not exceeded the total allowable catch (TAC) of these species, established by the EU to prevent overexploitation (CBS, PBL & Wageningen UR, 2015). The mortality rates imposed by fishing have decreased since 2000 by about 35% and the spawning stock biomass is starting to recover (ICES, 2013). However, fishing may lead to genetic effects due to the selection for particular life history traits. The changes in the onset of sexual maturation, growth rate and reproductive investment observed in North Sea plaice and sole are consistent with a fisheries-induced evolutionary change (Grift *et al*, 2003; Mollet *et al*, 2007; Van Walraven *et al*, 2010). Fisheries-induced evolution can reduce the productivity of the resource (Laugen *et al*, 2014). The few studies on the genetic diversity of North Sea sole and plaice using molecular tools show contradictory results (Hoarau *et al*, 2005; Cuveliers *et al*, 2011). Overexploitation in the inland fisheries sector seems to have continued in the past decade.
- Positive trends in species richness were observed in marine benthos and fish species. Marine Protected Areas are currently being established in the Dutch part of the North Sea. In the Dutch coastal zone, 10% of the surface has been closed to all fishing by 2011, 15% is closed to bottom trawling, and 28% is closed for fishing with heavy bottom trawl gear (http://www.noordzeeloket.nl/projecten/noordzee-natura-2000/nieuws/2012/nieuwsbrief-januari-2012/het-vibeg-akkoord.aspx). In the inland fishery sector, fishing activities are also regulated In the inland fishery sector, fishing activities are regulated through licenses and restrictions with respect to fishing gear, fishing areas and fishing seasons (De Leeuw *et al*; Noordijk *et al*, 2010).
- In the coastal fishery sector, special attention has been paid to the interrelations between fishing activities and the ecological value of nature. Where productive and ecological functions of the coastal area were mutually exclusive, a separation between the functions was established, leading to closures of specific areas for fishing (FAO, 2005). In the Wadden Sea area, mechanical cockle fishing was banned in 2004 (Floor *et al*, 2013).

- The observed increase in sea temperatures in the southern North Sea resulted in changes in the fish community. Species that prefer warmer temperatures, such as sea bass, have increased, while species that prefer cooler waters, such as plaice or cod, have decreased or moved to deeper waters (Dulvy *et al*, 2008; Ter Hofstede & Rijnsdorp, 2011). In general, the species richness is increasing, likely in response to the increase in temperature and the appearance of invasive species (Ter Hofstede *et al*, 2010; Oerlemans *et al*, 2015).
- Invasive species sometimes have beneficial effects. For instance, the American razor clam (*Ensis directis*), which has established itself in the 1980s (Wolff, 2005), has become the main wild shell fish species targeted by shellfish fisheries.
- Within the Dutch society, the concern about the ecological effects of fishing has grown. The introduction of certification schemes such as MSC became an important driver of more sustainable fishing practices (Agnew *et al*, 2014). Of the fish sold in Dutch supermarkets, 85% is now MSC certified (keurmerken.milieucentraal.nl).
- Technical innovations are being explored to reduce collateral damage to the ecosystem, in particular to reduce the bycatch of undersized fish and the reduction of the adverse effects on seabed habitats (Van Marlen *et al*, 2014).

A7 (Culture-based fisheries: Temperate)

- In the past years, the diversity of species (mainly European eel) targeted in culture-based fisheries has not changed, but the production volume of eel decreased due to a decline in the supply of glass eel.

A11 (Fed aquaculture: Temperate)

- There is no information on the effect of drivers on sector biodiversity for food and agriculture in the past 10 years.

A15 (Non-fed aquaculture: Temperate)

- There is no information on the effect of drivers on sector biodiversity for food and agriculture in the past 10 years. However, it has been reported that the American razor clam, which has established itself in the 1980s (Wolff, 2005), has become the main shell fish species targeted by the shellfish fisheries.

C11 (Rainfed crops: Temperate)

- In general, a large number of varieties for a substantial number of different crops is on offer in the market, and no indications exist that the diversity of these crops in the market is decreasing or threatened (Visser, 2008). On the other hand, although there may be a large number of varieties on the market for the major crops, a large part of the area is grown with only a few of these. A number of crops have almost disappeared in the past few decades, including rye, oats, caraway, and fodder beets, while crops such as rape seed, fodder maize, hemp, green manure crops and catch crops, have gained in importance and added to the total genetic diversity employed in agricultural production (Visser, 2008).
- Due to changes in land use in the past 50 years, with the summer flora in field boundaries, ditch banks and roadside verges being intensively mown or grazed, there has been a decline in wild bees. However, analyses of the population trends of all Dutch bee species suggest that more species have declined between the periods pre-1970 and 1970-1989 than between the periods 1970-1989 and post-1990. These findings suggest that the decline of the Dutch bee fauna has come to a standstill and could indicate a recovery of some bee populations (Scheper *et al*, 2014).
- In the period 1998-2010, the use of plant protection products in agriculture has placed a considerably smaller burden on the environment than in the 1980s, especially as a result of the implementation of emission reduction measures. However, surface waters still contain too many residues from plant protection products, adversely affecting aquatic organisms (Van Eerdt et al, 2012).
- The average fertilization in agriculture and horticulture decreased from 262 kg N and 99 kg P per ha per year in 2006 to 194 kg N and 56 kg P per ha per year in 2012 (LEI, 2015b), but the effects of this decrease on biodiversity is not known.
- Demand for and supply of organic agricultural products has risen. In 2013, the total area under organic agriculture was 49,400 ha, of which 7600 ha in farms with arable crops, 7400 ha in mixed farms, 1400 ha on horticultural farms, and 500 ha in farms with perennial crops (CBS, PBL & Wageningen UR, 2015).

- Niche markets for consumers with a keen interest in regional and traditional products or with an immigrant culture background, as well as organic production, are also slowly developing (Visser, 2008).
- At the EU-level, the reform of the Common Agricultural Policy (CAP) in 1992 envisaged the reduction of the negative consequences of agricultural intensification by financially supporting agri-environment schemes and organic farming (Council Regulation 2078/92/EEC). In a study in the Netherlands and various other European countries it was found that both agri-environment schemes and organic farming positively affected the species diversity of plants, and carabids in agricultural fields, but not bird species diversity (Geiger *et al*, 2010).
- The awareness of the importance of biodiversity and the interest in conservation and use of genetic resources that are characteristic of past land use, such as hedgerow landscapes have increased amongst the wider public (Buiteveld, 2012; Visser, 2008).

O1 (Others (horticulture under glass))

- The main vegetables grown in glasshouses are tomatoes, sweet peppers, cucumbers and eggplant. Of these, tomatoes have shown a rapidly increasing acreage since 2000, while the area under the other three main crops has remained more or less stable. The increase of the area under tomatoes is due to product diversification, as the increase may be attributed completely to small-fruited tomatoes (Visser, 2008).

2.4 Effects of drivers of change on regulating and supporting ecosystem services

Table 2.2 gives information on the influence of various groups of drivers on regulating and supporting ecosystem services during the past 10 years. Because for many drivers it was impossible to assess their influence on a specific production system in the specific period, only those Table rows are shown where an assessment could be made.

Qualitative descriptions of the effects of various drivers in the different production systems are given below.

L3 (Livestock grassland-based systems: Temperate)

- The management of grassland systems is changing, with pastures being mown more often. While the total area under grassland decreased slightly from about 980,000 ha in 2005 (data for 2003 not available) and 932,000 ha in 2013, the mown area increased considerably from 1,965,000 ha in 2005 to 2,482,000 in 2013 (CBS, 2014). Also, pastures are mown earlier in the season and more rapidly, and sometimes even at night. This has had negative effects on habitat provisioning to birds through damaging of nests and killing of young birds. Factors which have contributed to earlier and more frequent mowing include the lowering of groundwater levels, the extension of the growing season due to climate change, and the fact that more cows remain in stables throughout the year.
- The average fertilization of grassland decreased from 351 kg N and 88 kg P per ha per year in 2006 to 322 kg N and 77 kg P per ha per year in 2012, but is still high (LEI, 2015b). According to Melman & Van der Heide (2011), the number of grass and herb species on unfertilized grasslands with relatively poor soils is 20-30, while in fertilized grassland the number of species is 5-15.
- The lowering of groundwater tables reduces the availability of worms as food for meadow birds during droughts (Oerlemans *et al*, 2015).
- The abolition of the European milk quota system in 2015 has encouraged many dairy farmers to increase their production capacity, by increasing average farm and herd sizes and adopting robotic milking systems. This has been associated with a larger proportion of the dairy herd being kept indoors year-round, and more grassland being mown instead of grazed (Bos *et al*, 2013).
- The lowering of groundwater levels leads to mineralization and decomposition of peat soils, resulting a CO_2-emission of 4.2 Mt CO_2-equivalents, or 3-5% of the annual CO_2-emission of the Netherlands (De Knegt, 2014).

Table 2.2. *Effect of groups of drivers of change on regulating and supporting ecosystem services in production systems (effect strongly positive (+2), positive (+1), negative (-1), strongly negative (-2), or no effect at all (0); for a description of the drivers, see Annex 2; for a description of the ecosystem services, see Annex 3).*

Production systems	**Drivers of change**	**Effect of drivers of change on regulating and supporting ecosystem services**								
		Pollination	**Pest and disease regulation**	**Water purification and waste treatment**	**Natural hazard regulation**	**Nutrient cycling**	**Soil formation and protection**	**Water cycling**	**Habitat provisioning**	**Production of oxygen / Gas regulation**
L3 (Livestock grassland-based systems: Temperate)	Changes in land and water use and management								-2	-1
	Climate change								-1	
	Policies								-1	
	Advancements and innovations in science and technology								-1	
F7 (Planted forests: Temperate)	Changes in land and water use and management								+2	+1
	Population growth and urbanization								-1	
A3 (Self-recruiting capture fisheries: Temperate)	Changes in land and water use and management								+1	
	Climate change								+1	
	Over-exploitation and overharvesting								-1	
	Pests, diseases, alien invasive species								-1/ +1	
	Advancements and innovations in science and technology								+1	
A15 (Non-fed aquaculture: Temperate)	Changes in land and water use and management								+1	
	Policies								+1	
C11 (Rainfed crops: Temperate)	Changes in land and water use and management	-1/0	-2				-1	-1		
	Pollution and external inputs	-1/0	-2						-2	

L7 (Livestock landless systems: Temperate)

- The role and direct impact of these systems in providing regulating and supporting ecosystem services has remained limited.

F7 (Planted forests: Temperate)

- During the past decades, forest management has shifted from the purpose of only wood production to multi-purpose forest management. it now focuses on increasing the amount of dead wood in the forest, increasing the number of large and thick trees, enhancing structural diversity, increasing the number of different age classes, and promoting native tree species (Buiteveld, 2012). The changed forest management has led to increases in the numbers of certain forest birds, bats, invertebrates and mushrooms (Noordijk *et al*, 2010).
- In forest areas, fragmentation occurs through road construction (Buiteveld, 2012).
- The net annual CO_2-sequestration of forests in the Netherlands is about 2.7 Mt CO_2. The area under forest has increased in the past decades, resulting in increased CO_2-sequestration by forests (De Knegt, 2014).

A3 (Self-recruiting capture fisheries: Temperate)

- The increase in the surface area of the sea floor that is protected from bottom trawl fisheries has increased due to the building of oil/gas platforms and wind farms. The hard structures created adds habitat that was naturally absent in the soft sediments of the Dutch part of the North Sea. On the other hand, marine mammals (porpoises) may be adversely affected by the noise during the construction of wind farms.
- In the North Sea, the populations of fish showed an average increase of 25% between 1990 and 2001, with stabilization after 2003 (Oerlemans *et al*, 2015). The number of fish species increases, as a result of climate change (Oerlemans *et al*, 2015).
- Bottom trawl fisheries disturb sea bed habitats and reduce biodiversity. The effects are largest in biogenic habitats and relatively sTable habitats in deeper waters (Reiss *et al*, 2009; Lambert *et al*, 2014; Van Denderen *et al*, 2014). In shallow waters that are frequently exposed to natural perturbations by tidal currents or storms, bottom trawling has less impact (Diesing *et al*, 2013).
- Fisheries also affect the structure of ecosystems by selectively removing certain species and size classes of fish (Daan *et al*, 2005). The changes in species and size composition affect the functioning of the ecosystem, but it is unknown how this will affect services such as nutrient cycling.
- The introduction of the Pacific oyster (*Crassostrea gigas*) into the Netherlands in the 1960s has resulted in invasion of the Oosterschelde estuary that is still in progress. From the Oosterschelde proliferation has occurred to the adjacent water bodies and is now expanding to the North (Wadden Sea). On the one hand, this is considered a serious threat for existing functions of coastal waters such as for shellfish culture and as feeding areas for shellfish-eating birds. On the other hand, oyster reefs can also provide an important habitat for certain species (Smaal *et al*, 2009).
- Technical innovations are being explored to reduce collateral damage to the ecosystem, in particular to reduce the bycatch of undersized fish and the reduction of the adverse effects on seabed habitats (Van Marlen *et al*, 2014).
- In freshwater areas, improvements in water quality and the construction of fish passages has led to improved habitat provisioning. In freshwater and marshes, population sizes of animal species have increased with 40% in 1990-2003, with stabilization afterwards (Oerlemans *et al*, 2015).

A7 (Culture-based fisheries: Temperate)

- There is no information on the developments with respect to regulating and supporting ecosystem services in these systems, and their drivers.

A11 (Fed aquaculture: Temperate)

- Due to the use of recirculation systems in fed aquaculture, the role of these systems in providing regulating and supporting ecosystem services has remained limited.

A15 (Non-fed aquaculture: Temperate)

- Intensive shell fish cultures may potentially reduce the food availability of other species.
- In the past, the collection of mussel seed has reduced the surface area of inter-tidal mussel beds that provide habitat for a variety of invertebrate species as well as food for waders. Inter-tidal mussel beds have been closed for fishing, and mechanical fishing for mussel seed has been gradually reduced from 2009 onwards and will have been replaced by mussel seed collectors by 2020 (http://www.rijkewaddenzee.nl/programma/mosselconvenant/toelichting).

C11 (Rainfed crops: Temperate)

- As the surface of natural habitats in agricultural areas is decreasing, and it is assumed that a decrease in habitats for natural pest regulators leads to a decreased natural pest regulation, a decrease in natural pest regulation is probable (De Knegt, 2014).
- In a study in the Netherlands and various other European countries it was found that the use of pesticides, especially insecticides and fungicides, had consistently negative effects on the species diversity of plants, carabids and farmland birds and on the potential for biological pest control (Geiger *et al*, 2010).
- The use of certain chemical crop protection products (neonicotinoids) is suspected of playing a role in a decline in honeybee populations, important for pollination in Dutch agriculture. However, there is still no scientific consensus on the degree to which crop protection products contribute to this decline (CBS, PBL & Wageningen UR, 2014). The controversy over the possible effects of neonicotinoids on honey bees has led to a European Commission regulation in 2013, which restricted certain uses of these pesticides on flowering crops (EASAC, 2015). In a recent study it was emphasized that the discussion should not be limited to honey bees, but should also take into account the effects of neonicotinoids on other pollinators, such as bumble bees, solitary bees, hoverflies, butterflies and moths, and it was concluded that there is an increasing body of evidence that the widespread prophylactic use of neonicotinoids has severe negative effects on non-target organisms that provide ecosystem services, including pollination and natural pest control (EASAC, 2015). On the other hand, analyses of the population trends of all Dutch bee species suggest that more species have declined between the periods pre-1970 and 1970-1989 than between the periods 1970-1989 and post-1990. These findings suggest that the decline of the Dutch bee fauna has come to a standstill and could even indicate a recovery of some bee populations (Scheper *et al*, 2014).
- Intensification of cultivation has led to soil compaction and reduction of the water holding capacity of agricultural land in areas such as the polders in Lake IJssel (Staps *et al*, 2015). Soil compaction has a negative influence on soil life (Derks *et al*, 2012).
- On the loess soils of South Limburg, water erosion has increased in the past decades. This increase is strongly related to changing agricultural land use and practices: row crops such as maize and potatoes are more erosion-sensitive than winter cereals; re-allotment schemes (*ruilverkavelingen*) and the clearing of hedgerows have resulted in larger fields, causing surface runoff to be more erosive; and the use of heavy machinery has led to compaction and more runoff (Winteraeken & Spaan, 2010).

O1 (Others (horticulture under glass))

- The role of these systems in providing regulating and supporting ecosystem services has remained limited.

2.5 Effects of drivers of change on wild foods

Except for fish caught in marine and freshwater systems, the collection of wild foods has hardly any importance in the Netherlands (CBS, PBL & Wageningen UR, 2015). Terrestrial wild foods collected or hunted in the Netherlands include plants (e.g. berries), mushrooms, animals (e.g. boars, roes, hares, pheasants), but terrestrial wild foods are of minor importance only. It has been estimated that wild foods (including fish) comprise only 1-2% of the food consumed in the Netherlands (De Knegt, 2014).

With respect to the drivers causing changes in the availability, diversity and knowledge of aquatic wild foods in the Netherlands, the following remarks can be made.

- In North Sea fishing, quotas set by EU policies have led to more sustainable exploitation practices.
- In the North Sea, the species richness is increasing, likely in response to the increase in temperature and the appearance of invasive species (Ter Hofstede *et al*, 2010; Oerlemans *et al*, 2015).
- The number of wild species harvested from marine areas increased due to the increased supply and the development of the market that are interested to take new species.
- In inland waters, mass kills of fish may occur due to oxygen depletion or chemical or thermal pollution. Overexploitation of fresh water fish has led to a decline in availability of freshwater fish such as eel and pike-perch.

- The building of infrastructural works and hydro-electric power stations led to a decrease of anadromous and catadromous fish species as it created physical migration barriers that disconnected the spawning and feeding habitats (De Groot, 1992).
- The eutrophication in the 1960-1980s positively affected the productivity of the coastal waters of the Netherlands as reflected in trends in phytoplankton, benthic invertebrates and fish (Beukema, 1989; Colijn *et al*, 2002; Philippart *et al*, 2007; Tulp *et al*, 2008).

2.6 Effects of drivers of change on traditional knowledge and gender

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 amongst the wider public in the use of traditional genetic resources, local and regional products, and typical, quality products (Buiteveld, 2012; Hiemstra, 2014; Visser, 2008).

Gender
The main drivers causing changes in the involvement of women in the maintenance and use of biodiversity for food and agriculture in the Netherlands in the past decades are the increasing labour participation of women, and the shifting perceptions on the role of women in society.

