



Third National Report on Plant Genetic Resources for Food and Agriculture – the Netherlands

M. Brink

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Ministry of Agriculture, Nature and Food Quality, the Hague

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Dit rapport maakt informatie beschikbaar over vier hoofdcategorieën van activiteiten m.b.t. plantgenetische bronnen voor voedsel en landbouw in Nederland die in de periode 2012-2019 zijn uitgevoerd: *in situ* conservering en beheer; *ex situ* conservering; duurzaam gebruik; en de opbouw van duurzame institutionele and menselijke capaciteit. Het bouwt voort op de informatie die eerder werd aangeleverd via het FAO WIEWS rapportagesysteem. Deze informatie zal door de FAO gebruikt worden als input voor het *Third Report on the State of the World's Plant Genetic Resources for Food and Agriculture*.

This report makes information available on four main categories of activities on plant genetic resources for food and agriculture in the Netherlands carried out in the period 2012-2019: *in situ* conservation and management; *ex situ* conservation; sustainable use; and building sustainable institutional and human capacities. It extends the information previously submitted to the FAO WIEWS reporting system. This information will be used by the FAO as input for the Third Report on the State of the World's Plant Genetic Resources for Food and Agriculture.

Key words: *ex situ* conservation, *in situ* conservation, institutional capacity, on-farm conservation, Plant Genetic Resources for Food and Agriculture (PGRFA), sustainable use.

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Foreword

The global community is facing unprecedented challenges. It is estimated that in November 2022 the world's population surpassed 8 billion. At the same time, we are facing effects of climate change that impact global agricultural productivity. Farmers worldwide are experiencing this impact first hand. To feed the world's population in a way that is sustainable as the climate continues to change, we need to adapt our food systems and farming practices. Where possible, sustainable intensification is necessary to ensure that no more natural lands are converted into farmland. We also need to increase crop rotation, improve the use of irrigation and focus on breeding climate-resilient crop varieties.

This means that conservation and sustainable use and management of plant genetic resources is more important than ever. The world needs to conserve plant genetic resources to ensure they are not lost forever, and breeders need the rich diversity genetic resources contain in order to breed climate-resilient crop varieties.

In the Third National Report on Plant Genetic Resources for Food and Agriculture, we outline the efforts underway in the Netherlands, summarise the progress with regard to the implementation of the 18 priority activities agreed upon, and discuss the wide range of stakeholders involved. To further support and stimulate these activities, we have recently doubled the annual budget of our national Centre for Genetic Resources.

The conservation and sustainable use and management of plant genetic resources is a task no single country can do alone. We all depend on each other. The Netherlands is therefore committed to working together with other countries to share knowledge, tools and best practices.

Dr. Marije Beens, Director General Agro
Ministry of Agriculture, Nature and Food Quality

Executive summary

Introduction

The Food and Agriculture Organization of the United Nations (FAO) requests countries to report periodically on the conservation and sustainable use of plant genetic resources (PGR) at the national level, including data on *in situ* conservation, *ex situ* conservation, sustainable use and capacity building. The present Dutch country report on Plant Genetic Resource for Food and Agriculture (PGRFA) is the third country report on PGRFA, after earlier reports having been published in 1995 and 2008. The third country report on PGRFA is based on national reporting on the implementation of the FAO Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture over the period 2012-2019, through the FAO World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS; www.fao.org/wiews/en/), completed in 2021. The WIEWS reporting covered data on 18 priority activities, grouped in four main categories: *in situ* conservation and management; *ex situ* conservation; sustainable use; and building sustainable institutional and human capacities.

In Situ Conservation and Management

An important development for the inventory of crop wild relatives (CWR), was the establishment of the CWRnl website (www.cwrnl.nl) in 2014. This website provides an overview of the existing diversity and distribution of CWR in the Netherlands. For the *in situ* conservation and management of CWR and wild food plants, an important development was the establishment, in 2018, of the foundation 'Het Levend Archief', which not only aims at creating an *ex situ* seed collection of all wild plant species in the Netherlands (including crop wild relatives and wild food plants), but also supports initiatives aimed at *in situ* conservation and the prevention of extinction of indigenous species or autochthone populations.