2.7 Countermeasures addressing current and emerging drivers of change, best practices and lessons learned

General
- To counteract fragmentation of nature areas, the 'National Nature Network' (NNN; formerly called 'National Ecological Network'), has been established and is further extended. The NNN is an interconnected network of nature reserves and conservation areas, with the aim of securing and connecting existing nature reserves and creating 'new nature' (Noordijk *et al*, 2010; Buiteveld, 2012). It also includes production forests and farmland, such as grasslands used as breeding sites for meadow birds (De Kool, 2012). The land area is about 750,000 ha, consisting of existing nature areas (including the 20 national parks), areas where new nature is created, and areas under agrarian nature management, and the open water area is more than 6 million ha (including lakes, rivers, the North Sea and the Wadden Sea) (www.atlasleefomgeving.nl). The NNN contains a relatively large part of Dutch biodiversity, and its establishment contributes to a reduction of biodiversity loss in the country. It is also considered to be important for protecting Dutch nature against climate change and other environmental influences, because survival opportunities for populations are better in an ecological network than in isolated areas (Noordijk *et al*, 2010). By the end of 2012, the additional land area acquired for the NNN amounted to about 90,000 ha (CBS, PBL & Wageningen UR, 2015).
- 'Natura 2000' is the network of nature areas in the European Union, that are protected on the basis of the Birds (1979) and Habitats (1992) Directives. Natura 2000-areas in the Netherlands are selected on the species and habitats they harbour, and are mostly part of the NNN. At present, the Dutch Natura 2000-areas cover about 1 million ha, of which about two thirds open water (Noordijk *et al*, 2010; CBS, PBL & Wageningen UR, 2015).

Agriculture

- In the 1990s, the potential role of farmers in the management of landscape and agrarian nature was recognized more and more, which resulted in an increasing number of agrarian nature management agreements, with measures taken by farmers to improve the quality of nature and the landscape. Examples of these measures are maintenance or establishment of flower-rich field boundaries, natural management of ditch banks, and protection of birds in agricultural lands. By the end of 2012, the total area covered by agri-environment schemes in the Netherlands was almost 59,000 ha. After a decline of the area by about 10,000 ha between 1999 and 2009, it increased by 5000 ha between 2009 and 2012. The target in terms of numbers of hectares under agri-environmental schemes has been abandoned in the 2013 'Pact for nature' (*Natuurpact*) covenant, but not the instrument as such. However, the relatively short term of the contracts means that the continuity of agri-environment schemes remains uncertain (CBS, PBL & Wageningen UR, 2015).
- In the 'Integrated Approach to Nitrogen' (*Programmatische Aanpak Stikstof*, PAS), which has come into force on 1 July 2015, the national government and regional authorities cooperate to halt the loss of biodiversity due to nitrogen deposition, and to ensure the recovery of ecosystems. This has to be achieved by minimising nitrogen emissions, for instance by stricter rules for building stables, and by implementing nature restoration measures such as additional vegetation management or hydrological improvements. As long as the overall nitrogen emissions decrease and the conservation status of species and habitats increases, there will be room for economic development (Ministry of Economic Affairs, 2014; Oerlemans *et al*, 2015).
- The EU Common Agricultural Policy (CAP), launched in 1962, was originally aimed at increasing agricultural productivity to guarantee a sTable food supply at affordable prices and to ensure a viable agricultural sector. Many adaptations have been made since its establishment, and nowadays it has a wider range of goals, from contributing to farm incomes to the sustainable management of natural resources. The reform of the Common Agricultural Policy (CAP) in 1992, for instance, envisaged the reduction of the negative consequences of agricultural intensification by financially supporting agri-environment schemes and organic farming (Council Regulation 2078/92/EEC). In 2010 the European Commission published the document 'The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future', which outlines the challenges and policy options for the period 2014-2020. The document recognizes that agriculture plays a key role in the production of public goods, such as landscapes, farmland biodiversity and climate stability. The future CAP aims at viable food production throughout the EU, to guarantee long-term food security, sustainable management of natural resources and a balanced territorial development (Van Zeijts *et al*, 2011).
- The 'EU biodiversity strategy to 2020' of 2011 states that the reform of the CAP presents opportunities to enhance synergies and maximise coherence with biodiversity objectives. With regard to agriculture, the goal is to maximise areas that are covered by biodiversity-related measures under the CAP, to ensure and improve the conservation status of species and habitats that depend on or are affected by agriculture, and to provide ecosystem services, thus contributing to sustainable agricultural management. The CAP and the biodiversity strategy both aim at promoting the provision of environmental public goods by farmers. From the CAP perspective, the objective is not only to contribute to climate and environmental policy goals, but also to increase legitimacy for CAP payments by remunerating farmers for the collective services they provide to society (Van Zeijts *et al*, 2011).
- All EU Member States are obliged to develop alternative pest control methods to reduce the dependence on chemical crop protection. Integrated Pest Management (IPM) is considered the key instrument in achieving these targets, and therefore the principles of IPM must be implemented by all European growers by 2014 (Van Eerdt *et al*, 2014).
- Water boards are establishing covenants with farmers' organizations to increase the water holding capacity of polders.
- In the network 'Biodiversity under glass' farmers have experimented with planting flowers in and around glasshouses, to stimulate biological pest control organisms (Janmaat *et al*, 2014).

Forestry

- A living gene bank for trees and shrubs was established in 2006. Forest tree nurseries are increasingly using reproductive material derived from this gene bank to supply nature restoration projects (Buiteveld, 2012).

Fisheries and Aquaculture

- In the VIBEG agreement, concluded by the fishing industry, nature conservation organizations and the government in 2011, it was agreed to establish Marine Protected Areas in the Dutch part of the North Sea. In the Dutch coastal zone, 10% of the surface is closed to all fishing by 2011, 15% is closed to bottom trawling, and 28% is closed for fishing with heavy bottom trawl gear (http://www.noordzeeloket.nl/projecten/noordzee-natura-2000/nieuws/2012/nieuwsbrief-januari-2012/het-vibeg-akkoord.aspx).
- Physical migration barriers have been lifted by building fish passages, and plans are developed for creating migration possibilities in the barrier dams of major estuaries and rivers (Haringvliet, Afsluitdijk).
- Innovative fishing gears are being promoted to mitigate collateral damage to the ecosystem (pulse trawl, separator panels). Mussel Seed Collectors (MZI) are being introduced to replace the mussel dredge.

Best practices and lessons learned

Agri-environment schemes have been discontinued by farmers at a substantial scale. The reasons most commonly cited by farmers for ending their participation are land management problems (e.g. increased weed problems), problems of fitting the schemes in with their normal agricultural practices, the level of financial compensations, the level of bureaucracy involved, and having sold the land for which management contracts under agri-environment schemes had been concluded (CBS, PBL & Wageningen UR, 2015).

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

3.1 Overall assessment of the state and trends of diversity of plant, animal, forest and aquatic genetic resources

3.1.1 Overall state and trends of biodiversity

In the 20th century, species biodiversity in the Netherlands decreased strongly from a mean species abundance of about 40% in 1900 to about 15% in 2000, meaning that in 2000 the populations of species were on average 15% of that in the near natural state. This loss was mainly caused by land use change, environmental pressure and fragmentation of ecosystems. Since 1990, the loss of biodiversity has been slowing down, but with large differences between ecosystems: the biodiversity of heath lands, semi natural grasslands and agriculture is still in decline, whereas the biodiversity in forests and dunes has stabilised and even showed local improvements (Van Veen *et al*, 2008). As agricultural land comprises about 67% of the total land area of the Netherlands ((LEI & CBS, 2014; CBS, 2015), the decline in its biodiversity counts heavily.

In the framework of the Dutch nature policy, target species have been defined and their numbers are being monitored per square kilometre. In natural areas, the average numbers of target species of vascular plants and summer birds increased in the period 1990-2005, compared with the 1975-1989 period, whereas in agricultural areas, they decreased over the same period. Butterfly numbers decreased in both types of area, but more so in agricultural areas than in natural areas. The different trends for natural and agricultural areas are caused by the fact that in natural areas spatial and environmental conditions have improved (e.g. acidifying and nitrogen depositions have decreased, and habitat development and restoration projects have been implemented), whereas in agricultural areas, environmental conditions are being optimised for the needs of agriculture, maximising production and harvesting efficiency, resulting in fewer species having the space they need to survive (CBS, PBL & Wageningen UR, 2015).

For animal species, the Dutch Living Planet Index (LPI) shows that, on average, population sizes have increased with 15% from 1990 to 2003, and have stabilized in the period 2003-2013. Populations of mammals, breeding birds, reptiles and dragonflies increased, those of amphibians and butterflies decreased, and those of fish (freshwater and sea) remained sTable (Oerlemans *et al*, 2015). The population sizes of animal species in agricultural landscapes declined with 40% in the period 1990-2013, with population declines for both breeding birds and butterflies. In forests, animal population sizes have remained sTable since 1990, whereas in open nature areas (heath land, open dunes, non-agrarian grasslands) population sizes have decreased with 50% since 1990, with stabilization in the past 10 years. In cities and villages, the populations of breeding birds and butterflies decreased with 30% in the period 1990-2013.

In freshwater and marshes, on the other hand, population sizes of animal species have increased with 40% in 1990-2003, with stabilization afterwards (Oerlemans *et al*, 2015). In the North Sea, the populations of mammals and fish showed an average increase of 25% between 1990 and 2001, with stabilization after 2003 (Oerlemans *et al*, 2015). The number of fish species increases, as a result of climate change (Oerlemans *et al*, 2015).

3.1.2 Plant genetic resources for food and agriculture

In total, over 41 different food and feed crops have a production area of over 100 ha in the Netherlands. Only five of those (wheat, barley, maize, sugar beet and potato) have an acreage of over 25,000 ha. Twenty vegeTable crops are extensively cultivated in the Netherlands. In terms of diversity, this group is richer than any of the other groups. In general, a large number of varieties for a substantial number of different crops is on offer in the market, and no indications exist that the diversity of crop varieties in the market is decreasing or threatened (Visser, 2008). On the other hand, although there may be a large number of varieties on the market for the major cops, a large part of the area is grown with only a few of these.

A number of crops have almost disappeared in the past few decades, including rye, oats, caraway, and fodder beets. The number of farms cultivating these crops and the number of varieties offered in the market have decreased to a similar extent. The genetic diversity of the crops that have almost completely disappeared from the Dutch farming systems is largely maintained in *ex situ* collections in the country and abroad. Over the past decade, crops such as rape seed, fodder maize, hemp, green manure crops and catch crops, have gained in importance and added to the total genetic diversity employed in agricultural production (Visser, 2008).

Product diversity is increasingly created by processing rather than by diversity in the harvested product. However, niche markets for consumers with a keen interest in regional and traditional products or with an immigrant culture background, as well as organic production, are also slowly developing (Visser, 2008).

3.1.3 Animal genetic resources for food and agriculture

The major species of economic importance in the Netherlands are cattle (dairy and dual purpose milk and beef), pigs (pork), poultry (meat and eggs), sheep (meat and milk), goats (milk) and horses (sports). Less important species include ducks, geese, pigeons, rabbits and dogs (Hiemstra, 2014).

During the second half of the 20th century, European and Dutch agricultural policies, together with technological developments, resulted in cost price reductions, an increase in production efficiency and greater uniformity of starting material and end products. In the animal production sector, this resulted in increased use of a small number of specialized breeds (Hiemstra, 2002; Hiemstra, 2014). Nowadays, livestock kept in the Netherlands largely consists of a few highly productive, globally used breeds. In the dairy sector, for instance, the principal, mainstream dairy breed is the Holstein Friesian. In poultry, 99.98% are globally-used commercial breeding lines, with the remaining 0.02% consisting of about 20 old Dutch breeds (Van Veen *et al*, 2008). In the poultry sector, only a limited number of breeding organisations are active, and the major part of commercial production utilises a limited number of breeds or lines. A similar development is taking place within the pig sector, although there are currently more active breeding companies than in the poultry sector. Due to their different structure, a greater diversity exists within beef cattle, sheep and horses. A large diversity of rare, local livestock breeds is still maintained by farmers and hobby breeders, and an increasing diversity of local breeds is employed in nature and landscape management (Hiemstra, 2002; Hiemstra, 2014).

The major specialization already happened during the last decades of the 20th century, and the contribution of locally adapted/native breeds to total livestock production in the Netherlands did not substantially change in the past decade. Part of the breeds with small population sizes show increasing number of breeding animals, while others are decreasing in numbers. Breeding associations and NGO networks are active in supporting *in situ* conservation of locally adapted/native breeds (Hiemstra, 2014). Besides genetic diversity in terms of number of breeds, monitoring and management of within-breed genetic diversity is relevant for both mainstream and rare breeds (Hiemstra, 2002; Hiemstra, 2014).

3.1.4 Forest genetic resources

There are only 12 main tree species in the Netherlands, together constituting almost all tree species in Dutch forests. About 54% of the Dutch forest area is dominated by coniferous tree species, mainly Scots pine (120,000 ha) but also European larch (21,000 ha), Douglas fir (20,000 ha) and Norway spruce (14,000 ha), whereas some 21,000 ha is dominated by other conifers. The other 46% consists of broadleaved forest dominated by pedunculate oak (66,000 ha), poplar and willow (25,000 ha), birch (22,000 ha), beech (14,000 ha) and other broadleaved species (38,000 ha). The proportion of native deciduous species, mainly native oak, has increased over the past decades at the expense of exotic conifers (Buiteveld, 2012). The Dutch forest is increasingly mixed, mainly at the cost of mono species coniferous forest (Oerlemans *et al*, 2015; Schelhaas *et al*, 2014).

During the last few decades forest management in the Netherlands has shifted from the purpose of wood production towards multi-purpose forest management with the focus on recreation and nature conservation. As a result, the forest area primarily assigned for wood production has declined from 31,000 ha in 1990 to only 4,000 ha (1% of forest area) in 2000 and has remained constant ever since. Conversely, the forest area managed for biodiversity conservation has increased from 19,000 ha to 90,000 ha (25% of forest area) within the same period. The remaining 74% of the forest area has a multi-use function (266,000 ha in 2000). Furthermore, 60 forest reserves totalling 3,500 ha had been established by 2000, ranging in size from 5 to 400 ha. These are managed primarily to conserve biodiversity. Some recreation does take place but timber harvesting is prohibited in the reserves (Buiteveld, 2012).

3.1.5 Aquatic genetic resources

Economically important target species in marine fishing are Atlantic horse mackerel (*Trachurus trachurus*), blue whiting (*Micromesistius poutassou*), European plaice (*Pleuronectes platessa*), Atlantic mackerel (*Scomber scombrus*), Atlantic herring (*Clupea harengus*), shrimp (*Crangon crangon*), common sole (*Solea solea*) and Atlantic cod (*Gadus morhua*) (CBS, 2014). Due to the restrictive quota and reduction of the overcapacity of the fishing fleet, fishing pressure has been reduced over the last decade and the adult biomass of the exploited fish species has increased (ICES, 2013). Long-lived species have declined and opportunistic small species have increased. Positive trends in species richness were observed in benthos and fish species. However, there is concern about the evolutionary effects of fishing (Jørgensen *et al*, 2007; Laugen *et al*, 2014), such as the changes in the onset of sexual maturation, growth rate and reproductive investment observed in North Sea plaice and sole; exploited fish species now mature at a younger age and smaller size (Grift *et al*, 2003; Mollet *et al*, 2007; Van Walraven *et al*, 2010). The collateral damage caused by fishing is high, but depends on the type of fishing gear used. In bottom-trawl fisheries, an estimated 75% of the catch is discarded, and in most cases does not survive. Bottom trawls also adversely affect sea bed habitats and the structure and functioning of the benthic ecosystem. Shellfish fisheries on wild stocks target the invasive American razor clam (*Ensis directis*), which has established itself in the 1980s (Wolff, 2005). The cockle is a native shellfish that is harvested from wild stocks present in Dutch coastal waters (Van der Heijden, 2007). Mechanical cockle dredging is prohibited.

The most important species targeted in inland fishing are European eel (*Anguilla anguilla*) and pike-perch (*Stizostedion lucioperca*) (FAO, 2008). European eel is classified as 'critically endangered' in the IUCN Red List (Jacoby & Gollock, 2014).

In the past years, the diversity of species (mainly European eel) targeted in culture-based fisheries has not changed, but the production volume of eel decreased due to a decline in the supply of glass eel.

The most important fish species used in aquaculture are European eel (*Anguilla anguilla*), African catfish (*Clarias gariepinus*) and tilapia (*Oreochromis niloticus*). In addition, turbot (*Scophthalmus maximus*), sole (*Solea solea*), barramundi (*Lates calcarifer*) and pike-perch (*Stizostedion lucioperca*) are grown in indoor heated systems. Rainbow trout (*Oncorhynchus mykiss*) is kept in outdoor ponds and basins. The European eel is an endemic species that cannot yet be reproduced in hatcheries. Eel culture is actually the ongrowing of juveniles (glass eels) caught from wild stocks. Because of the very serious decrease in the number of glass eels entering Dutch rivers since the early 1980s, the capture of glass eels in Dutch waters has been prohibited and the eel farmers depend on glass eels caught from French and British estuaries. African catfish is an exotic species originally imported from Central Africa in 1975, and improved and adapted by means of selection for farming in intensive systems. African catfish which escape from farms do not survive the Dutch winters. Tilapia and barramundi are also exotic species. Pike-perch is originally from Central Europe, but it entered Dutch inland waters a century ago and is now considered endemic. Turbot and common sole are endemic species grown in indoor marine farms using water recirculation systems. Turbot fingerlings are imported from France. Rainbow trout is an exotic species, of which fingerlings are mostly obtained from neighbouring countries. A part of the production is used in a put-and-take sports fishery in recreational fishing ponds which are part of the trout farm (Van der Heijden, 2007).

The shellfish species used in aquaculture are blue mussels (*Mytilus edulis*), flat oysters (*Ostrea edulis*), both endemic species, and Pacific oysters (*Crassostrea gigas*), an exotic species introduced for farming purposes in 1964. The shellfish sector relies on natural oyster spat fall and the collection of mussel seed from natural populations. Mussel farms depend mostly on mussel seed found in shallow coastal waters (especially the Wadden Sea in the North of the country). The annual amount of seed which may be harvested fluctuates considerably from year to year. Mussel production is supplemented by imported seeds.

3.2 State and trends of associated biodiversity and regulating and supporting ecosystem services

3.2.1 Trends in the state of components of associated biodiversity

In Table 3.1 the trends in the state of components of associated biodiversity for the different production systems over the last 10 years are assessed, where possible. Qualitative descriptions of the trends are given below.

L3 (Livestock grassland-based systems: Temperate)

- The number of birds has declined due to the fact that pastures are being mown more often, earlier in the season and more rapidly, resulting in damaging of nests and killing of young birds. In 2011, the countrywide populations of the black-tailed godwit (*Limosa limosa*), the oystercatcher (*Haematopus ostralegus*) and the lapwing (*Vanellus vanellus*), for instance, were 40-60% smaller than in 1990 (CBS, PBL & Wageningen UR, 2014).
- The lowering of groundwater tables reduces the availability of worms as food for meadow birds during droughts (Oerlemans *et al*, 2015).

L7 (Livestock landless systems: Temperate)

- The importance of associated biodiversity in these systems has remained limited.

F7 (Planted forests: Temperate)

- Changed forest management (from the purpose of wood production towards multi-purpose forest management) has led to increases in the numbers of certain forest birds, bats, invertebrates and mushrooms (Noordijk *et al*, 2010).

Table 3.1. *Trends in the state of components of associated biodiversity within production systems (effect strongly positive (+2), positive (+1), negative (-1), strongly negative (-2), or no effect at all (0))*

Production system	**Trends in last 10 years**			
	Micro-organisms	**Invertebrates**	**Vertebrates**	**Plants**
L3 (Livestock grassland-based systems: Temperate)		-1	-2	
L7 (Livestock landless systems: Temperate)				
F7 (Planted forests: Temperate)	+1	+1	+1	+1
A3 (Self-recruiting capture fisheries: Temperate)		+1	+1	
A7 (Culture-based fisheries: Temperate)				
A11 (Fed aquaculture: Temperate)				
A15 (Non-fed aquaculture: Temperate)		-1	-1	
C11 (Rainfed crops: Temperate)		-1	-2	-1
O1 (Others (horticulture under glass))		0		

A3 (Self-recruiting capture fisheries: Temperate)

- In the North Sea, the populations of mammals and fish showed an average increase of 25% between 1990 and 2001, with stabilization after 2003 (Oerlemans *et al*, 2015). The species richness in marine areas is increasing, likely in response to the increase in temperature and the appearance of invasive species (Ter Hofstede *et al*, 2010; Oerlemans et al, 2015).
- In freshwater and marshes, population sizes of animal species have increased with 40% in 1990-2003, with stabilization afterwards (Oerlemans *et al*, 2015).

A7 (Culture-based fisheries: Temperate)

- There is no information on the developments with respect to associated biodiversity in these systems.

A11 (Fed aquaculture: Temperate)

- Due to the use of recirculation systems in fed aquaculture, the importance of associated biodiversity in these systems has remained limited.

A15 (Non-fed aquaculture: Temperate)

- In the past, the collection of mussel seed has reduced the surface area of inter-tidal mussel beds that provide habitat for a variety of invertebrate species as well as food for waders. Inter-tidal mussel beds have been closed for fishing, and mechanical fishing for mussel seed has been gradually reduced from 2009 onwards and will have been replaced by mussel seed collectors by 2020 (http://www.rijkewaddenzee.nl/programma/mosselconvenant/toelichting).

C11 (Rainfed crops: Temperate)

- Not only the populations of birds nesting in grassland have declined, but also those of birds nesting in arable land. For instance, the number of skylarks (*Alauda arvensis*) is 60% lower than in 1990 (CBS, PBL & Wageningen UR, 2014).

- In a study in the Netherlands and various other European countries it was found that the use of pesticides, especially insecticides and fungicides, has had negative effects on the species diversity of plants, carabids and farmland birds (Geiger *et al*, 2010). Both agri-environment schemes and organic farming positively affected the species diversity of plants and carabids in agricultural fields, but not bird species diversity (Geiger *et al*, 2010).

O1 (Others (horticulture under glass))

- In horticulture under glass, biological pest control organisms, set out by farmers, play an important role. In vegetables, the area with biological pest control increased from 2946 ha in 2000 to 3267 ha in 2012, but the application of biological pest control decreased from almost 100% of the total area under vegetables in 2000 to 83.5% in 2012 (CBS, PBL & Wageningen UR, 2015). For flowers and ornamental plants under glass, the area with biological pest control increased from 1485 ha in 2000 to 1557 ha in 2012, and the percentage of the total area increased from 34% to 46% in the same period (CBS, PBL & Wageningen UR, 2015). Sometimes, spontaneous biological pest control organisms appear in glasshouses, such as *Scymnus* beetles, which eat aphids (Janmaat *et al*, 2014).

3.2.2 Trends in the state of regulating and supporting ecosystem services

In Table 3.2 the trends in the state of regulating and supporting ecosystem services for the different production systems over the last 10 years are assessed, where possible. Qualitative descriptions of the trends are given below.

L3 (Livestock grassland-based systems: Temperate)

- In some areas, the management of grassland has been adapted to increase the water-retaining capacity. An example is the Keizersrande farm in the province of Overijssel, situated in the floodplains of the river IJssel and managing the Natura 2000 area of which it forms a part. The farm manages grazing and the design of its landscape in a way that gives it flexibility to adapt to high water levels (De Groot, 2014).
- The habitat provisioning role of these systems has declined due to the more intensive use: it is mown more often, earlier in the season and more rapidly, resulting in damaging of nests and killing of young birds. The lowering of groundwater tables reduces the availability of worms as food for meadow birds during droughts (Oerlemans *et al*, 2015).
- The lowering of groundwater levels leads to mineralization and decomposition of peat soils, resulting a CO_2-emission of 4.2 Mt CO_2-equivalents, or 3-5% of the annual CO_2-emission of the Netherlands (De Knegt, 2014).

L7 (Livestock landless systems: Temperate)

- The role and direct impact of these systems in providing regulating and supporting ecosystem services has remained limited.

F7 (Planted forests: Temperate)

- Changed forest management, now focusing on increasing the amount of dead wood in the forest, increasing the number of large and thick trees, enhancing structural diversity, increasing the number of different age classes, and promoting native tree species (Buiteveld, 2012) has led to increases in the numbers of certain forest birds, bats, invertebrates and mushrooms (Noordijk *et al*, 2010).
- The net annual CO_2-sequestration of forests in the Netherlands is about 2.7 Mt CO_2. The area under forest has increased in the past decades, resulting in increased CO_2-sequestration by forests (De Knegt, 2014).

Table 3.2. Trends in the state of regulating and supporting ecosystem services within production systems over the last 10 years (effect strongly positive (+2), positive (+1), negative (-1), strongly negative (-2), or no effect at all (0); for a description of the ecosystem services, see Annex 3).

Production systems	**Trends in last 10 years**									
	Pollination	**Pest and disease regulation**	**Water purification and waste treatment**	**Natural hazard regulation**	**Nutrient cycling**	**Soil formation and protection**	**Water cycling**	**Provisioning of habitat**	**Production of oxygen / Gas regulation**	**Others [*please specify*]**
L3 (Livestock grassland-based systems: Temperate)				+1				-2	-1	
L7 (Livestock landless systems: Temperate)										
F7 (Planted forests: Temperate)								+1	+1	
A3 (Self-recruiting capture fisheries: Temperate)								-1/ +1		
A7 (Culture-based fisheries: Temperate)										
A11 (Fed aquaculture: Temperate)										
A15 (Non-fed aquaculture: Temperate)								-1		
C11 (Rainfed crops: Temperate)	-1	-2				-1	-1	-2		
O1 (Others (horticulture under glass))										

A3 (Self-recruiting capture fisheries: Temperate)

- Fisheries affect the structure of ecosystems by selectively removing certain species and size classes of fish (Daan *et al*, 2005). The changes in species and size composition affect the functioning of the ecosystem. It is unknown how this affects nutrient cycling.
- Bottom trawl fisheries disturb sea bed habitats and reduce biodiversity. The effects are largest in biogenic habitats and relatively sTable habitats in deeper waters (Reiss *et al*, 2009; Lambert *et al*, 2014; Van Denderen *et al*, 2014). The sediment structure, such as the content of organic material, may be degraded due to bottom trawling (Piersma *et al*, 2001). In shallow waters that are frequently exposed to natural perturbations by tidal currents or storms, bottom trawling has less impact (Diesing *et al*, 2013).
- The increase in the surface area of the sea floor that is protected from bottom trawl fisheries has increased due to the building of oil/gas platforms and wind farms. The hard structures created adds habitat that was naturally absent in the soft sediments of the Dutch part of the North Sea. Marine mammals (such as porpoises) may be adversely affected by the noise during the construction of wind farms.
- In the North Sea, the populations of mammals and fish showed an average increase of 25% between 1990 and 2001, with stabilization after 2003 (Oerlemans *et al*, 2015). The number of fish species increases, as a result of climate change (Oerlemans *et al*, 2015).
- The introduction of the Pacific oyster (*Crassostrea gigas*) into the Netherlands in the 1960s has resulted in invasion of the Oosterschelde estuary that is still in progress. From the Oosterschelde, proliferation has occurred to the adjacent water bodies and is now expanding to the North (Wadden Sea). This is considered a

serious threat for existing functions of coastal waters such as for shellfish culture and as feeding areas for shellfish-eating birds. On the other hand, oyster reefs can also provide an important habitat for certain species (Smaal *et al*, 2009).

- In freshwater areas, improvements in water quality, the construction of fish passages, and the restoration of natural banks of waterways to create spawning habitats, have led to improved habitat provisioning. In freshwater and marshes, population sizes of animal species have increased with 40% in 1990-2003, with stabilization afterwards (Oerlemans *et al*, 2015).

A7 (Culture-based fisheries: Temperate)

- There is no information on the developments with respect to regulating and supporting ecosystem services in these systems, and their drivers.

A11 (Fed aquaculture: Temperate)

- Due to the use of recirculation systems in fed aquaculture, the role of these systems in providing regulating and supporting regulating and supporting ecosystem services has remained limited.

A15 (Non-fed aquaculture: Temperate)

- In the past, the collection of mussel seed has reduced the surface area of inter-tidal mussel beds that provide habitat for a variety of invertebrate species as well as food for waders, but activity has been gradually reduced from 2009 onwards, and mechanical fishing for mussel seed will have been replaced by mussel seed collectors by 2020.

C11 (Rainfed crops: Temperate)

- Wild pollinators such as bees and hover flies seem to make a significant contribution to pollination in Dutch agriculture. During the past 50 years, there has been a decline in wild bees due to the summer flora in field boundaries, ditch banks and roadside verges being intensively mown or grazed, leading to a reduced availability of floral resources, especially in the second half of the flying season. However, analyses of the population trends of all Dutch bee species suggest that more species have declined between the periods pre-1970 and 1970-1989 than between the periods 1970-1989 and post-1990. These findings suggest that the decline of the Dutch bee fauna has come to a standstill and could indicate a recovery of some bee populations (Scheper *et al*, 2014).
- The habitat provisioning role of these systems has declined due to the more intensive use, changes in crops (more maize) and more large-scale farming, leading to the disappearance of many small landscape elements (CBS, PBL & Wageningen UR, 2014).
- As the surface of natural habitats in agricultural areas is decreasing, and it is assumed that a decrease in habitats for natural pest regulators leads to a decreased natural pest regulation, a decrease in natural pest regulation is probable (De Knegt, 2014).
- The use of pesticides, especially insecticides and fungicides, has had negative effects on the species diversity of plants, carabids and farmland birds and on the potential for biological pest control (Geiger *et al*, 2010).
- Intensification of cultivation has led to soil compaction and reduction of the water holding capacity of agricultural land in areas such as the polders in Lake IJssel (Staps *et al*, 2015). Soil compaction has a negative influence on soil life (Derks *et al*, 2012).
- On the loess soils of South Limburg, an increase in water erosion during the past decades has been observed. This increase is strongly related to changing agricultural land use and agricultural practices: row crops such as maize and potatoes are considered more erosion-sensitive than winter cereals; re-allotment schemes (*ruilverkavelingen*) and clearing of hedgerows have resulted in larger fields, causing surface runoff to be more erosive; and the use of heavy machinery has led to compaction and more runoff (Winteraeken & Spaan, 2010).

O1 (Others (horticulture under glass))

- The role of these systems in providing regulating and supporting ecosystem services has remained limited.

3.2.3 Impacts of changes in biodiversity for food and agriculture on regulating and supporting ecosystem services

In Table 3.3 the impacts of changes in biodiversity for food and agriculture on regulating and supporting ecosystem services in the different production systems over the last 10 years are assessed, where possible. Because for many changes it was impossible to assess their influence on a specific production system in the specific period, only those Table rows are shown where an assessment could be made.

Qualitative descriptions of the effects of various drivers in the different production systems are given below.

L3 (Livestock grassland-based systems: Temperate)

- The lowering of groundwater tables reduces the availability of worms as food for meadow birds during droughts (Oerlemans *et al*, 2015).

L7 (Livestock landless systems: Temperate)

- The role of these systems in providing regulating and supporting ecosystem services has remained limited.

F7 (Planted forests: Temperate)

- Changed forest management, which includes, among other things, increasing the number of large and thick trees, enhancing structural diversity, increasing the number of different age classes, and promoting native tree species (Buiteveld, 2012) has led to increases in the numbers of certain forest birds, bats, invertebrates and mushrooms (Noordijk *et al*, 2010).
- The net annual CO_2-sequestration of forests in the Netherlands is about 2.7 Mt CO_2. The area under forest has increased in the past decades, resulting in increased CO_2-sequestration by forests (De Knegt, 2014).

A3 (Self-recruiting capture fisheries: Temperate)

- Fisheries affect the structure of ecosystems by selectively removing certain species and size classes of fish (Daan *et al*, 2005). The changes in species and size composition affect the functioning of the ecosystem. It is unknown how this affects nutrient cycling.
- The introduction of the Pacific oyster (*Crassostrea gigas*) into the Netherlands in the 1960s has resulted in invasion of the Oosterschelde estuary that is still in progress. From the Oosterschelde, proliferation has occurred to the adjacent water bodies and is now expanding to the North (Wadden Sea). This is considered a serious threat for existing functions of coastal waters such as for shellfish culture and as feeding areas for shellfish-eating birds. On the other hand, oyster reefs can also provide an important habitat for certain species (Smaal *et al*, 2009).

A7 (Culture-based fisheries: Temperate)

- There is no information on the impact of changes in biodiversity for food and agriculture on regulating and supporting ecosystem services.

A11 (Fed aquaculture: Temperate)

- Due to the use of recirculation systems in fed aquaculture, the role of these systems in providing regulating and supporting ecosystem services has remained limited.

A15 (Non-fed aquaculture: Temperate)

- There is no information on the impact of changes in biodiversity for food and agriculture on regulating and supporting ecosystem services.

Table 3.3. *Impact of changes in biodiversity for food and agriculture on regulating and supporting ecosystem services over the last 10 years (effect strongly positive (+2), positive (+1), negative (-1), strongly negative (-2), or no effect at all (0); for a description of the drivers, see Annex 2; for a description of the ecosystem services, see Annex 3).*

Production systems	**Changes**	**Impact of changes in biodiversity for food and agriculture on regulating and supporting ecosystem services**								
		Pollination	**Pest and disease regulation**	**Water purification and waste treatment**	**Natural hazard regulation**	**Nutrient cycling**	**Soil formation and protection**	**Water cycling**	**Habitat provisioning**	**Production of oxygen / Gas regulation**
L3 (Livestock grassland-based systems: Temperate)	Changes in invertebrates genetic resources (associated biodiversity)								-1	
F7 (Planted forests: Temperate)	Changes in forest genetic resources								+2	+1
A3 (Self-recruiting capture fisheries: Temperate)	Changes in aquatic genetic resources					nk			-1/ +1	
C11 (Rainfed crops: Temperate)	Changes in crop genetic resources						-1	-1	-1	
	Changes in invertebrates genetic resources (associated biodiversity)	-2	-1							
	Changes in vertebrates genetic resources (associated biodiversity)		-1							
	Changes in plants genetic resources (associated biodiversity)	0/-1	-1				-1	-1	-1	

C11 (Rainfed crops: Temperate)

- Changes in crops (more maize) are among the factors leading to decreased habitat provisioning (CBS, PBL & Wageningen UR, 2014).
- The use of certain chemical crop protection products (neonicotinoids) is suspected of playing a role in a decline in honeybee populations, important for pollination in Dutch agriculture. However, there is still no scientific consensus on the degree to which crop protection products contribute to this decline (CBS, PBL & Wageningen UR, 2014). The controversy over the possible effects of neonicotinoids on honey bees has led to a European Commission regulation in 2013, which restricted certain uses of these pesticides on flowering crops (EASAC, 2015). In a recent study it was emphasized that the discussion should not be limited to honey bees, but should also take into account the effects of neonicotinoids on other pollinators, such as bumble bees, solitary bees, hoverflies, butterflies and moths, and it was concluded that there is an increasing body of evidence that the widespread prophylactic use of neonicotinoids has severe negative effects on non-target

organisms that provide ecosystem services including pollination and natural pest control (EASAC, 2015). On the other hand, analyses of the population trends of all Dutch bee species suggest that more species have declined between the periods pre-1970 and 1970-1989 than between the periods 1970-1989 and post-1990. These findings suggest that the decline of the Dutch bee fauna has come to a standstill and could indicate a recovery of some bee populations (Scheper *et al*, 2014).

- As the surface of natural habitats in agricultural areas is decreasing, and it is assumed that a decrease in habitats for natural pest regulators (i.e. decrease in plant associated biodiversity) leads to a decreased natural pest regulation, a decrease in natural pest regulation is probable (De Knegt, 2014).
- The species diversity of plants, carabids and farmland birds and the potential for biological pest control has decreased due to the use of pesticides, especially insecticides and fungicides (Geiger *et al*, 2010).
- On the loess soils of South Limburg, an increase in water erosion during the past decades has been observed. This increase is related to, among other things, changes in crop genetic resources (row crops such as maize and potatoes are considered more erosion-sensitive than winter cereals) and changes in associated biodiversity (clearing of hedgerows have resulted in larger fields, causing surface runoff to be more erosive) (Winteraeken & Spaan, 2010).

O1 (Others (horticulture under glass))

- The role of these systems in providing regulating and supporting ecosystem services has remained limited.

3.2.4 Actively managed associated biodiversity

Table 3.4 lists some associated biodiversity species that are in some way actively managed in the Netherlands to help provide regulating or supporting ecosystem services.

Table 3.4. *Associated biodiversity species that are in some way actively managed to help provide regulating or supporting ecosystem services.*

Ecosystem service provided	**Actively managed species (name) and sub-species (where available)**	**Production systems (code or name)**	**Availability of diversity information (Y/N)**	**Source of information**
Pollination	*Apis mellifera* *Bombus terrestris*	- Greenhouse horticulture - Rainfed crops (outdoor horticulture)	Y	Producers
Pest and disease regulation	A wide range of insects, mites, nematodes and centipedes	- Greenhouse horticulture - Rainfed crops (outdoor horticulture)	Y	Producers
Water purification and waste treatment	Various plant species			

3.2.5 Monitoring activities related to associated biodiversity

The Dutch Network Ecological Monitoring (NEM) programme is a cooperation platform of the Ministry of Economic Affairs, the Ministry of Infrastructure and the Environment, Rijkswaterstaat, the Provinces, PBL Netherlands Environmental Assessment Agency (PBL), and Statistics Netherlands (CBS). The goal of NEM is to match data collection to the information needs of the government. It comprises monitoring networks on mammals, birds, reptiles, amphibians, fish, butterflies, dragonflies, flora, and mushrooms. Data are mostly collected by volunteers, and provided to private data management organizations (PGOs), such as Sovon (wild birds), Ravon (reptiles, amphibians, fish) and the Zoogdierenvereniging (mammals). The results are published by, among others, CBS and PBL. Most Red Lists have been updated in the form of basic PGO reports. In the monitoring networks, around sixteen thousand volunteers are active (De Groot, 2014; www.netwerkecologischemonitoring.nl).