While more information has been gathered on the distribution and conservation status of crop wild relatives, information on existing on-farm crop diversity is still incomplete. A thorough overview of traditional varieties (grown in the period from 1850 until the Second World War) can be found in the Orange List of Dutch biocultural heritage (www.deoerakker.nl/nl/oerakker/oranje-lijst.htm), which was completed in the reporting period. Important for the support of on-farm management and improvement of plant genetic resources for food and agriculture, was the further development of foundation 'De Oerakker', which aims at the maintenance of the Dutch crop biocultural heritage. The 'Zaadgoed' foundation is supporting farmer and community based plant breeding and the conservation of traditional varieties for organic agriculture.

Although the Netherlands does not have explicit disaster risk management policies for restoring crop systems, the national plant genebank held by the Centre for Genetic Resources, the Netherlands (CGN) at Wageningen University & Research (WUR), has a collection of seeds of commercial varieties, landraces and farmer varieties, and wild relatives of crops, with safety duplications of its accessions in other European genebanks and in the Svalbard seed vault. In addition, breeding companies keep stocks of genetic resources of various nature in many different places in the world, which gives additional security.

Ex Situ Conservation

The number of accessions in the national genebank of the Netherlands, held by CGN, increased from 22,447 on 1 January 2012 to 23,289 on 31 December 2019. In the period 2012-2019, four new crops were added to the collection: black salsify (*Scorzonera hispanica*, *Tragopogon porrifolius*), caraway (*Carum carvi*), carrot (*Daucus* spp.), and lamb's lettuce (*Valerianella* spp.). During the same period, the capacity of CGN in terms of human and financial resources and infrastructure remained more or less stable. Because of the discontinuation of the Solanaceae collection of the Radboud University, the total number of accessions reported as being conserved *ex situ* under medium- or long-term conditions in national genebank collections declined from over 25,000 to 23,289 in the same period.

In the period 2012-2019, CGN collected 42 wild accessions in the Netherlands: allium (*Allium schoenoprasum*); asparagus (*Asparagus officinalis*); caraway (*Carum verticillatum*); carrot (*Daucus carota*); wild cabbage (*Brassica oleracea*); lamb's lettuce (*Valerianella* spp.); *Scorzonera humilis*; *Tragopogon pratensis*; and *Tragopogon porrifolius*. CGN also carried out collecting missions abroad: in Armenia, asparagus and lettuce were collected, in Azerbaijan asparagus and lettuce, in Uzbekistan carrot, melon and lettuce, in Kyrgyzstan carrot and in Jordan lettuce. In total 474 accessions of predominantly crop wild relatives were collected during these missions. In view of the size of the national genebank held by CGN relative to the Dutch breeding industry, combined with the increasing difficulty to obtain PGR abroad (due to the complexity of domestic regulation of access in various countries following the coming into force of the Convention on Biological Diversity in 1993 and the Nagoya Protocol in 2014), there is a need to expand the CGN collection.

More than 2100 accessions in the CGN genebank were regenerated in the period 2012-2019. Most regenerations of CGN material were done by seed companies, usually in various company locations in the Netherlands, sometimes in other countries such as France, Spain, Slovakia and Morocco.

An important collection of living fruit trees is held by the 'Fruithof Frederiksoord', which contains apple, pear, peach and quince trees. Information on the presence of seeds and/or living plants of agricultural and horticultural species and varieties in many other collections of breeders, research institutes or others is not available. It would be worthwhile to get a better picture of the material present in these collections. The database of the 'Pomological Society North-Holland' ('*Pomologische Vereniging Noord-Holland*'), established in 2002 to promote the conservation of fruit tree diversity, in particular of tall-stemmed trees, contains information on apple, pear, plum, cherry varieties, quince and walnut trees kept in orchards and gardens in the provinces of North-Holland, South-Holland, Utrecht, Gelderland, Groningen and Flevoland.

As for ornamental plants, the Dutch Plant Collections (NPC), initiated by the 'Koninklijke Vereniging voor Boskoopse Culturen' (KVBC), exist since 1995. The NPC comprise around 100 plant collections, signed up and held by specialist growers of often a single species. The collections are accessible and serve as a living database of the ornamental plants range, as a reference for trials and research, and as a source of motivation and inspiration. The collections can be found on the website of the Dutch Plant Collections (www.plantencollecties.nl/collecties/).

Although PGRFA are often present in botanical gardens, these gardens have a much wider scope and usually focus on species instead of varieties or cultivars. The website of Dutch Association of Botanical Gardens (*Nederlandse Vereniging van Botanische Tuinen*, NVBT) contains a search module where the plants present in the 27 affiliated botanic garden collections can be found (www.botanischetuinen.nl/en/plants).

Sustainable Use

Characterization and evaluation, including by the use of molecular markers and omics technology, is important for a proper assessment of the potential value of genebank accessions. On 31 December 2019, on average 13 traits per accession had been characterized for the CGN national collection of PGRFA. During the period 2012-2019, more than 500 sets with accessions possessing a certain trait were documented. Characterization data for accessions in the CGN national collection were usually generated during regenerations of the genebank material and during experimental field trials. Evaluation data were mostly generated by users of the material, particularly breeding companies. Evaluation data for eggplants, peppers and tomatoes were also obtained in the EU-funded Horizon 2020 project G2P-SOL. Molecular information was obtained in the framework of various projects and initiatives.

As for the distribution of genebank accessions, in the period January 2012 to June 2014, the CGN national collection distributed 17,509 samples from 7829 accessions (7004 samples per year), and in the period July 2014 to December 2019 the collection distributed 23,337 samples from 10,199 accessions (4243 samples per year).

The breeding sector remained a well-developed and economically important sector in the Netherlands, and the Dutch breeding sector has continued to develop new varieties. It was estimated that varieties of around 50 crops, mainly vegetables, had been developed and were marketed by private breeding companies in the

Netherlands in 2019. In the first reporting period (1 January 2012 - 30 June 2014), a total of 2748 plant varieties were admitted to the national list of varieties of agricultural and vegetable material in the Netherlands, while in the second reporting period (1 July 2014 - 31 December 2019), a total of 3690 varieties were admitted in the country. In fruit crops, especially new varieties of soft fruits, such as strawberry and raspberry, are introduced. The number of new varieties of ornamental crops introduced in the Netherlands is estimated annually at 800-1000. Due to intensive breeding activities, the number of varieties in agricultural field crops, vegetable crops and fruit crops has been rising, and the genetic diversity of these crops has been increasing. The focus of plant breeding has extended to sustainability, and new varieties contain resistances and tolerances to pests and diseases, thus reducing the need for chemical plant protection products. Some commercial breeding companies focus more or specifically on the breeding and sale of organic seeds. Other breeding companies breed and sell conventional as well as organic seeds.

While breeding programmes in the Netherlands are typically carried out by private breeding companies, public organizations carry out more fundamental research contributing to breeding activities. The Plant Breeding group of Wageningen University & Research had various programmes in the period 2012-2019, with the crops researched including apple, *Brassica* spp., fibre hemp, miscanthus, quinoa, potatoes and tomatoes. A complicating factor for private and public breeding activities is the reduced access to foreign material due to the complexity of domestic regulation of access in various countries following the coming into force of the Convention on Biological Diversity in 1993 and the Nagoya Protocol in 2014.

At the end of the first reporting period (2014) as well as at the end of the second reporting period (2019), the five crops with the highest harvested area in the Netherlands were maize (*Zea mays*), potatoes (*Solanum tuberosum*), wheat (*Triticum aestivum*), sugar beet (*Beta vulgaris* subsp. *vulgaris*) and barley (*Hordeum vulgare*). From 2014 to 2019, the harvested area of maize and wheat decreased, while the harvested area of potatoes, sugar beet and barley increased.