Soil biology is also monitored in a nationwide monitoring programme, and measurements are combined in the Biological Indicator of Soil Quality (BISQ). For this, about 300 locations, with different combinations of land use and soil type, have been selected, and since 1999 every year about 60 locations have been sampled. The BISQ has been incorporated into an abiotic soil monitoring programme, the Netherlands Soil Monitoring Network (NSMN), with 200 locations, which started in 1993 (Rutgers *et al*, 2009).

On the European level, all member states are obliged to send reports to Brussels. Within the framework of the Wild Birds Directive, the member states need to report every 3 years, while the Habitats Directive calls for reports every 6 years (De Kool, 2012).

In the context of the Data Collection Framework of the European Union, the Netherlands conduct several fish monitoring programmes; herring acoustic survey; larval herring survey; international Bottom Trawl Survey – IBTS; Beam Trawl Survey – BTS; Sole Net Survey – SNS; Demersal Young Fish Survey - DFS). In addition, national surveys are conducted of the benthic invertebrates of the Dutch continental shelf, shellfish resources in the Dutch coastal zone and the fish community in the major water systems (the Lake IJssel and the main rivers).

3.3 Species of associated biodiversity at risk of loss

In the period 1950-1995, more than a third of all species in the Netherlands have become endangered and have been placed on the Red List. More recently, however, the trend has reversed. Since 1995, the number of endangered species of mammals, dragonflies and vascular plants has decreased and since 2005 fewer breeding bird and reptile species are threatened (CBS, PBL & Wageningen UR, 2015). The total number of threatened species slightly increased from 1995 to 2005, but slightly decreased from 2005 to 2013 (Oerlemans *et al*, 2015).

Honeybees are threatened by various threats, including Varroa mites, Nosema parasites and Colony Collapse Disorder. The use of certain chemical crop protection products (neonicotinoids) is suspected of playing a role in a decline in honeybee populations, important for pollination in Dutch agriculture. However, there is still no scientific consensus on the degree to which crop protection products contribute to this decline (CBS, PBL & Wageningen UR, 2014). As for wild bees and bumblebees, the 20 species which are found on the highest number of crop genera are currently not threatened (Scheper *et al*, 2014).

3.4 Conservation of associated biodiversity

3.4.1 Ex situ conservation or management of associated biodiversity

Ex situ conservation activities or programmes for associated biodiversity for food and agriculture are given in Table 3.5.

Table 3.5. Ex situ conservation or management activities or programmes for associated biodiversity for food and agriculture.

Components of associated biodiversity	**Organisms, species and sub-species (where available) conserved**	**Size of collection**	**Conservation conditions**	**Objective(s)**	**Characterization and evaluation status**
Micro-organisms	Fungi and bacteria	Over 80,000 strains	Living material	Reference collection for research	
Invertebrates					
Vertebrates					
Plants					

A collection of living filamentous fungi, yeasts and bacteria, containing over 80,000 strains, is maintained by the CBS-KNAW Fungal Biodiversity Centre (www.cbs.knaw.nl/).

3.4.2 In situ conservation or management of associated biodiversity

Examples of *in situ* conservation of associated biodiversity in the aquatic production systems are the Marine Protected Areas that are being established in the Dutch part of the North Sea. In the Dutch coastal zone, 10% of the surface has been closed to all fishing by 2011. In the Wadden Sea, inter-tidal mussel beds have been closed for fishing.

In the agricultural production systems, the maintenance or creation of field boundaries to support insect fauna and its role in providing pollination and crop protection services can be considered a form of *in situ* conservation and management.

3.4.3 Traditional knowledge of associated biodiversity

In the Netherlands, traditional knowledge on genetic resources has been largely incorporated in existing documentation systems (Visser *et al*, 2015).

3.4.4 Gender dimensions with respect to associated biodiversity

In the Netherlands, differences in the roles and insights of women and men with respect to the maintenance of particular resources, the monitoring of their state, and overseeing their management at different stages of production are of minor importance.

3.5 State, trends and risks of wild food resources

As indicated in Chapter 2, the collection of wild foods has hardly any importance in the Netherlands, except for fish caught in marine and freshwater systems (CBS, PBL & Wageningen UR, 2015).

With respect to the state, trends and risks of wild food resources, the following remarks can be made.

- In marine fishing, quotas imposed by EU policies have led to more sustainable exploitation practices in North Sea fisheries.
- The number of wild species harvested from marine areas increased due to the increased supply and the development of the market that are interested to take new species.
- Overexploitation of fresh water fish has led to a decline in availability of freshwater fish such as eel and pike-perch.
- The building of infrastructural works (such as the Haringvlietdam and the Afsluitdijk) and hydroelectric power stations led to a decrease of anadromous and catadromous fish species as it created physical migration barriers that disconnected the spawning and feeding habitats (De Groot, 1992).
- In inland waters, mass kills of fish may occur due to chemical pollution, oxygen depletion or thermal pollution.
- The eutrophication in the 1960-1980s positively affected the productivity of the coastal waters of the Netherlands as reflected in trends in phytoplankton, benthic invertebrates and fish (Beukema, 1989; Colijn, 2002; Philippart *et al*, 2007; Tulp *et al*, 2008).

3.6 Natural or human-made disasters and biodiversity for food and agriculture

In the Netherlands, there have been no natural or human-made disasters that have had a significant effect on biodiversity for food and agriculture and/or on ecosystem services in the past 10 years.

3.7 Invasive alien species and biodiversity for food and agriculture

The number of alien species settling in the Netherlands has strongly increased in the past 20 years (CBS, PBL & Wageningen UR, 2014; Oerlemans *et al*, 2015). An estimated 2100 exotic species are now present in the Netherlands (Oerlemans *et al*, 2015). On the one hand, the introduction of new species increases biodiversity. For instance, the harlequin ladybird (*Harmonia axyridis*), released in the 1990s as a predator of aphids in glasshouses and open fields, has become one of the most common beetles in the Netherlands (Noordijk *et al*, 2010). On the other hand, the introduction of new species can also form a threat to existing biodiversity, as some alien species have negative effects on indigenous flora and fauna, because they eat them, compete for food or space, or transmit diseases to indigenous species (CBS, PBL & Wageningen UR, 2014; Noordijk *et al*, 2010; Oerlemans *et al*, 2015; Smaal *et al*, 2009).

An important factor in the introduction of alien species is international trade, which has become more easy because of improved international communication through the internet. Traders and private persons import large quantities of plants and other materials from abroad, which may carry exotic species, including harmful organisms such as the citrus long-horned beetle (*Anoplophora chinensis*), first observed in the country in 2007 (Noordijk *et al*, 2010; Oerlemans *et al*, 2015). The fungus *Batrachochytrium salamandrivorans*, probably introduced into the country through the trade in salamanders for terrarium owners, has caused a sharp decline in fire salamander populations in the Netherlands (Oerlemans *et al*, 2015).

Factors in the introduction of exotic freshwater species are the opening, in 1992, of the Main-Danube Canal, which connects the catchment area of the Rhine with that of the Danube, and the release of animals ponds and aquariums into the wild (Oerlemans *et al*, 2015).

In Table 3.6 some invasive alien species are listed that have had a significant effect on biodiversity for food and agriculture in the past 10 years. Additional information on these species and their effects is given beneath the table.

Table 3.6. Invasive alien species that have had a significant effect on biodiversity for food and agriculture in the past 10 years (strong increase (+2), increase (+1), no effect (0), some loss (-1), significant loss (-2)).

Invasive alien species (scientific name)	**Production system(s) affected (code or name)**	**Effect on components of biodiversity for food and agriculture (2,1,0,-1,-2, NK)**	**Effect on ecosystem services (2,1,0,-1,-2, NK)**
Anoplophora chinensis (Citrus long-horned beetle)	F7 (Planted forests: Temperate)	-2	-2
Batrachochytrium salamandrivorans	F7 (Planted forests: Temperate)	-1	
Crassostrea gigas (Pacific oyster)	A15 (Non-fed aquaculture: Temperate)	-1/+1	-1/+1
Drosophila suzukii (spotted-wing drosophila)	C11 (Rainfed crops: Temperate)	-1	
Ensis directes (American razor shell)	A3 (Self-recruiting capture fisheries: Temperate)		+1
Hydrocotyle ranunculoides (Water pennywort)	A7 (Culture-based fisheries: Temperate)	-2	-2
Mnemiopsis leidyi (Sea walnut)	A3 (Self-recruiting capture fisheries: Temperate)	-2	
Phytophthora ramorum	F7 (Planted forests: Temperate)	-2	-2
Procambarus clarkii (Red swamp crayfish)	A3 (Self-recruiting capture fisheries: Temperate)	-2	
Prunus serotina American black cherry)	F7 (Planted forests: Temperate)	-1	

The citrus long-horned beetle (*Anoplophora chinensis*), first observed in the country in 2007 (Noordijk *et al*, 2010), is very harmful to trees and shrubs. It occurs naturally in Asia, but is occasionally encountered in the Netherlands, due to international transport of wood and plants.

The fungus *Batrachochytrium salamandrivorans*, originating from South-East Asia, has caused a sharp decline in fire salamander populations in the Netherlands. It was probably introduced into the country through the trade in salamanders for terrarium owners. The disease is considered a major threat for amphibians in the Netherlands (Oerlemans *et al*, 2015).

The Pacific oyster (*Crassostrea gigas*) was introduced into the Netherlands in the 1960s, and has invaded the Oosterschelde estuary. From the Oosterschelde, proliferation has occurred to the adjacent water bodies and is now expanding to the North (Wadden Sea). It is considered a serious threat for existing functions of coastal waters such as for shellfish culture and as feeding areas for shellfish-eating birds. On the other hand, oyster reefs can also provide an important habitat for certain species (Smaal *et al*, 2009).

The spotted-wing drosophila (*Drosophila suzukii*) originates from Asia, and has been observed in the Netherlands since 2013. It is a pest in fruit growing, especially that of soft fruit, such as strawberries, raspberries, cherries and grapes.

American razor clam (*Ensis directis*) established itself in the 1980s (Wolff, 2005) and has become the main shell fish species targeted in shellfish fisheries. It is unknown how this species affected biodiversity though competition for food or space with other suspension feeders.

Water pennywort (*Hydrocotyle ranunculoides*) has been causing problems in the Netherlands since 1994 and is covering large surfaces of water, thereby obstructing water flows (CBS, PBL & Wageningen UR, 2014; Noordijk *et al*, 2010).

The sea walnut or American comb jelly (*Mnemiopsis leidyi*) was first seen in the Netherlands in 2006. It occurs locally in high densities, and consumes massive amounts of plankton, including the larvae of many marine animal species. The arrival of this species may result in substantial negative effects on biodiversity (Noordijk *et al*, 2010).

Phytophthora ramorum is a fungus-like pathogen which has caused massive death of oak trees and some other tree species in California. It has been observed in the Netherlands on non-native trees and shrub species, such as *Rhododendron*. It has also attacked indigenous beech trees, and it is feared that the disease will spread to other indigenous woody species (www.plantenziektekunde.nl/pramorum).

The red swamp crayfish (*Procambarus clarkii*) in one of the exotic crayfishes that have almost caused disappearance of the indigenous European crayfish (*Astacus astacus*) from the Netherlands, by transmitting Crayfish plague (*Aphanomyces astaci*) (CBS, PBL & Wageningen UR, 2014; Noordijk *et al*, 2010).

American black cherry (*Prunus serotina*), the main invasive exotic species in Dutch forests, complicates forest management and hinders the regeneration of native species (Buiteveld, 2012).

3.8 Gaps and priorities

With respect to the state, trends and conservation of associated biodiversity and regulating and supporting ecosystem services, the major gap in information and knowledge is the lack of data to make a more quantitative assessment of the developments in the past 10-20 years in most production systems. While it is clear that trends in the past 50 years have been unfavourable for associated biodiversity in agriculture, the picture of the past 10-20 years is less clear. In the latter period, nutrient balances, for instance, have become more even (although supply still exceeds removal), but it is still unclear to what extent this has had influence on associated biodiversity and regulating and supporting ecosystem services. A strategy is needed to monitor, analyse and control the impact of changes.

With respect to the impact of invasive alien species on biodiversity for food and agriculture, the major gap in information and knowledge is probably the initial lack of knowledge of the invasive potential and risks of new alien species. While the introduction of invasive alien species can lead to increased biodiversity, there are also risks involved, as alien species may have negative effects on indigenous flora and fauna through competition for food or space. Once these risks are known, it may be too late, and the dispersal of the species cannot be controlled anymore. The main capacity or resources limitations concern the lack of sufficient capacity to check imported material for the presence of harmful organisms, such as the citrus long-horned beetle.

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

4.1 The use of management practices or actions that favour or involve the use of biodiversity for food and agriculture

4.1.1 Management practices

In Table 4.1, an assessment is made of the extent of use of management practices that are considered to favour the maintenance and use of biodiversity for food and agriculture, for each of the production systems. Only those Table rows are shown where an assessment could be made. For a description of the management practices, see Annex 4.

Qualitative descriptions of the use of the relevant management practices are given below.

Integrated Plant Nutrient Management (IPNM)

- According to the Guidelines, 'Integrated Plant Nutrient Management' refers to 'Soil, nutrient, water, crop, and vegetation management practices undertaken with the aim of improving and sustaining soil fertility and land productivity and reducing environmental degradation, often tailored to a particular cropping and farming system'. In Dutch agriculture, much attention is paid to nutrient balances. As explained in section 2.1, the phosphorus balance of agricultural soils has almost become even. The nitrogen balance has also become more even over the past decades, but nitrogen supply was still at least 100 kg/ha higher than removal in all years of the period 2003-2013. However, it is still unclear to what extent these changes in nutrient balances have had influence on biodiversity for food and agriculture.

Landscape management

- The area under 'agrarian nature management' (with measures taken by farmers to improve the quality of nature and the landscape) decreased from about 64,000 ha in 1999 to about 54,000 ha in 2009, after which it increased again to 59,000 ha in 2012 (CBS, PBL & Wageningen UR, 2015). It has been observed, however, that agrarian nature management generally has had little effect on the nature value, except for some regional successes, for instance with birds of arable land (Noordijk *et al*, 2010). No information is available how the area under 'agrarian nature management' is divided over the different production systems.
- During the last few decades forest management in the Netherlands has shifted from the purpose of wood production towards multi-purpose forest management with the focus on recreation and nature conservation. As a result, the forest area primarily assigned for wood production has declined from 31,000 ha in 1990 to only 4,000 ha (1% of forest area) in 2000 and has remained constant ever since. Conversely, the forest area managed for biodiversity conservation has increased from 19,000 ha to 90,000 ha (25% of forest area) within the same period (Buiteveld, 2012). The changed forest management has led to increases in the numbers of forest birds, bats, invertebrates and mushrooms (Noordijk *et al*, 2010).

Table 4.1. *Management practices that are considered to favour the maintenance and use of biodiversity for food and agriculture: percent of production area (%); change in production area over the past 10 years (significant increase (+2), some increase (+1), no change (0), some decrease (-1), significant decrease (-2)); effect on diversity (strongly increasing (2), increasing (1), sTable (0), decreasing (-1), strongly decreasing (-2); not known (nk); for a description of the management practices, see Annex 4).*

Production system	**Management practices**	**Percent of production area or quantity under the practice**	**Change in production area or quantity under the practice**	**Effect on biodiversity for food and agriculture**
L3 (Livestock grassland-based systems: Temperate)	Integrated Plant Nutrient Management (IPNM)	100%	0	0
	Landscape management	<10%	0	0
	Organic agriculture	3%	+1	+1
F7 (Planted forests: Temperate)	Landscape management	25%	+2	+2
A3 (Self-recruiting capture fisheries: Temperate)	Ecosystem approach to capture fisheries	100%	0	+1
A7 (Culture-based fisheries: Temperate)	Ecosystem approach to capture fisheries	nk	+1	+1
C11 (Rainfed crops: Temperate)	Integrated Plant Nutrient Management (IPNM)	100%	0	0
	Integrated Pest Management (IPM)	60-70%	1	
	Pollination management		+1	nk
	Landscape management	<10%	0	0
	Organic agriculture	±1.5%	+1	+1
O1 (Others (horticulture under glass))	Integrated Pest Management (IPM)	93% (vegetables); 46% (ornamental plants)	-1 (vegetables) +1 (ornamental plants)	+1
	Pollination management	nk	nk	nk

Organic agriculture

- In 2013, the total area under biological agriculture was 49,400 ha, of which 31,200 ha in farms with grazing animals, 7600 ha in farms with arable crops, 7400 ha in mixed farms, 1400 ha on horticultural farms, 1300 ha in farms with non-grazing animals, and 500 ha in farms with perennial crops (CBS, PBL & Wageningen UR, 2015).
- In a study in the Netherlands and various other European countries it was found that organic farming positively affected the species diversity of plants, and carabids in agricultural fields, but not bird species diversity (Geiger *et al*, 2010).

Ecosystem approach to capture fisheries

- In marine fishing, quotas have been established by the EU to prevent overexploitation (CBS, PBL & Wageningen UR, 2015). Marine Protected Areas are currently being established in the Dutch part of the North Sea. In the Dutch coastal zone, 10% of the surface has been closed to all fishing by 2011, 15% is closed to bottom trawling, and 28% is closed for fishing with heavy bottom trawl gear (http://www.noordzeeloket.nl/projecten/noordzee-natura-2000/nieuws/2012/nieuwsbrief-januari-2012/het-vibeg-akkoord.aspx). Through the Fisheries Act, fishing methods and fish sizes are regulated (FAO, 2005).

- In the inland fishery sector, fishing activities are regulated through licenses and restrictions with respect to fishing gear, fishing areas and fishing seasons (De Leeuw *et al*; Noordijk *et al*, 2010).

Others

- In the *Mosselconvenant* it has been agreed that mechanical fishing for mussel seed will be gradually reduced from 2009 onwards and be replaced by mussel seed collectors by 2020 (www.rijkewaddenzee.nl/programma/mosselconvenant/toelichting).

Integrated Pest Management (IPM)

- According to Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009, the principles of IPM must be implemented by all European growers by 2014 (Van Eerdt *et al* 2014). A survey indicated that in 2010 about 60% of growers of arable crops, fruit crops and vegetables in the Netherlands applied IPM measures, while adoption was 65–70% in tree nurseries and flower bulbs (Van Eerdt *et al* 2014).
- In horticulture under glass, the area with biological pest control in vegetables increased from 2946 ha in 2000 to 3267 ha in 2012, but the application of biological pest control decreased from almost 100% of the total area under vegetables in 2000 to 83.5% in 2012 (CBS, PBL & Wageningen UR, 2015). A reason mentioned for this decrease is the availability of new, selective crop protection products, which are more reliable than biological agents (Mulder *et al*, 2011). For flowers and ornamental plants under glass, the area with biological pest control increased from 1485 ha in 2000 to 1557 ha in 2012, and the percentage of the total area increased from 34% to 46% in the same period (CBS, PBL & Wageningen UR, 2015).