Crops that have been introduced or reintroduced into commercial cultivation in the Netherlands in the past decade include Dyer's Rocket (*Reseda luteola*), lupins (*Lupinus* spp.), quinoa (*Chenopodium quinoa*), Russian dandelion (*Taraxacum kok-saghyz*), sorghum (*Sorghum bicolor*), soybeans (*Glycine max*), spelt (*Triticum spelta*) and yacon (*Smallanthus sonchifolius*). New genetic material, not yet grown or otherwise present in the Netherlands, was introduced with new varieties from abroad.

Wageningen University & Research (WUR) studied new crops as well as 'forgotten' crops for which there is renewed interest, often in collaboration with partners from the business sector. WUR also provided advice to farmers and vegetable producers looking to introduce new crops, e.g. on cultivation, storage and processing. For instance, WUR has been researching the introduction of soya in the Netherlands for several years, examining the possibilities of producing this crop under Dutch growing conditions, and has contributed to the successful introduction of quinoa. WUR has also carried out research in the Netherlands on strip cropping in arable and vegetable crops. WUR participated in various EU-funded PGR-related projects, including 'DiverIMPACTS' ('Diversification through Rotation, Intercropping, Multiple Cropping, Promoted with Actors and value-Chains Towards Sustainability'), 'ReMIX' ('Species mixtures for redesigning European cropping systems'), and G2P-SOL ('Linking genetic resources, genomes and phenotypes of Solanaceous crops').

The Louis Bolk Institute (LBI) participated from 2015 to 2022 in the EU-funded projects 'Liveseed', 'Libbio', 'ReMIX', 'Diversifood' and the more recently started 'Liveseeding', which were aimed at increased diversity in crop production and food supply, and the development and increased availability of organic propagation material. A range of different crops were addressed, including traditional wheat varieties (such as einkorn, emmer and rivet wheat), Andean lupin and different varieties of broccoli and tomato. The Bioimpuls programme (from 2009 onwards), funded by the Dutch Ministry of Economic Affairs and coordinated by LBI, aims at breeding new disease resistant potato varieties for the organic sector. In this programme, LBI works closely together with Wageningen University & Research (WUR), commercial breeders and farmer-breeders. From 2014-2017, LBI participated in the EU-funded European FP7 project 'Agforward' ('AGroFOREstry that Will Advance Rural Development'), which aimed at promoting agroforestry practices in Europe that will advance rural development.

The foundation 'De Oerakker' is present at fairs and on the internet, to give information on old varieties, distribute old varieties free of charge and/or sell material. In October 2015, 'De Oerakker', with support of CGN, started the 'Heritage seeds project', in which seeds of heritage varieties (such as the old bitter Brussels sprouts, tomato, pea, bean and wheat) are multiplied and made better available to the public for cultivation and consumption. The Orange List of Dutch bio-cultural heritage contains agricultural and horticultural varieties that were grown in the period from 1850 until the Second World War. Of the varieties listed by the 'Heritage seeds project' and in the Orange List, about 1000 are still commercially available, and the lists indicate where they can be acquired. The 'Zaadgoed' foundation supports farmer and community based plant breeding and the conservation of traditional varieties for organic agriculture.

Building Sustainable Institutional and Human Capacities

The basic structure of the Dutch policy and institutional framework on PGRFA has not changed since 2012, as the national policy outlined in the 'Sources of Existence' policy document (Ministry of Agriculture, Nature Management and Fisheries, 2002) remained applicable. CGN has remained the national entity functioning as a coordination mechanism for PGRFA activities and/or strategies, with CGN not only holding the national genebank, but also being involved in activities related to on-farm conservation, crop wild relatives and genetic resources policies.

The Nagoya Protocol (Implementation) Act of the Netherlands, a national law to implement EU Regulation 511/2014 (which regulates the compliance aspects of the Nagoya Protocol across the EU) in the Netherlands came into force on 23 April 2016. The explanatory memorandum accompanying the law states that no specific rules governing access to genetic resources occurring *in situ* in the Netherlands will apply. This is because the Dutch government considers it unnecessary to exercise its sovereignty regarding access to genetic resources occurring in the Netherlands in national legislation (section 6.2.1 of the Explanatory Memorandum of the Nagoya Protocol (Implementation) Act of the Netherlands).