Pollination management

- Farmers are stimulated to maintain or create broad field boundaries to provide habitats for pollinating organisms and organisms that contribute to the control of pests and diseases. However, the actual effectivity of this practice has never been properly evaluated (Bos *et al*, 2014).
- Pollinators, such as honeybees (*Apis mellifera*) and bumblebees (*Bombus terrestris*) are kept near fields or introduced into glasshouses to improve the pollination of crops.

4.1.2 Diversity based practices

In Table 4.2, an assessment is made of the extent of use of diversity based practices that involve the use of biodiversity for food and agriculture, for each of the production systems. Only those Table rows are shown where an assessment could be made. For a description of the diversity based practices, see Annex 5. Qualitative descriptions of the use of the relevant management practices in the different production systems are given below.

L3 (Livestock grassland-based systems: Temperate)

- Demand for and supply of biological agricultural products has risen, and there is also an increasing interest in regional products, “local to local”, and typical, quality products. These developments may provide new opportunities to exploit farm animal genetic diversity, to support the conservation of animal biodiversity, and to promote diversification of breed and agro-ecosystem related food products and services (Hiemstra, 2014).
- An increasing diversity of breeds is employed in nature and landscape management and for other (new) farm animal functions (Hiemstra, 2002).
- CGN is collecting genetic material and maintains gene bank collections of cattle, horses, sheep, and goats. Rare breeds as well as widely used, commercial breeds are represented in the gene bank (Hiemstra, 2014).
- The awareness of the importance of biodiversity and the interest in conservation and use of genetic resources that are characteristic of past land use, such as hedgerow landscapes have increased amongst the wider public (Buiteveld, 2012; Visser, 2008).

Table 4.2. *Diversity based practices that involve the use of biodiversity for food and agriculture: percent of production area (%); change in production area over the past 10 years (significant increase (+2), some increase (+1), no change (0), some decrease (-1), significant decrease (-2)); effect on diversity (strongly increasing (2), increasing (1), sTable (0), decreasing (-1), strongly decreasing (-2); not known (nk); for a description of the management practices, see Annex 5).*

Production system	**Diversity based practices**	**Percent of production area or quantity under the practice**	**Change in production area or quantity under the practice**	**Effect on biodiversity for food and agriculture**
L3 (Livestock grassland-based systems: Temperate)	Diversification	nk	+1	+1
	Base broadening	nk	+1	+1
	Maintenance or conservation of landscape complexity	nk	+1	+1
L7 (Livestock landless systems: Temperate)	Diversification	nk	+1	+1
	Base broadening	nk	+1	+1
F7 (Planted forests: Temperate)	Diversification	nk	+2	+2
	Enriched forests	nk	+1	+1
A3 (Self-recruiting capture fisheries: Temperate)	Restoration practices		+1	+1
A7 (Culture-based fisheries: Temperate)	Diversification		+1	+1
A11 (Fed aquaculture: Temperate)	Diversification			
	Base broadening			
	Domestication			
	Restoration practices			
A15 (Non-fed aquaculture: Temperate)	Restoration practices		+1	+1
C11 (Rainfed crops: Temperate)	Diversification	nk	+1	+1
	Base broadening	nk	+1	+1
	Maintenance or conservation of landscape complexity	nk	+1	+1
O1 (Others (horticulture under glass))	Diversification		+1	+1
	Base broadening		+1	+1

L7 (Livestock landless systems: Temperate)

- The developments with respect to biological, regional and local products, described above for Livestock grassland-based systems, also apply to Livestock landless systems.
- CGN is collecting genetic material and maintains gene bank collections of pigs and poultry. Rare breeds as well as widely used, commercial breeds are represented in the gene bank (Hiemstra, 2014).

F7 (Planted forests: Temperate)

- During the past decades, the objective of forest management has shifted from wood production to multi-purpose forest management with the focus on recreation and nature conservation. As a result, the forest area primarily assigned for wood production has declined, and the forest area managed for biodiversity conservation has increased. Management now focuses on increasing the amount of dead wood in the forest, increasing the number of large and thick trees, enhancing structural diversity, increasing the number of different age classes, and promoting native tree species (Buiteveld, 2012). The Dutch forest is increasingly mixed, mainly at the cost of mono species coniferous forest (Schelhaas *et al*, 2014). Changed forest management has led to increases in the numbers of certain forest birds, bats, invertebrates and mushrooms (Noordijk *et al*, 2010).

- Harvesting is most often carried out by selective thinning.

A3 (Self-recruiting capture fisheries: Temperate)

- - Marine Protected Areas are being established in the Dutch part of the North Sea. In the Dutch coastal zone, 10% of the surface has been closed to all fishing by 2011, 15% is closed to bottom trawling, and 28% is closed for fishing with heavy bottom trawl gear (http://www.noordzeeloket.nl/projecten/noordzee-natura-2000/nieuws/2012/nieuwsbrief-januari-2012/het-vibeg-akkoord.aspx).
- - Physical migration barriers have been lifted by building fish passages and plans are being developed for creating migration possibilities in the barrier dams of major estuaries and rivers (Haringvliet, Afsluitdijk).

A7 (Culture-based fisheries: Temperate)

- Eels are set out in inland waters by professional fishermen and by the Dutch government. Young eels ("glass eels") are obtained from specialized French and British fishermen, and either set out immediately or first raised for some time in eel farms. Other fish species are also restocked, e.g. by anglers.

A11 (Fed aquaculture: Temperate)

- There is no information on the use of diversity based practices in this production system.

A15 (Non-fed aquaculture: Temperate)

- In the past, the collection of mussel seed has reduced the surface area of inter-tidal mussel beds that provide habitat for a variety of invertebrate species as well as food for waders. Inter-tidal mussel beds have been closed for fishing, and mechanical fishing for mussel seed has been gradually reduced from 2009 onwards and will have been replaced by mussel seed collectors by 2020 (http://www.rijkewaddenzee.nl/programma/mosselconvenant/toelichting).

C11 (Rainfed crops: Temperate)

- Substantial traditional diversity is maintained in homegardens. Sales of traditional and regional products through farm shops and other niche markets increasingly contribute to the conservation and utilization crop genetic diversity (Visser, 2008). Niche markets for consumers with a keen interest in regional and traditional products or with an immigrant culture background, as well as organic production, are also slowly developing (Visser, 2008).
- The awareness of the importance of biodiversity and the interest in conservation and use of genetic resources that are characteristic of past land use, such as hedgerow landscapes have increased amongst the wider public (Buiteveld, 2012; Visser, 2008).
- To increase the genetic diversity of the collections, and thus the available genetic diversity for the agricultural sector, CGN and other collection holders in the public and private sector add material, for instance by carrying out collection missions in the Netherlands and abroad.

O1 (Others (horticulture under glass))

- Pollinators such as *Bombus terrestris* and a wide range of organisms controlling pests are used in glass horticulture. In vegetables, the area with biological pest control increased from 2946 ha in 2000 to 3267 ha in 2012, but the application of biological pest control decreased from almost 100% of the total area under vegetables in 2000 to 83.5% in 2012. A reason mentioned for this decrease is the availability of new, selective crop protection products, which are more reliable than biological agents (Mulder *et al*, 2011). For flowers and ornamental plants, the area with biological pest control increased from 1485 ha in 2000 to 1557 ha in 2012, and the percentage of the total area increased from 34% to 46% in the same period (CBS, PBL & Wageningen UR, 2015).

- To increase the genetic diversity of the collections, and thus the available genetic diversity for the agricultural sector, CGN and other collection holders in the public and private sector add material, for instance by carrying out collection missions in the Netherlands and abroad.

4.1.3 Programmes and projects undertaken to support management and diversity based practices

The core of the area-focused measures is the National Nature Network (NNN; formerly called 'National Ecological Network'), which was launched in the 1990 *Natuurbeleidsplan* (NBP, 'Nature policy plan'). The NNN is an interconnected network of nature reserves and conservation areas, with the aim of securing and connecting existing nature reserves and creating 'new nature' (Noordijk *et al*, 2010; Buiteveld, 2012). It also includes production forests and farmland, such as grasslands used as breeding sites for meadow birds (De Kool, 2012). The land area is about 750,000 ha, consisting of existing nature areas (including the 20 national parks), areas where new nature is created, and areas under agrarian nature management, and the open water area is more than 6 million ha (including lakes, rivers, the North Sea and the Wadden Sea) (www.atlasleefomgeving.nl). The NNN contains a relatively large part of Dutch biodiversity, and contributes to a reduction of biodiversity loss in the country. It is also considered to be important for protecting Dutch nature against climate change and other environmental influences, because survival opportunities for populations are better in an ecological network than in isolated areas (Noordijk *et al*, 2010). By the end of 2012, the land area acquired for the NNN amounted to about 90,000 ha (CBS, PBL & Wageningen UR, 2015).

'Natura 2000' is the network of nature areas in the European Union, that are protected on the basis of the Birds (1979) and Habitats (1992) Directives. Natura 2000-areas in the Netherlands are selected on the species and habitats they harbour, and are mostly part of the NNN. At present, the Dutch Natura 2000-areas cover about 1 million ha, of which about two thirds open water (Noordijk *et al*, 2010; CBS, PBL & Wageningen UR, 2015).

The main policy instruments for the conservation of farmland biodiversity are the biodiversity measures under the 'Farmland Conservation Scheme', co-funded by the EU. The scheme facilitates nature and landscape management contracts with farmers on a voluntary basis for a period of six years, with a strong focus on the management of grassland-birds (nest protection, postponed mowing) (Notenboom *et al*, 2006).

In the VIBEG agreement, concluded by the fishing industry, nature conservation organizations and the government in 2011, it was agreed to establish Marine Protected Areas in the Dutch part of the North Sea. In the Dutch coastal zone, 10% of the surface is closed to all fishing by 2011, 15% is closed to bottom trawling, and 28% is closed for fishing with heavy bottom trawl gear (http://www.noordzeeloket.nl/projecten/noordzee-natura-2000/nieuws/2012/nieuwsbrief-januari-2012/het-vibeg-akkoord.aspx).

4.2 Sustainable use of biodiversity for food and agriculture

Table 4.3 lists major practices that negatively impact associated biodiversity, and their importance in the Netherlands.

Table 4.3. Practices that negatively impact associated biodiversity.

Types of practices	**Major practice? (Y/N)**	**Description**	**Reference**
Over-use of artificial fertilizers or external inputs	Y	The phosphorus and nitrogen balances of agricultural soils have become more even over the past decades, but were still positive in all years of the period 2003-2013, meaning that the amounts of phosphorus and nitrogen in agricultural soils have increased in the period considered.	- CBS, PBL & Wageningen UR, 2015
Over-use of chemical control mechanisms (e.g. disease control agents, pesticides, herbicides, veterinary drugs, etc.)	Y	The use of pesticides, especially insecticides and fungicides, was shown to have consistently negative effects on the species diversity of plants, carabids and birds in agricultural fields.	- Geiger *et al*, 2010.
Inappropriate water management	Y	In many areas, water management has been adapted to agriculture, meaning that groundwater levels are kept low. This is unfavourable for much natural vegetation, and has profound impacts on the ecology of grasslands and wetlands	- CBS, PBL & Wageningen UR, 2015 - Notenboom *et al*, 2006
Practices leading to soil and water degradation	Y	In certain areas, soil compaction has occurred as a result of intensive cultivation. Soil compaction has a negative influence on soil life. In South Limburg, water erosion is strongly related to changing agricultural land use and agricultural practices: row crops such as maize and potatoes are considered more erosion-sensitive than winter cereals; re-allotment schemes and clearing of hedgerows have resulted in larger fields, causing surface runoff to be more erosive; and the use of heavy machinery has led to compaction and more runoff	- Derks *et al*, 2012 - Staps *et al*, 2015 - Winteraeken & Spaan, 2010.
Over-grazing	N		
Uncontrolled forest clearing	N		
Fishing in protected areas	N		
Overharvesting	N/Y	Overharvesting is not a problem in terrestrial systems. In the marine fisheries sector, fishing pressure has been reduced over the last decade, due to restrictive quota and reduction of the overcapacity of the fishing fleet. Licensing and restrictions have also been introduced for the inland fishery sector.	- ICES, 2013 - CBS, PBL & Wageningen UR, 2015 - De Leeuw *et al*, 2008 - FAO, 2005 - Noordijk *et al*, 2010

Actions and countermeasures taken to limit unsustainable use and/or support sustainable use of associated biodiversity include the following.

- Fisheries management and fishery inspections are in place to sustainable exploit the aquatic living resources.
- In the capture fisheries sector, technical innovations are being explored to reduce collateral damage to the ecosystem, in particular to reduce the bycatch of undersized fish and the reduction of the adverse effects on seabed habitats (Van Marlen *et al*, 2014).
- In the coastal fishery sector (mussels, oysters, cockles and shrimps), special attention has been paid to the interrelations between fishing activities and the ecological value of nature. Where productive and ecological functions of the coastal area were mutually exclusive, a separation between the functions was established, leading to closures of specific areas for fishing (FAO, 2005). In the Wadden Sea area, mechanical cockle fishing was banned in 2004 (Floor *et al*, 2013). Mechanical fishing for mussel seed has been gradually reduced from 2009 onwards and will have been replaced by mussel seed collectors by 2020 (http://www.rijkewaddenzee.nl/programma/mosselconvenant/toelichting).

4.3 The contribution of biodiversity for food and agriculture to improving productivity, food security and nutrition, livelihoods, ecosystem services, sustainability, resilience and sustainable intensification

In forest ecosystems, the shift in management objectives during the last few decades (from wood production towards multi-purpose forest management) has led to increased tree diversity (more large and thick trees, more structural diversity, increased number of different age classes, greater role of native tree species) (Buiteveld, 2012). This changed forest management has led to increases in the numbers of certain forest birds, bats, invertebrates and mushrooms, and has thus improved the ecosystem function of habitat provisioning (Noordijk *et al*, 2010).

As wild foods (including fish) are estimated to comprise only 1-2% of the food consumed in the Netherlands (De Knegt, 2014), the contribution of biodiversity for food and agriculture to improving food security and nutrition in the Netherlands through wild foods is very limited.

4.4 The adoption of ecosystem approaches

In Table 4.4 it is assessed to what extent ecosystem and landscape approaches have been adopted for different production systems in the Netherlands, and the importance of these ecosystem approaches is indicated.

Beneath Table 4.4, additional information is given, where possible, for the production systems in which an ecosystem and/or landscape approach has been widely adopted, with respect to specific actions that have been taken to ensure adoption, observed results from adoption, plans for adoption in new areas or further adoption in existing production areas, and lessons learned.

Table 4.4. Adoption of ecosystem and/or landscape approaches in production systems in the Netherlands (widely adopted (2), partially adopted (1), not adopted (0)), and the importance assigned to these ecosystem approaches (major importance (2), some importance (1), no importance (0)).

Production systems	**Ecosystem and/or landscape approach adopted**	**Extent of adoption**	**Importance assigned to the approach**
L3 (Livestock grassland-based systems: Temperate)	- National Nature Network (NNN); - Agrarian nature management agreements	1	2
F7 (Planted forests: Temperate)	- National Nature Network (NNN); - Natura 2000 - Management aimed at biodiversity conservation	1	2
A3 (Self-recruiting capture fisheries: Temperate)	- Marine Strategy Framework Directive (MSFD) - Natura 2000 (Marine Protected Areas)	1	2
A15 (Non-fed aquaculture: Temperate)	- *Mosselconvenant*	1	1
C11 (Rainfed crops: Temperate)	- National Nature Network (NNN); - Agrarian nature management agreements	1	1

L3 (Livestock grassland-based systems: Temperate)

- The establishment of the National Nature Network (NNN; formerly called 'National Ecological Network') is aimed at establishing an interconnected network of nature reserves and conservation areas, which also includes production forests and farmland.
- Agrarian nature management agreements are established with farmers, who commit themselves to take measures to improve the quality of nature and the landscape on their farms. The target in terms of numbers of hectares has been abandoned in the 2013 'Pact for nature' (*Natuurpact*) covenant, but not the instrument as such (CBS, PBL & Wageningen UR, 2015). It has been observed that agrarian nature management generally has had little effect on the nature value, except for some regional successes, for instance with birds of arable land (Noordijk *et al*, 2010).

F7 (Planted forests: Temperate)

- The establishment of the National Nature Network (NNN) is aimed at establishing an interconnected network of nature reserves and conservation areas, which also includes production forests and farmland.
- 'Natura 2000' is the network of nature areas in the European Union'. Natura 2000-areas in the Netherlands are mostly part of the NNN. At present, the Dutch Natura 2000-areas cover about 1 million ha, of which about two thirds open water.
- The objective of forest management has shifted from wood production to multi-purpose forest management with the focus on recreation and nature conservation. As a result, the forest area primarily assigned for wood production has declined, and the forest area managed for biodiversity conservation has increased (Buiteveld, 2012). The Dutch forest is increasingly mixed, mainly at the cost of mono species coniferous forest (Schelhaas *et al*, 2014). Changed forest management has led to increases in the numbers of certain forest birds, bats, invertebrates and mushrooms (Noordijk *et al*, 2010).

A3 (Self-recruiting capture fisheries: Temperate)

- The Marine Strategy Framework Directive (MSFD) aims to reach Good Environmental Status (GES) by 2020. Indicators are being developed that encompass biodiversity. A network of Marine Protected Areas is being implemented in the Dutch part of the North Sea. The implementation is ongoing. It is too early to evaluate its results.
- Cockle fishery using dredges has been banned from the Wadden Sea.

A15 (Non-fed aquaculture: Temperate)

- In the *Mosselconvenant* it has been agreed that mechanical fishing for mussel seed will be gradually reduced from 2009 onwards and be replaced by mussel seed collectors by 2020 (www.rijkewaddenzee.nl/programma/mosselconvenant/toelichting).

C11 (Rainfed crops: Temperate)

- The establishment of the National Nature Network, is aimed at establishing an interconnected network of nature reserves and conservation areas, which also includes production forests and farmland.
- Agrarian nature management agreements are established with farmers, who commit themselves to take measures to improve the quality of nature and the landscape on their farms. The target in terms of numbers of hectares has been abandoned in the 2013 'Pact for nature' (*Natuurpact*) covenant, but not the instrument as such (CBS, PBL & Wageningen UR, 2015). It has been observed that agrarian nature management generally has had little effect on the nature value, except for some regional successes, for instance with birds of arable land (Noordijk *et al*, 2010).

4.5 Gaps and priorities

A major gap in information and knowledge with respect to the use of management practices, is the lack of thorough evaluation of practices intended to favour associated biodiversity and the provision of regulating and supporting ecosystem services. An example is the establishment of field boundaries, of which Bos *et al* (2014) say that the "Dutch practice is ahead of scientific developments, when it comes to assess the societal services of field boundaries". They argue that, so far, there has been no structural evaluation of field boundaries (with respect to intermediate and final objectives), which makes assessment of the actual effectivity impossible. Required actions required include proper and more in-depth evaluation of the effectiveness of management practices intended to favour the use of biodiversity for food and agriculture.

With respect to the sustainable use of biodiversity for food and agriculture, gaps in information and knowledge exist with respect to the sustainability or unsustainability of certain practices in using biodiversity for food and agriculture. There is, for instance, controversy about the impact of bottom trawling, in particular in waters that are exposed to natural disturbance by wave actions and tidal currents, and the effects on the food availability of bottom dwelling fish. There is a lack of experimental studies of the chronic effects of bottom trawling. Another example is the lack of consensus on the effects of the use of neonicotinoid chemical crop protection products, which are suspected of playing a role in a decline in honeybee populations, important for pollination in Dutch agriculture (CBS, PBL & Wageningen UR, 2014).

There is also a lack of knowledge of the effects of the use of diversity of plant and animal genetic resources. Does it have impact on sustainability? For instance, the presence of resistance to pests may lead to reduced use of pesticides.

5. The state of interventions in the conservation and use of biodiversity for food and agriculture

5.1 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

5.1.1 Interventions supporting the integrated conservation and sustainable use of biodiversity for food and agriculture across sectors

In the past 10-15 years, Dutch biodiversity policies contained measures focused on species as well as measures focused on areas. The policy document Natuur voor mensen, mensen voor natuur ('Nature for People, People for Nature'), published in 2000, emphasized the conservation of both species and nature sites (Notenboom *et al*, 2006; Noordijk *et al*, 2010).

The core of the species-specific legislation was the 1998 Flora- en faunawet ('Flora and fauna Act') and fisheries regulations. The former indicates which species are protected, and what cannot be done with these species, while the latter set rules for the catching of fish and shellfish (Noordijk *et al*, 2010).
Currently, a proposal for a Nature Conservation Act (Wetsvoorstel Natuurbescherming) is in the legislative process. The purpose of this new Act is to consolidate the current Nature Conservation Act of 1998, the Flora and Fauna Act and the Forest Act, and to implement duties under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the corresponding EU regulation, and the EU Timber Regulation (Visser *et al*, 2015; www.government.nl). Under the new Nature Conservation Act and the future Environmental Act the government aims to involve nature and landscape interests at an early stage in area-specific development and large projects. The plan is to incorporate the new Nature Conservation Act into the Environmental Act (De Groot, 2014).

The core of the area-focused measures is the National Nature Network (NNN; formerly called 'National Ecological Network'), launched in the 1990 Natuurbeleidsplan (NBP, 'Nature policy plan'). The NNN consists of an interconnected network of nature reserves and conservation areas, with the aim of securing and connecting existing nature reserves and creating 'new nature' (Noordijk *et al*, 2010; Buiteveld, 2012). The NNN also includes production forests and farmland, such as grasslands used as breeding sites for meadow birds (De Kool, 2012). The NNN contains a relatively large part of Dutch biodiversity, and contributes to a reduction of biodiversity loss in the country. It is also considered to be important for protecting Dutch nature against climate change and other environmental influences, because survival opportunities for populations are better in an ecological network than in isolated areas (Noordijk *et al*, 2010). By the end of 2012, the land area acquired for the NNN amounted to about 90,000 ha (CBS, PBL & Wageningen UR, 2015).

'Natura 2000' refers to the network of nature areas in the European Union, that are protected on the basis of the Birds (1979) and Habitats (1992) Directives. Natura 2000-areas in the Netherlands have been selected on the species and habitats they harbour, and are mostly part of the NNN. At present, the Dutch Natura 2000-areas cover about 1 million ha, of which about two thirds open water (Noordijk *et al*, 2010; CBS, PBL & Wageningen UR, 2015).

5.1.2 Interventions supporting the conservation and sustainable use of associated biodiversity

At the EU-level, the reform of the Common Agricultural Policy (CAP) in 1992 envisaged the reduction of the negative consequences of agricultural intensification by financially supporting agri-environment schemes and organic farming (Council Regulation 2078/92/EEC) (Geiger *et al*, 2010).

In the Netherlands, a part of the European subsidies for farmers is used for specific management measures, for instance for the protection of meadow birds, birds of agricultural land, and landscape elements, through the *Subsidiestelsel Natuur en Landschapsbeheer* (SNL, 'Subsidy system for Nature and Landscape management'). SNL subsidies are provided by the provincial authorities. The SNL system is based on habitat types and management types, which are defined in a nationally uniform 'natural habitats terminology system' developed by habitat management organisations, agricultural and private organisations and governments at various levels. Farmers adopting nature-friendly management practices on their land can apply for remuneration under the SNL grant scheme (www.government.nl).

Three types of agri-environment schemes can be distinguished: schemes addressing the maintenance of landscape features outside the productive area of the farm; schemes that impose restrictions on farming practices, such as a delayed mowing regime or restricted fertiliser use; and a land retirement facility to change the function to nature. The schemes are different in each province, with some focussing more on landscape features and botanical measures, and others focusing mainly on meadow bird protection (Schrijver & Uetake, 2014).

By the end of 2012, the total area covered by agri-environment schemes in the Netherlands was almost 59,000 ha. After a decline of the area with about 10,000 ha between 1999 and 2009, it increased with 5000 ha between 2009 and 2012. The initial target in terms of numbers of hectares under agri-environmental schemes has been abandoned in the 2013 'Pact for nature' (*Natuurpact*) covenant, but not the instrument as such. However, the relatively short term of the contracts means that the continuity of agri-environment schemes remains uncertain (CBS, PBL & Wageningen UR, 2015).

Private owners of estates who adopt nature-friendly management practices and provide public access to their land may also apply for a grant under the SNL scheme (www.government.nl). The total area of land covered by such contracts had was about 6300 ha by the end of 2012 (CBS, PBL & Wageningen UR, 2015).

The government encourages enlarged involvement of the public and businesses by concluding Green Deals and organising Green Tables, and it aims to reduce the regulatory burden through simpler, clearer regulations (www.government.nl).

5.1.3 Interventions addressing the maintenance of ecosystem services

No separate National Forest Programme exists in the Netherlands, but a forest policy programme has been incorporated in the government's nature policy (Buiteveld, 2012). The policy is focused on multifunctional management to meet society's needs: nature conservation, recreation, landscape values and timber production. The other main objectives of the forest policy are sustainable management of the forests and expansion of the forested area. These policy objectives are outlined in a range of documents.

Sustainable management of the forests is guaranteed by the Forest Act (1961). Under this law, the forest area existing in 1961 must be maintained and, where possible, expanded (Buiteveld, 2012). Felling and replanting of trees outside urban areas is regulated through the Forest Act (Noordijk *et al*, 2010).

The policy letter Functionele agrobiodiversiteit (2004) with additions (2009) contain actions to promote that agriculture benefits more from natural biodiversity, including soil organisms and natural predators (Noordijk *et al*, 2010).

5.1.4 Interventions improving the resilience and sustainability of production systems

The policy document 'Nature for People, People for Nature' (2000) stated that forests must be managed in an economically feasible, sustainable manner, and that long-term conservation of woodlands and further expansion of the forested area to more than 400,000 ha by 2020 will be continued (Buiteveld, 2012).

North sea fisheries are almost completely regulated by European legislation, which sets, among other things, the total allowable catch for various species, and the number of days that these species may be caught. Fisheries in the Dutch coastal waters is especially being regulated through the Visserijwet (Fisheries Act), which regulates fishing methods and fish sizes, and policy decisions such as Vast en zeker (2002) dealing with fixed fishing gear, and Ruimte voor een zilte oogst (2004) dealing with shellfish fisheries (FAO, 2005; Noordijk *et al*, 2010).

The policy document Biodiversiteit werkt: voor natuur, voor mensen, voor altijd (2008) contains various actions that take into account unwanted side effects of fisheries on marine ecosystems. It promotes that beam trawler fishermen use other fishing methods, that more selective fishing gear is used, and that less fish is thrown overboard. It also announces international efforts to limit by-catches and disturbance of sea mammals (Noordijk *et al*, 2010).

In the VIBEG agreement, concluded by the fishing industry, nature conservation organizations and the government in 2011, it was agreed to establish Marine Protected Areas in the Dutch part of the North Sea. In the Dutch coastal zone, 10% of the surface is closed to all fishing by 2011, 15% is closed to bottom trawling, and 28% is closed for fishing with heavy bottom trawl gear (http://www.noordzeeloket.nl/projecten/noordzee-natura-2000/nieuws/2012/nieuwsbrief-januari-2012/het-vibeg-akkoord.aspx).

In inland waters, professional and recreational fisheries are almost entirely regulated through the Visserijwet, e.g. with licenses and restrictions with respect to fishing gear, fishing areas and fishing seasons (De Leeuw *et al*; Noordijk *et al*, 2010).

5.1.5 Interventions supporting farmers, pastoralists, forest dwellers and fisher folk to adopt and maintain practices that strengthen the conservation and use of biodiversity for food and agriculture

Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 is aimed at reducing the overall risk from pesticides. All Member States must develop alternative pest control methods to reduce the dependence on chemical crop protection. Integrated Pest Management (IPM) is considered the key instrument in achieving these targets, and therefore the principles of IPM must be implemented by all European growers by 2014 (Van Eerdt *et al*, 2014).

5.1.6 Policies, programmes and enabling frameworks that enhance the application of an ecosystem approach or a landscape approach

The National Nature Network (NNN), including the Natura 2000 areas, is focused on the implementation of the ecosystem approach, as the protection of habitat is considered essential for the conservation of biodiversity as a whole. Outside the NNN, the government has set targets to increase the conservation status of species and habitats that depend on or are affected by agriculture (Ministry of Economic Affairs, 2014).

Other policies, programmes and enabling frameworks in the Netherlands that enhance the application of an ecosystem approach or a landscape approach include:

- Forest management aimed at biodiversity conservation;
- The VIBEG agreement.
- Common Fisheries Policy
- Marine Strategy Framework Directive

These policies, programmes and enabling frameworks have all been described in the preceding paragraphs.

5.1.7 Arrangements that help to ensure that the conservation of biodiversity for food and agriculture is taken into account in national planning and policy development of sectors other than agriculture

An important arrangement in place that helps to ensure that the conservation of biodiversity for food and agriculture is taken into account in national planning and policy development of sectors other than agriculture, is the Environmental Impact Assessment (EIA; in Dutch: *Milieu Effect Rapportage, MER*).

EIA was introduced into the Netherlands in 1987. The associated EIA Decree has since been modified a number of times. The objective of EIA is to ensure that the environment is properly considered in the decision making process with respect to activities with possible negative consequences on the environment (www.eia.nl). EIA is obligatory for activities that may have considerable impacts on the environment, such as road construction and other infrastructural activities, the creation of industrial areas, the lowering of water levels, excavations, and intensive livestock keeping

The 1998 *Flora- en faunawet* ('Flora and fauna Act') obliges citizens to take into account the effects of landscape changes on protected species that may be affected. Because it is not always known which protected species are present, an inventory has to be carried out first. From the National Databank Flora and Fauna (NDFF), information can be obtained on the distribution of protected and rare species.

5.1.8 Obstacles to developing and implementing legislation that would protect associated biodiversity

The main obstacle to the development and implementation of legislation intended to protect associated biodiversity, is probably the fear that this legislation will have negative consequences on the economic viability of existing enterprises and practices, for instance in the agriculture and fisheries sectors.

Other obstacles are that, as already indicated in paragraph 4.5, there is a lack of thorough evaluation of practices intended to favour associated biodiversity and the provision of ecosystem services, and a lack of knowledge with respect to the sustainability or unsustainability of certain practices. In these situations it is hard to justify legislation favouring or requiring these practices.

5.2 Policies, programmes and enabling frameworks governing exchange, access and benefits

In 2002, a government policy document on genetic resources ("Sources of Existence") was adopted. This document states that the government does not recognize the need for specific legislation with respect to access to genetic resources. Thus, the Dutch government does not require users of genetic resources under its sovereignty to obtain PIC from the government. However, other legislation, such as species or habitat protection, may apply and access may not be free of obligations.

A national law to implement in the Netherlands the EU Regulation 511/2014 on the implementation of the Nagoya Protocol in the European Union is under preparation. The elaboration accompanying the legislation will state that no specific access rules to genetic resources occurring in the Netherlands in *in situ* conditions apply.

5.3 Information management

In Table 5.1 national information systems on associated biodiversity are listed, along with the components of associated biodiversity addressed and a brief description of the information system.

Table 5.1. National information systems on associated biodiversity in the country.

National information system (List)	Components of associated biodiversity addressed (List)	Concise description of information systems
National Databank Flora and Fauna (NDFF)	plants animals	The NDFF provides information on the distribution of protected and rare plants and animals, based on validated observations.
Network Ecological Monitoring (NEM)	mammals birds reptiles amphibians fish butterflies dragonflies other insects plants mushrooms	The NEM is a partnership of government organizations for the monitoring of nature in the Netherlands. Its objective is to align data collection with the information needs of the government. The NEM monitors trends of groups of species in separate monitoring networks for different categories of species. Data are mostly collected by private organizations, such as Sovon (wild birds), Ravon (reptiles, amphibians, fish) and the *Zoogdierenvereniging* (mammals).

An important point of linkage between information from national information systems and sector information systems is the Environmental Data Compendium (*Compendium voor de Leefomgeving*;

www.compendiumvoordeleefomgeving.nl), which intends to characterize the quality of the environment and nature, and spatial developments in the Netherlands through indicators. The Environmental Data Compendium is a joint publication by Statistics Netherlands (CBS), the Netherlands Environmental Assessment Agency (PBL) and Wageningen University and Research centre (Wageningen UR).

5.4 Stakeholder participation and ongoing activities that support maintenance of biodiversity for food and agriculture

A large number of stakeholder groups are active in the conservation of biodiversity for food and agriculture, including:

- The private sector.
- Associations of primary producers (farmers, fishermen).
- National nature conservation organizations, such as natuurmonumenten.
- Regional organizations aimed at the protection of specific areas, or groups of species (e.g. Meadow birds).
- Organizations aimed at monitoring of populations of species or groups of species, such as sovon (birds) and floron (plants).

Incentives and benefits to support activities for the conservation and sustainable use of biodiversity for food and agriculture or associated biodiversity include payments in the framework of agri-environment conservation. Farmers adopting nature-friendly management practices on their land can apply for remuneration under the 'Subsidy system for Nature and Landscape management' (SNL). Private landowners who adopt nature-friendly management practices and provide public access to their land may also apply for a grant under the SNL scheme (www.government.nl). All agri-environmental payments to farmers are based on the principle of income foregone and costs incurred (plus up to 20% for transaction costs), and the schemes are normally co-financed under Pillar 2 of the CAP (Schrijver & Uetake, 2014).

The reasons most commonly cited by farmers for ending their participation in agri-environment schemes are land management problems (e.g. weeds); problems of fitting the schemes in their core agricultural practices; the level of financial compensations; the level of bureaucracy involved, and having sold the land for which management contracts under agri-environment schemes had been concluded (CBS, PBL & Wageningen UR, 2015).

Table 5.2 presents the main landscape based initiatives to protect or recognize areas of land and water in the Netherlands of particular significance for biodiversity for food and agriculture.

The NNN is an interconnected network of nature reserves and conservation areas, with the aim of securing and connecting existing nature reserves and creating 'new nature' (Noordijk *et al*, 2010; Buiteveld, 2012). It also includes production forests and farmland, such as grasslands used as breeding sites for meadow birds (De Kool, 2012). The land area is about 750,000 ha, consisting of existing nature areas (including the 20 national parks), areas where new nature is created, and areas under agrarian nature management, and the open water area is more than 6 million ha (including lakes, rivers, the North Sea and the Wadden Sea) (www.atlasleefomgeving.nl).

Natura 2000' is the network of nature areas in the European Union, that are protected on the basis of the Birds (1979) and Habitats (1992) Directives. Natura 2000-areas in the Netherlands are selected on the species and habitats they harbour, and are mostly part of the NNN. At present, the Dutch Natura 2000-areas cover about 1 million ha, of which about two thirds open water (Noordijk et al., 2010; CBS, PBL & Wageningen UR, 2015). The area under 'agrarian nature management' (with measures taken by farmers to improve the quality of nature and the landscape) decreased from about 64,000 ha in 1999 to about 54,000 ha in 2009, after which it increased again to 59,000 ha in 2012 (CBS, PBL & Wageningen UR, 2015).

Table 5.2. Landscape based initiatives to protect or recognize areas of land and water in the country with particular significance for biodiversity for food and agriculture.

Landscape based initiatives	**Description of sites and their characteristics of relevance to biodiversity for food and agriculture**	**Extent (area)**
National Nature Network (NNN)	An interconnected network of nature reserves and conservation areas, which also includes production forests and farmland.	Land area about 750,000 ha; area open water more than 6 million ha (www.atlasleefomgeving.nl).
Natura 2000	A network of nature areas in the European Union' (in the Netherlands mostly part of the NNN)	Approximately 1 million ha in the Netherlands, of which about two thirds open water.
Agrarian nature management schemes	Agrarian land with measures taken by farmers to improve the quality of nature and the landscape	Approximately 59,000 ha in 2012

5.5 Collaboration between sectors, institutions and organizations

5.5.1 Linkages and collaboration

Cooperation between ministries and with other authorities and actors in civil society is considered a key feature of the Dutch biodiversity policy. Under the Administrative Agreement on Nature of 2012, many nature policy tasks were transferred to the provinces. Under the 'Pact for Nature' of 2013, it has been agreed that the provinces are responsible for the protection of National Nature Network, drawing up the spatial plans, bringing partners and stakeholders together, giving people a greater say in deciding how to make use of it in a sustainable manner.

One of the main national instruments to promote cooperation between governments and other actors is the 'Green Deal': an agreement or covenant between a coalition of companies, civil society organizations and local and regional government. It defines the initiative and the actions involved, and the input by the participants involved as clearly as possible. Green Deals cover nine themes: energy, the bio-based economy, mobility, water, food, biodiversity, resources, construction and the climate. The Green Deal approach is a joint initiative by the Ministry of Economic Affairs, the Ministry of Infrastructure and the Ministry of Environment and the Interior and Kingdom Relations. In the period 2011-2014, a total of 176 Green Deals were closed in the Netherlands, involving a total of 1,090 participants. Among these were 26 Biodiversity Deals, with 167 participants (www.greendeals.nl).

5.5.2 Collaboration to meet the Aichi Biodiversity Targets

In 2010, the Conference of the Parties of the Convention on Biological Diversity (CBD) adopted a Strategic Plan for Biodiversity, with 20 new biodiversity targets for 2020, called the Aichi Biodiversity Targets. Aichi Biodiversity Target 17 states that: “By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan” (www.cbd.int).

The Netherlands doesn’t have one National Biodiversity Strategy Action Plan (NBSAP) but has integrated actions for implementing the Aichi targets into several policy plans, including the Natural Capital Agenda and he Nature Pact. Together, these serve as a NBSAP (Ministry of Economic Affairs, 2014; www.cbd.int).