As for European collaboration, in the period 2012-2019 the Netherlands has remained a member of the European Collaborative Programme on Plant Genetic Resources (ECPGR), a regional network in which almost all European countries are participating. In this period, the country has continued to actively contribute to the functioning of the network. From 2013 to 2016, CGN participated in the EU-funded TRAF00N ('Traditional food network to improve the transfer of knowledge for innovation') project which brought together researchers, knowledge transfer agents and SME associations from 14 European countries, with the aim of fostering the transfer of sustainable innovation and entrepreneurship in the traditional foods sector for the benefit of European consumers. From 2013 to 2019, CGN was involved in two complementary 'preparatory actions' commissioned by the European Commission, aimed at improved networking among those involved in the conservation of genetic resources in agriculture and to tap their economic potential. CGN was also active in GenRes Bridge project, which started in 2019, and resulted in an overarching Genetic Resources Strategy for Europe, which was launched in November 2021.

With respect to information systems on PGRFA, information on *ex situ* conserved material held in the national genebank collection of CGN has remained publicly available through the CGN website. CGN contributed information to various publicly accessible international PGRFA information systems: EURISCO (bi-monthly), Genesys (through EURISCO, annually) and the ECPGR Central Crop Databases (on request). As for *in situ* and on-farm conservation, much more information on crop wild relatives and traditional varieties has become publicly available. Both the Orange List of Dutch bio-cultural heritage and the CWRnl website have been developed and have become publicly available on the internet.

Education and training on PGRFA conservation and use are well developed in the Netherlands. Wageningen University & Research (WUR) offers a Dutch-language BSc programme in Plant Sciences, and English-language MSc programmes in Plant Sciences and Organic Agriculture. WUR also offers an online (distance learning) MSc Plant Breeding programme as well as tailor-made plant courses for professionals. The Centre for Development Innovation (CDI, part of WUR) and CGN annually organize short-term post-graduate courses on PGRFA conservation and use. HAS University of Applied Sciences in Den Bosch offers Dutch-language BSc programmes in Applied Biology and Horticulture and Arable Farming, and an English-language BSc programme in Horticulture and Business Management. The Aeres University of Applied Sciences offers Dutch-language BSc programmes in Applied Biology and in Horticulture and Arable Farming, and English-

language BSc programmes in International Horticulture and Management, in Plant Breeding and in Plant Production. The Van Hall Larenstein University of Applied Sciences offers a Dutch-language BSc programme in Horticulture and Arable Farming. Inholland University of Applied Sciences offers Dutch-language BSc programmes in Horticulture and Agribusiness and in Horticulture management.

Public awareness of the importance of PGRFA is promoted and strengthened by various organizations. CGN has followed a two-pronged approach by targeting regular education (from primary schools to dedicated agricultural education) as well as a wider interested public. CGN has produced and distributed brochures on topics such as forgotten vegetables and the history of breeding of cabbage and potatoes in the Netherlands. CGN is also present on fairs to inform the general public. 'De Oerakker' and other seed suppliers have been active in awareness-raising, giving information on old varieties, distribute old varieties free of charge and/or sell material. Various NGOs and farmers/gardeners in the Netherlands regularly organize field days so as to reach out to a wider public and to distribute seed and planting material to interested hobbyists. Local governments sometimes support these activities financially.

Selected organisations active with Plant Genetic Resources for Food and Agriculture (PGRFA) in the Netherlands

Centre for Genetic Resources, the Netherlands (CGN, cgn.wur.nl)

The Centre for Genetic Resources, the Netherlands (CGN) is the national entity functioning as the Dutch coordination mechanism for genetic resources activities and/or strategies, and focuses on conservation and use of vegetable crops, farm animal breeds and autochthonous forest species. CGN maintains collections, does methodological research and participates actively in national, European and global organisations and networks. CGN collaborates actively with the private breeding industry and also supports the Dutch government in the field of policy development and implementation. As for plant genetic resources, CGN holds the national genebank, which consists of over 23,000 varieties and wild populations (accessions) of some 30 different crops. The collections include commercial varieties, landraces, farmer varieties and wild varieties of crops. CGN manages the genebank on behalf of the Dutch government. CGN is also involved in activities related to on-farm conservation, crop wild relatives and genetic resources policies. CGN forms part of Wageningen University & Research (WUR).