The Natural Capital Agenda (June 2013), a joint effort of the Ministry of Economic Affairs and the Ministry of Infrastructure and the Environment, is a translation of the international agreements on biodiversity, including the Aichi targets, into an implementation agenda on biodiversity in the Netherlands for the 2011-2020 period. Emphasis is placed on strengthening the economy-ecology relationship, with four main themes defined (sustainable production and consumption: sustainable supply chains; sustainable fisheries and protection of marine biodiversity; sustainable agriculture and protection of biodiversity; valuing natural capital). General objectives and specific action points are identified for each theme, with activities to be implemented by all stakeholders, including civil society and the private sector (www.cbd.int).

5.5.3 Regional and/or international initiatives

The Netherlands is involved in various regional and/or international initiatives targeting the conservation and sustainable use of associated biodiversity. The main ones are listed in Table 5.3.

Table 5.3. Regional and/or international initiatives targeting the conservation and sustainable use of associated biodiversity.

Initiatives	Scope (R: regional, I: international)	Description	References
Convention on Biological Diversity (CBD)	International	An international agreement aiming at the conservation of biological diversity, the sustainable use of its components, and the fair and equiTable sharing of the benefits arising from the utilisation of genetic resources.	www.cbd.int
EU Common Agricultural Policy (CAP)	Regional	Goals include the reduction of the negative consequences of agricultural intensification by financially supporting agri-environment schemes and organic farming.	EU, 2011; Van Zeijts *et al*, 2011
EU biodiversity strategy	Regional	Aims at halting the loss of biodiversity and the degradation of ecosystem services in the EU, and restoring them as much as possible.	EU, 2011; Van Zeijts *et al*, 2011
Natura 2000 (Part of EU biodiversity strategy)	Regional	A network of nature areas in the European Union, that are protected on the basis of the Birds and Habitats Directives.	EU, 2011; Noordijk *et al*, 2010; CBS, PBL & Wageningen UR, 2015

5.6 Capacity development

5.6.1 Training programmes

Various training programmes targeting the conservation and sustainable use of associated biodiversity have been developed.

In the EU Local Skills for Biodiversity Project, with the *Gelderse Natuur en Milieufederatie* (GNMF) as one of the partner organizations, training materials have been developed on the use of an ecosystems approach in local planning. These materials are intended for staff of local and regional administrations, in particular planners. In the framework of this project, training workshops have been conducted in several countries, including the Netherlands (www.biodiversityskills.eu; www.gnmf.nl).

In various parts of the country, 'Biodiversity in Action' trainings have been given for local organizations and government officials, and Biodiversity Action Plans have been developed (www.biodiversiteit.nl/bap).

The Louis Bolk Institute offers trainings for farmers, policy makers and commercial businesses, for instance on sustainable soil management (www.louisbolk.org).

5.6.2 Higher education

Some higher education programmes targeting the conservation and sustainable use of associated biodiversity genetic resources are listed in Table 5.4.

Table 5.4. Higher education programmes specifically targeting the conservation and sustainable use of associated biodiversity genetic resources in the country.

Institution	Programme	Level	Enrolment		
			Total	Male	Female
Wageningen University	Aquaculture and Marine Resource Management	MSc	75	59%	41%
Wageningen University	Earth and Environment	MSc	119	58%	42%
Wageningen University	Forest and Nature Conservation	MSc	195	54%	46%
Wageningen University	Organic Agriculture	MSC	101	56%	44%
Inholland University of Applied Sciences	Landscape and Environment Management	BSc	80	84%	16%
VHL University of Applied Sciences	Coastal Zone Management	BSc	214	63%	37%
VHL University of Applied Sciences	Forestry and Nature Management	BSc	452	81%	19%

5.7 Knowledge generation and science for the management and sustainable use of biodiversity for food and agriculture

Major institutions in the Netherlands directly involved in research on the conservation and sustainable use of associated biodiversity include Wageningen University, Alterra, IMARES, CLM and the Louis Bolk Institute.

Wageningen University carries out research activities in three core areas:

- 'Food, feed and biobased production', focusing on the sustainable production and processing of food, feed and biobased products, international food chains and networks, food safety and the health aspects of food.
- Natural resources and living environment', focusing on natural habitats, landscape, land use, the management of water, sea and natural resources and biodiversity.
- 'Society and well-being', with a focus on human behaviour in relation to food and living environment, lifestyle and perceptions, but on institutions, governance, the market and chains, and societal innovations.

The research is conducted by chair groups, with each chair group, under leadership of a professor, having its own area of expertise. Wageningen University forms part of Wageningen University and Research centre (WUR), which consists of Wageningen University and several research institutes (http://www.wageningenur.nl/en/wageningen-university.htm). In total, WUR employs more than 5200 people.

Alterra carries out scientific and practical research related to the green living environment. Aspects that Alterra focuses on include soil, water, the atmosphere, the landscape, and biodiversity, on a global scale as well as regionally. Alterra forms part of Wageningen University and Research centre (WUR), and has more than 400 employees (www.wageningenUR.nl/alterra).

IMARES (Institute for Marine Resources and Ecosystem Studies) conducts research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas. IMARES also forms part of Wageningen University and Research centre (WUR). Activities include:

- Monitoring the status of fish, marine mammals, and benthos.
- Conducting studies on the ecological impact of human activities on the marine ecosystem.
- Studying possibilities to mitigate adverse effects.
- Participatory research.

IMARES has about 200 active researchers (www.wageningenUR.nl/imares).

CLM is an independent consultancy organisation working in the field of sustainable food, farming and rural development. It carries out research and advises government (from local authorities to the European Union), companies and non-profit organisations. Its expertise is supported by its network of 250 farmers. CLM has about 20 staff members involved in research and advice (www.clm.nl).

The Louis Bolk Institute is an independent knowledge institute which aims at advancing sustainable agriculture, nutrition and health. It carries out practice-oriented research and advice activities on organic and sustainable agriculture, using a systems approach. Clients include the Dutch ministry of Economic Affairs, the European Commission, provincial governments, water boards, nature conservation organisations, foundations, companies, and farmers. The Louis Bolk Institute employs about 30 researchers and advisors (www.louisbolk.org).

5.8 Gaps and priorities

There is a general tendency in the Netherlands and other European countries for the government to reduce its active involvement in agriculture and other economic sectors. An example is the dissolution of all product boards (*productschappen*), organizations aimed at promoting the collective interests of companies in a particular sector and setting rules for these companies, as of 1 January 2015. Their activities have been shut down, transferred or continued privately. This has lead to reduced availability of financial means for research and other activities in these sectors.

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

6.1 Enhancing the contribution of biodiversity for food and agriculture

A shift in nature policy is currently taking place. In 2013, the national government and provincial authorities have drawn up the 'Pact for Nature', in which they have defined their ambitions regarding the development and management of nature in the Netherlands for the period up to 2027:

- Extension of the National Nature Network with ca. 80.000 hectares, including realisation of important ecological connections.
- Management of nature and environmental conditions so as to meet the goals set by the EU Birds and Habitats Directives.
- Improving the system of nature management by farmers to make it more efficient and more effective.
- More cross-sectoral strategies to integrate nature management with other spatial functions, such as water management and recreation.

The national government remains responsible for achieving the internationally agreed targets, while the provinces have become responsible for the management and further development of the NNN and the Natura 2000 areas, and for the management of the agri-environment schemes. Provinces have concluded agreements with civil society organizations on the implementations of their nature policies (CBS, PBL & Wageningen UR, 2015; De Groot, 2014; Ministry of Economic Affairs, 2014; Van Gerwen *et al*, 2015).

The policy document 'The Natural Way Forward - Government Vision 2014' has outlined how the government wants to shape its nature policy over the next 15-20 years. There will be more attention for natural systems on a landscape-scale, and the focus on specific species and habitats will be reduced, in order to increase the opportunities for the development of more robust natural areas, opening the way for nature and social and economic developments to go together more easily. An important notion reflected in the vision is 'nature-inclusive agriculture', which means that attention for nature forms an integral part of farm management. This can be accomplished through: 1. taking care of nature on the farm (agrarian nature management); 2. making use of natural processes, for instance for pollination, water retention, pest and disease control (ecosystem services); 3. ensuring that agriculture and nature can exist next to each other (co-existence), by limiting external effects of agriculture as much as possible (striving for closed water, nutrient and energy cycles on farm and regional level). Examples of nature-inclusive agriculture are the deployment of insects for pest control purposes in the horticulture sector and the creation of improved conditions in dairy farms to attract meadow birds by combining cattle-grazing with practices favouring high soil biodiversity (De Groot, 2014). The government has set the goal of surveying all ecosystem services in the country by 2020, to give them a place in the economic system and to have them incorporated in decision-making processes (De Knegt, 2014).

At the EU-level, the reforms of the Common Agricultural Policy (CAP) are important for the Dutch agriculture-related biodiversity. The CAP, launched in 1962, was originally aimed at increasing agricultural productivity to guarantee a sTable food supply at affordable prices and to ensure a viable agricultural sector. Many adaptations have been made since its establishment, and nowadays it has a wider range of goals, from contributing to farm incomes to the sustainable management of natural resources. In 2010 the European Commission published the document 'The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future', which outlines the challenges and policy options for the period 2014-2020. The document recognizes that agriculture plays a key role in the production of public goods, such as landscapes, farmland biodiversity and climate stability. The future CAP aims at viable food production throughout the EU, to guarantee long-term food security, sustainable management of natural resources and a balanced territorial development (Van Zeijts *et al*, 2011).

The main target of the 'EU biodiversity strategy to 2020' (EU, 2011) is: "Halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss". Important elements of the EU biodiversity strategy are full implementation of the Birds and Habitats Directives, with a focus on completion and good management of the Natura 2000 Network, and supporting the biodiversity in agricultural, forestry and fisheries systems. The EU biodiversity strategy states that the reform of the CAP presents opportunities to enhance synergies and maximise coherence with biodiversity objectives. These opportunities should be exploited as much as possible to increase the positive contribution that agriculture and forestry can make to maintaining and enhancing Europe's biodiversity while remaining viable businesses.

With regard to agriculture, the target is to maximise areas that are covered by biodiversity-related measures under the CAP, to ensure and improve the conservation status of species and habitats that depend on or are affected by agriculture, and to ensure that agricultural lands can better provide ecosystem services, thus contributing to sustainable agricultural management. The CAP and the biodiversity strategy both aim at promoting the provision of environmental public goods by farmers. In the EU biodiversity strategy, it is foreseen that direct payments will be adjusted to better reward the delivery of environmental public goods, and to improve the potential for rural development measures to also serve biodiversity conservation objectives (EU, 2011). From the CAP perspective, the objective is not only to contribute to climate and environmental policy goals, but also to increase legitimacy for CAP payments by remunerating farmers for the collective services they provide to society (Van Zeijts *et al*, 2011).

As for forestry, the actions envisaged in the EU biodiversity strategy aim to encourage forest holders to adopt forest management plans that integrate biodiversity measures, and foster mechanisms to finance the maintenance and restoration of ecosystem services generated by sustainably managed multifunctional forests (EU, 2011).

For the fisheries sector, the target of the EU biodiversity strategy is to achieve a population age and size distribution indicative of a healthy stock, through fisheries management with no significant adverse impacts on other stocks, species and ecosystems. The implementation of Marine Strategy Framework Directive will be supported, and financial incentives will be provided for activities such as the restoration of marine ecosystems, the adaptation of fishing activities, and the promotion of involvement of the sector in alternative activities (e.g. eco-tourism, monitoring and managing marine biodiversity, and combating marine litter) (EU, 2011).

The Netherlands uses the EU Biodiversity Strategy for 2020 as a framework for its national biodiversity activities (Ministry of Economic Affairs, 2014).

6.2 Strengthening the conservation and management of associated biodiversity and wild foods

The 'Integrated Approach to Nitrogen' (*Programmatische Aanpak Stikstof*, PAS), which has come into force on 1 July 2015, is the most important strategy to improve environmental conditions necessary for biodiversity protection in the Netherlands. In the PAS, national and regional governments cooperate to halt the loss of biodiversity due to nitrogen deposition, and to ensure its recovery. This has to be achieved by minimising nitrogen emissions, for instance by stricter rules for building stables, and by implementing nature restoration measures such as additional vegetation management or hydrological improvements. As long as the overall nitrogen emissions decrease and the conservation status of species and habitats increases, there will be room for economic development (Ministry of Economic Affairs, 2014; Oerlemans *et al*, 2015).

6.3 Improving stakeholder involvement and awareness

In the policy document 'The Natural Way Forward - Government Vision 2014', the importance of the involvement of the public, businesses and private organisations is stressed, and the intended role of the government will be more to facilitate and encourage (De Groot, 2014).

In the framework of the current shift in the nature policy of the Dutch government, the responsibility for agri-environment schemes is being transferred to area-based collectives, because the instruments aimed at individual enterprises the schemes were not very effective and relatively expensive (De Groot, 2014; www.government.nl). In these collectives, farmers work together and share their knowledge with other stakeholders, such as nature and landscape organisations, inhabitants and businesses (De Groot, 2014). The idea is that activities such as meadow bird protection works best when applied over large areas, and that, to achieve this, farmers need to co-operate with each other. Currently there are almost 200 agri-environmental associations (Schrijver & Uetake, 2014). With the reform of the system of agri-environment schemes, the government anticipates that farmers' collectives will make a serious contribution to the conservation of species protected under the Birds and Habitats Directives, both within and outside the Natura 2000 areas. The change to a collective agri-environment model is not expected to be fully realised before 2016 (De Groot, 2014).

Conclusions

Drivers of change

1. Important drivers causing changes in associated biodiversity in and around production systems in the Netherlands are the high inputs of nutrients, low groundwater tables, the use of chemical crop protection products, and changed landscape configuration in the livestock and rainfed crop systems. During the last 30 years, these factors have resulted in a decline of biodiversity in Dutch agricultural landscapes. For some of these drivers of change, the trend in the past 10 years has become more favourable for associated biodiversity, when compared with the decades before. The nitrogen and phosphorus balances of agricultural soils have become more even, but supply still exceeded removal in every year of the last decade, which means that the overall amounts of nitrogen and phosphorus in these soils have further increased. Calculated ammonia emissions into the air have declined, but measured ammonia concentrations in the atmosphere have nevertheless remained at the same level as in previous decades. The use of plant protection products in agriculture has declined from 1985 until 2000, but showed a slight increase again from 2000 onwards. Continuous improvements in management practices are needed as still too much nutrients and pesticides are leaching to the ground and surface water.

2. During the past 100 years, the average annual temperature in the Netherlands has increased with 1,5 °C and the total annual rainfall with about 20%. The past 20 years, the temperature increase has been about 0.03 °C per year. The effects of climate change on associated biodiversity in and around production systems in the Netherlands seem to have been limited so far, but may become more pronounced in the future. Probable effects include longer growing seasons, shifts in distribution areas and life cycles of species (including pests and diseases), and increased water problems due to peak rainfall.

3. The most important countermeasures to reduce adverse consequences of drivers of change are the establishment of the National Nature Network (NNN; formerly called 'National Ecological Network') and Natura 2000-areas, the establishment of agrarian nature management agreements with farmers, and the obligation by the EU for all European farmers to have implemented Integrated Pest Management (IPM) by 2014. In the 'Integrated Approach to Nitrogen' (PAS), national and regional governments cooperate to halt the loss of biodiversity due to nitrogen deposition, and to ensure ecosystem recovery. Important countermeasures to reduce biodiversity loss in the fisheries sector are the establishment of Marine Protected Areas in the Dutch part of the North Sea, the lifting of physical migration barriers for fish, and the promotion of innovative fishing gear to mitigate collateral damage to the ecosystem.

The state and trends of biodiversity for food and agriculture

4. In the 20th century species biodiversity in the Netherlands decreased, mainly due to land use change, environmental pressure and fragmentation of ecosystems. Since 2000, the loss of biodiversity has been slowing down, but with large differences between ecosystems: the biodiversity of heath lands, semi natural grasslands and agriculture is still declining, whereas the biodiversity in forests and dunes has stabilised and even showed local improvements.

5. With respect to the state and trends of genetic resources for food and agriculture, the main conclusions are the following.
   - For <u>plant genetic resources for food and agriculture</u>, generally a large number of varieties for a substantial number of different crops are available for farmers, and no indications exist that the diversity of crops varieties in the market is decreasing or threatened.
   - Regarding <u>animal genetic resources</u>, policies and technological developments resulted in a loss of genetic diversity, and nowadays livestock kept in the Netherlands largely consists of a few highly

productive, globally used breeds. However, a large diversity of rare, local livestock breeds is still maintained by farmers and hobby breeders, and an increasing diversity of local breeds is employed in nature and landscape management.

- With respect to forest genetic resources, the proportion of native deciduous species has increased over the past decades at the expense of exotic conifers, and the Dutch forest is increasingly mixed, at the cost of mono species coniferous forest.
- As for aquatic genetic resources, fishing pressure has been reduced over the last decade and the adult biomass of the exploited fish species has increased, and positive trends in species richness were observed. Exploited fish species now mature at a younger age and smaller size, likely due to fisheries-induced evolution.

6. With respect to the state and trends of associated biodiversity in and around production systems, and the regulating and supporting ecosystem services provided by associated biodiversity in these production systems, the main conclusions for the different production systems are the following.
    - In Rainfed crops systems, the habitat provisioning role has declined due to more intensive land use, changes in cropping patterns and more large-scale farming, leading to the disappearance of many small landscape elements. The decrease in the surface of natural habitats in agricultural areas has probably led to a decrease in natural pest regulation. The use of pesticides has had negative effects on the species diversity of plants, carabids and farmland birds, and on the potential for biological pest control. The introduction of agri-environment schemes and the growth of organic farming positively affected the species diversity of plants and carabids, but not bird species diversity.
    - In Livestock grassland-based systems, the trends in the associated biodiversity of this system and in the regulating and supporting ecosystem services provided are generally negative, due to pastures being mown more often, earlier in the season and more rapidly, high inputs of nutrients, and low groundwater tables, resulting in a decline in the habitat provisioning role of these systems. The populations of the most common meadow bird species (the black-tailed godwit, the oystercatcher and the lapwing) still continue to decline.
    - In Planted forests, the changed forest management (from management for wood production towards multi-purpose forest management) has led to increased habitat provisioning for birds, bats, invertebrates and mushrooms.
    - In the Self-recruiting capture fisheries system, the species richness is increasing, likely in response to the increase in temperature and the appearance of invasive species. Practices such as bottom trawl fisheries have disturbed sea bed habitats and reduced biodiversity, while the building of oil/gas platforms and wind farms adds habitats. Invasive species pose a threat for existing functions of coastal waters, but can also provide a habitat for certain species.
    - In the Non-fed aquaculture system, the collection of mussel seed has reduced the surface area of mussel beds that provide a habitat for a variety of invertebrate species as well as food for waders.
    - For Culture-based fisheries insufficient information on the developments with respect to associated biodiversity and regulating and supporting ecosystem services was available, while in Livestock landless systems, Fed aquaculture and Horticulture under glass the importance of associated biodiversity and regulating and supporting ecosystem services has remained limited.

7. The number of alien species settling in the Netherlands has strongly increased in the past 20 years. On the one hand, the introduction of new species increases biodiversity, but, on the other hand, the introduction of new species can also form a threat to existing biodiversity, as some alien species have negative effects on indigenous flora and fauna, because they compete for food or space, or because they attack indigenous species or transmit diseases. Large quantities of plants and other materials are imported from abroad, and these may carry exotic species, including harmful organisms.

8. The major gap in information and knowledge is probably the initial lack of knowledge of the invasive potential and risks of new alien species. Once these are known, it may be too late, and the dispersal of the species cannot be controlled anymore. The main capacity or resources limitations concern the lack of sufficient

capacity to check imported material for the presence of harmful organisms, such as the citrus long-horned beetle.

The state of use of biodiversity for food and agriculture

9. The most important management practices that are considered to favour the maintenance and use of biodiversity for food and agriculture and that are applied in one or more of the terrestrial production systems, fall into the categories 'Integrated Plant Nutrient Management', 'Integrated Pest Management', 'Pollination management', 'Landscape management' and 'Organic agriculture'. In the aquatic production systems, the main practices with a positive effect on biodiversity fall into the category 'Ecosystem approach to capture fisheries'.

10. The main diversity based practices applied in one or more of the production systems fall into the categories 'Diversification', 'Base broadening', 'Domestication', 'Maintenance or conservation of landscape complexity', 'Restoration practices' and 'Enriched forests'.

11. With respect to the programmes and projects undertaken to support management and diversity based practices, the core of the area-focused measures is the National Nature Network (NNN). 'Natura 2000' is the network of nature areas in the European Union; Natura 2000-areas in the Netherlands are mostly part of the NNN. The main policy instruments for the conservation of farmland biodiversity are the biodiversity measures under the 'Farmland Conservation Scheme', which facilitates nature and landscape management contracts with farmers.

12. The major practices that negatively impact associated biodiversity in terrestrial production systems are over-fertilization with nitrogen in agricultural soils, the use of pesticides, and groundwater levels being kept low. In marine and inland fishing, overharvesting has been a problem, but fishing pressure has been reduced over the last decade. Actions and countermeasures taken to limit overharvesting include fisheries management and fishery inspections, technical innovations to reduce collateral damage to the ecosystem, separation of productive and ecological functions, and the banning of mechanical cockle fishing.

13. Ecosystem and landscape approaches that have been adopted for different production systems in the Netherlands include the National Nature Network, Natura 2000, management aimed at biodiversity conservation, agrarian nature management agreements, the establishment of Marine Protected Areas in the Dutch part of the North Sea, the banning of mechanical cockle fishing, and the gradual reduction of mechanical fishing for mussel seed.

14. A major gap in information and knowledge with respect to the use of management practices is the lack of thorough evaluation of practices intended to favour associated biodiversity and the provision of regulating and supporting ecosystem services, such as the establishment of field boundaries. Actions required include proper and more in-depth evaluation of the effectiveness of management practices intended to favour the use of biodiversity for food and agriculture. Gaps in information and knowledge also exist with respect to the sustainability or unsustainability of certain practices in using biodiversity for food and agriculture, such as bottom trawling and the use of neonicotinoid chemical crop protection products.

The state of interventions in the conservation and use of biodiversity for food and agriculture

15. Dutch biodiversity policies in the past decade contained measures focused on species as well as measures focused on areas. The core of the species-specific legislation was formed by the *Flora- en faunawet* ('Flora and fauna Act') and by fisheries regulations. The new Nature Conservation Act (*Wet Natuurbescherming*) will integrate the Flora and Fauna Act, the Nature Conservation Act of 1998 and the Forest Act. The core of the area-focused measures is the National Nature Network. Dutch forest policies are promoting multifunctional

management (nature conservation, recreation, landscape values and timber production), and on sustainable management of the forests and expansion of the forested area.

16. The reform of the EU Common Agricultural Policy (CAP) in 1992 envisaged the reduction of the negative consequences of agricultural intensification by financially supporting agri-environment schemes. In the Netherlands, a part of the European subsidies for farmers is used for specific management measures through the *Subsidiestelsel Natuur en Landschapsbeheer* (SNL, 'Subsidy system for Nature and Landscape management'). The EU also supports organic farming and has obliged all European growers to have implemented Integrated Pest Management by 2014.

17. North Sea fisheries have almost completely been regulated by European legislation, which has set, among other things, the total allowable catch for various species, and the maximum number of fishing days. As for fisheries in the Dutch coastal waters, fishing methods and fish sizes have been regulated. Marine Protected Areas have been established in the Dutch part of the North Sea. In the inland fishery sector, fishing activities are regulated through licenses and restrictions with respect to fishing gear, fishing areas and fishing seasons.

18. Important national information systems on associated biodiversity are the National Databank Flora and Fauna, providing information on the distribution of protected and rare plants and animals, and the Network Ecological Monitoring, monitoring trends of groups of species in separate networks for different categories of species. The Environmental Data Compendium intends to characterize the quality of the environment, nature and spatial developments in the Netherlands through indicators.

Future agendas for conservation and sustainable use of biodiversity for food and agriculture

19. At present, a shift in nature policy is taking place. In 2013, the national government and provincial authorities have drawn up the 'Pact for Nature', in which they have defined their ambitions regarding the development and management of nature in the Netherlands. The policy document 'The Natural Way Forward - Government Vision 2014' has outlined how the government wants to shape its nature policy over the next 15-20 years. There will be more attention for natural systems on a landscape-scale, and the focus on specific species and habitats will be reduced, in order to increase the opportunities for the development of more robust natural areas. An important notion reflected in the vision is 'nature-inclusive agriculture', which means that attention for nature forms an integral part of farm management. Examples of nature-inclusive agriculture are the deployment of insects for pest control purposes in the horticulture sector and the creation of improved conditions in dairy farms to attract meadow birds by combining cattle-grazing with practices favouring high soil biodiversity.

20. The involvement of the public, businesses and private organisations is to increase, and the intended role of the government will be more to facilitate and encourage. Considerable parts of the gamma of Dutch nature policies (including responsibility for the management and further development of the National Nature Network, the Natura 2000 areas and agri-environment schemes) have been transferred to provincial authorities. The new agri-environment schemes are being placed in the hands of area-based collectives.

21. At the EU-level, the Common Agricultural Policy (CAP) and the EU biodiversity strategy are important policies for the Dutch agriculture-related biodiversity. For the period to 2020, the target is to maximise areas that are covered by biodiversity-related measures under the CAP, to ensure and improve the conservation status of species and habitats that depend on or are affected by agriculture, and to ensure that agricultural lands can better provide ecosystem services, thus contributing to sustainable agricultural management. The CAP and the EU biodiversity strategy both aim at promoting the provision of environmental public goods by farmers. From the CAP perspective, the objective is not only to contribute to climate and environmental policy goals, but also to increase legitimacy for CAP payments by remunerating farmers for the collective services they provide to society.

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Annex 1 Composition National Committee

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Annex 2 Drivers of change

Drivers	Description, Subcategories and Examples
Changes in land and water use and management	A change in the use, management and practices around land and water (e.g., deforestation; fragmentation; modification of water regimes; forest degradation; land conversion for agriculture; ecosystem restoration; the role of women and men in land and water use and management, etc.)
Pollution and external inputs	The mismanaged, excessive or inappropriate use of external inputs (e.g., over application of fertilizer and pesticides; excessive use of antibiotics or hormones; nutrient loading, including from use of imported feed; ocean acidification, CO_2 fertilization; chemical and particulate pollutants, etc.
Over-exploitation and overharvesting	Unsustainable extraction practices (e.g., overfishing; overhunting; overgrazing; logging and extractive activities exceeding replacement rates or affecting species of uncertain and at-risk conservation status, etc.)
Climate change	The impacts and effects of progressive climate change (e.g., alterations in precipitation regimes; temperature changes; loss of water supply; increased variability; sea level rise; shifts in flowering time or seasonality, etc.)
Natural disasters	Climate shocks, extreme weather events and other natural disasters that threaten agricultural production and resilience of production systems (e.g., hurricanes, earthquakes, floods, fires).
Pests, diseases, alien invasive species	New and emerging threats from pests, diseases and invasive species affecting biodiversity for food and agriculture (e.g., shifting ranges; introductions; increased suitability; loss of predator, etc.)
Markets, trade and the private sector	**Trade-** Changing terms of trade, globalization of markets, commercialization of products, retailing, the separate capacities of women and women to commercialize products, etc. **Markets and consumption -** Demand driven changes in production or practices including the tastes, values or ethics of consumers that may impact directly or indirectly biodiversity for food and agriculture, product quantity or quality **Private sector -** The changing role and influence of private sector and corporate interests
Policies	**Policies** - Global, regional, national, and subnational legislation and regulations (e.g., conservation regulations, participation and compliance with International treaties and conventions); **Economic and policy interventions** - Interventions that impact biodiversity for food and agriculture directly or indirectly (e.g., taxes, subsidies, charges for resource use, payments for ecosystem services) **Intellectual Property Rights (IPR), Access and Benefit Sharing (ABS) -** Direct or indirect impacts of IPR and ABS policy and regulations on biodiversity for food and agriculture.
Population growth and urbanization	**Population** - Changes in population metrics (e.g., growth, fertility, composition, mortality, migration, health and disease, including different affects on men and women.) **Urbanization**- (e.g., shifts in proportion of urban and rural; change in urbanization trends, including different effects on men and women)
Changing economic, socio- political, and cultural factors	**Economic development** - A change in economic circumstances of countries, industries, households (e.g., change in GDP and economic growth; structural change of economy; income diversification, and the different economic circumstances of men and women.) **Changing socio-political, cultural or religious factors** - Variation in the forces influencing decision-making of men and women, e.g., public participation, shifts in the influence of the state vs. private sector, changes in levels of education and knowledge, shifts in the beliefs, values and norms held by a group of people. **Participatory actions** – the role of collective action toward conservation and use of biodiversity by stakeholders
Advancements and innovations in science and technology	The development and diffusion of scientific knowledge and technologies, (e.g., advances in breeding; improvements in mobile extension; tools for monitoring; biotechnology applications, access of men and women to information).

Annex 3 Ecosystem services

Category	Ecosystem services	Description	Relevant ecosystem functions
Regulating services	Pollination	Role ecosystems play in transferring pollen from male to female flower parts	Agricultural productivity; production of food and goods.
	Pest and disease regulation	Influence ecosystems have on the prevalence of crop and livestock pests and diseases	Biological control; the maintenance and feedback mechanisms preventing outbreaks of pests and diseases, including invasive species.
	Water purification and waste treatment	Role ecosystems play in the filtration and decomposition of organic wastes and pollutants in water; assimilation and detoxification of compounds through soil and subsoil processes	Filtering function performed by vegetation cover, soil and aquatic biota.
	Natural hazard regulation	Capacity for ecosystems to ameliorate and reduce the damage caused by natural disasters	Vegetative structure can alter potentially catastrophic effects of storms, floods and droughts through its storage capacity and surface resistance; coral reefs buffer waves and protect adjacent coastlines from storm damage. The services provided by this function relate to providing safety of human life and human constructions.
Supporting services	Nutrient cycling	Flow of nutrients (e.g., nitrogen, sulfur, phosphorus, carbon) through ecosystems	Maintenance of fertility; regulation of excess nutrients; climate regulation; regulation of biotic communities
	Soil formation and protection	Degradation of ecosystems, such as decomposition of organisms or weathering of substrate, to form soil	Maintenance of crop productivity on cultivated lands and the integrity and functioning of natural ecosystems.
	Water cycling	Flow of water through ecosystems in its solid, liquid, or gaseous forms	Regulation of hydrological flows at the earth surface. Maintenance of natural irrigation and drainage, buffering of extremes in discharge of rivers, regulation of channel flow, and provision of a medium for transportation.
	Habitat provisioning	Role of ecosystems in creating and maintaining habitats for a wide variety of organisms	Providing diverse and suiTable habitats for species; nursery function for migratory species and as breeding areas.
	Production of oxygen/ Gas regulation	The creation of atmospheric oxygen through photosynthesis	Gas regulation functions include the maintenance of clean, breathable air, and the prevention of diseases (e.g. skin cancer, asthma) May include regulation of the CO_2/O_2 balance, maintaining ozone-layer (O_3), and regulation of SOx levels.

(Source: Guidelines for the preparation of the Country Reports for The State of the World's Biodiversity for Food and Agriculture)

Annex 4 Management practices

Management practices supporting the use and conservation of biodiversity for food and agriculture	**Description/ examples of management practices**
Integrated Plant Nutrient Management (IPNM)	Soil, nutrient, water, crop, and vegetation management practices undertaken with the aim of improving and sustaining soil fertility and land productivity and reducing environmental degradation, often tailored to a particular cropping and farming system. May include the use of farmyard manures, natural and mineral fertilizers, soil amendments, crop residues and farm wastes, agroforestry and tillage practices, green manures, cover crops, legumes, intercropping, crop rotations, fallows, irrigation, drainage, plus a variety of other agronomic, vegetative and structural measures designed to conserve both water and soil.
Integrated Pest Management (IPM)	Pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment by encouraging natural pest control mechanisms that include: crop rotation; inter-cropping; seedbed sanitation, sowing dates and densities, under- sowing, conservation tillage, pruning and direct sowing; where appropriate, use of pest resistant/tolerant cultivars, push-pull strategies and standard/certified seed and planting material; balanced soil fertility and water management, making optimum use of organic matter; prevent spreading of harmful organisms by field sanitation and hygiene measures; protection and enhancement of important beneficial organisms.
Pollination management	Practices that accomplish or enhance pollination of a crop, to improve yield or quality, by understanding of the particular crop's pollination needs, and by knowledgeable management of pollenizers, pollinators, and pollination conditions. Pollinator-friendly practices include minimizing the use of agrochemicals, integrated pest management and mixed cropping to include pollinator friendly crops, preserving wild habitats, maintaining flower-rich field margins, buffer zones and permanent hedgerows to ensure habitat and forage, cultivating shade trees, managing for bee nest sites, and establishing landscape configurations that favour pollination services.
Landscape management	Practices that support the maintenance of biodiversity friendly farming systems, or the diversity of landscape mosaics within and surrounding production systems over particular geographic areas. Examples include riparian corridors, hedges, margins, woodland patches, clearings in forests, ponds or other biodiversity friendly features characteristic of the production environment that may be the result of national or regional policies such as the EU set aside schemes.
Sustainable soil management practices	Management of soil biodiversity to enhance agricultural production by both direct and indirect means, including alteration of the abundance or activity of specific groups of organisms through inoculation and/or direct manipulation of soil biota. Indirect interventions may include manipulation of the factors that control biotic activity (habitat structure, microclimate, nutrients and energy resources) rather than the organisms themselves such as the maintenance of soil cover with organic mulch including crop residues, green manure/cover crops including legumes, and compost to increase soil organic matter, irrigation and liming, as well as cropping system design and management.
Conservation agriculture	Conservation Agriculture (CA) aims to achieve sustainable and profiTable agriculture and improve livelihoods of farmers through the application of the three CA principles: no or minimal soil disturbance through direct seeding into untilled soils, maintenance of permanent soil mulch cover, and crop diversification through rotations, associations and sequences.

Water management practices, water harvesting	Water harvesting and management through rain water retention or modification of the landscape (e.g., bunds, zais, terracing) for the restoration and improvement of degraded lands, and to allow cultivation of additional crops with higher water requirements, and improving water productivity of crops.
Agroforestry	Agroforestry is a collective name for land-use systems where woody perennials (trees, shrubs, palms, etc.) are integrated in the farming system.
Organic agriculture	Organic agriculture is a production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.
Low external input agriculture	Production activity that uses synthetic fertilizers or pesticides below rates commonly recommended for intensive industrial tillage agriculture. It does not mean elimination of these materials. Yields are maintained through greater emphasis on agronomic practices, IPM, and utilization of on-farm resources (especially labor) and management.
Home gardens	An integrated system which comprises different components in a small area around the homestead, including staple crops, vegetables, fruits, medicinal plants, livestock and fish both for home consumption or use and for income. May include the family house, a living/playing area, a kitchen garden, a mixed garden, a fish pond, stores, an animal house, etc.
Areas designated by virtue of production features and approaches	These include areas recognized nationally or internationally by virtue of their landscape and agricultural features. In addition to Satoyama, GIAHS, national parks (IUCN categories), they also include areas recognized for specific agricultural products (e.g. DOP, IGP or Slow Food).
Ecosystem approach in capture fisheries	Approach promoting the diversity of the whole ecosystem in order to support the target species. Considerations include sustainable harvesting of the retained species (target and by-product species); managing the direct effects of fishing (especially on non-retained by-catch and habitat); and managing the indirect effects of the fishery on ecosystem structure and processes.
Conservation hatcheries	Hatcheries and production systems that optimize natural levels and organization of genetic diversity over production. Often for rebuilding depleted populations of commercially important species, (e.g. Atlantic and Pacific salmon).
Reduced-impact logging	A series of practices to improve logging practices such as vine removal, directional felling, limiting skid trails, logging roads and stumping grounds, restrictions on the size and number of trees felled, and post felling removal of waterway blockages, to reduce the residual damage, biodiversity loss and excess CO2 emissions associated with conventional logging practices.

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Annex 5 Diversity based interventions

Diversity based practices	Description/ examples of interventions
Diversification	The introduction of new varieties, species, and groups of organisms (e.g., livestock, crops, trees, fish) into a production system or managed environment without replacement or abandonment of other groups, or the maintenance of already-existing diversity in the case of traditionally diverse production systems. May include introductions for restoration or IPM objectives, including fish introduced to control reproduction.
Base broadening	Increasing the amount of genetic diversity used to produce new varieties or breeds used in agricultural production.
Domestication	The development of new crop, aquatic, forest and animal species through deliberate breeding programmes or the continued selection and improvement of existing species from their wild progenitors. These activities may be carried out by national breeding programmes or by farmers and communities themselves.
Maintenance or conservation of landscape complexity	Maintenance or management of components of a landscape mosaic including hedges, waterways, road margins, corridors, windbreaks, living fences, native grasses wild patches of vegetation in the farming landscape, etc.
Restoration practices	Restoring functionality and productive capacity to ecosystems, forests, landscapes, waterways, grasslands and rangelands in order to provide food, fuel, and fiber, improve livelihoods, store carbon, improve adaptive capacity, conserve biodiversity, prevent erosion and improve water provisioning and quality.
Management of micro-organisms	The intentional incorporation, management or maintenance of microbes, fungi and other micro-organisms into a production system or organisms; e.g., inoculation of plants and seeds with arbuscular mycorrhizal fungi, the addition of probiotics in aquaculture and livestock, etc.
Polyculture/Aquaponics	Integrated multi-trophic aquaculture, utilization of different trophic and spatial niches of an aquaculture system in order to obtain maximum fish production per unit area, utilizing natural resource availability.
Swidden and shifting cultivation agriculture	Rotation of plots from intensive cultivation to extended fallow periods for the replenishment of soil fertility.
Enriched forests	Selective logging and enrichment planting to increase the abundance of useful species for food, medicine and timber, often a feature of traditional management practices.

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