'De Oerakker' foundation (www.deoerakker.nl)

The foundation 'De Oerakker' aims at the maintenance of the Dutch crop biocultural heritage. Next to a section focused on vegetables, which existed already before 2012, a section on grains and accompanying species and a section on fruit (mainly apples) are currently active. Presently, over 100 people are involved in 'De Oerakker' of which ca. 25 are active members involved in multiplication and description of varieties. 'De Oerakker' has been active in awareness-raising and it is present at fairs and on the internet, to give information on old varieties, distribute old varieties free of charge and/or sell material.

'Het Levend Archief' foundation (www.hetlevendarchief.nl)

The main objective of the foundation 'Het Levend Archief' ('The Living Archive'), established in 2018, is the establishment, maintenance, and keeping alive of an *ex situ* seed collection of all wild plants in the Netherlands (including crop wild relatives and wild food plants), but it also supports initiatives aimed at *in situ* conservation and the prevention of extinction of indigenous species or autochthone populations.

Louis Bolk Institute (LBI; www.louisbolk.nl)

The Louis Bolk Institute (LBI) is a non-profit foundation, founded in 1976, active in research and consultancy work. Its objective is to promote knowledge development for organic and sustainable agriculture, nature, nutrition and health care, in a holistic way that does justice to the integrity of life. The work of LBI is grouped into six themes: Sustainable Soil Management; Biodiversity & Climate; Sustainable Livestock Farming; Innovative and Resilient Plant Species & Systems; Integrative Medicine & Positive Health; and Healthy Lifestyle and Nutrition. Around 45 researchers work in LBI.

Nederlandse Algemene Keuringsdienst voor zaaizaad en pootgoed van landbouwgewassen (NAK, www.nak.nl)

The Dutch General Inspection Service for agricultural seeds and seed potatoes ('Nederlandse Algemene Keuringsdienst voor zaaizaad en pootgoed van landbouwgewassen', NAK) is the Dutch inspection service for seed and propagating material of agricultural crops (including seed potatoes). It carries out statutory inspections commissioned by and under supervision of the Dutch Ministry of Agriculture, Nature and Food Quality.

Naktuinbouw (www.naktuinbouw.com)

Naktuinbouw (the Netherlands Inspection Service for Horticulture) promotes and monitors the quality of products, processes and production chains in the horticultural sector. The main focus is on propagating material, of national and international origin.

Nederlandse Vereniging van Botanische Tuinen (NVBT, www.botanischetuinen.nl)

The *Nederlandse Vereniging van Botanische Tuinen* (NVBT, 'Dutch Association of Botanical Gardens'), established in 1998, is an umbrella organization with 27 affiliated botanical gardens in the Netherlands. Its mission is to contribute to the conservation of biodiversity of plants in the context of a sustainable world. In order to realize this mission, the members commit themselves to NVBT criteria on the management of the plant collections and the way in which they are used for scientific research, nature conservation, exhibition and/or education.

Plantum (www.plantum.nl)

Plantum, established in 2001 through a merger of various organisations, is the Dutch association for companies active in breeding, propagation, production and trade of seeds, bulbs, tubers, cuttings and young plants. Currently, it has about 350 members. Plantum represents and promotes the interests of its members and, on behalf of the sector, acts as a discussion partner with government bodies and interest groups. Plantum's focus is on consolidating the competitive position of the sector and of the groups of affiliated members on an international level. Plantum also initiates new developments and serves as a source of information for companies.

Pomologische Vereniging Noord-Holland (www.hoogstamfruitnh.com)

The '*Pomologische Vereniging Noord-Holland*' ('Pomological Society North-Holland'), established in 2002, promotes the conservation of fruit tree diversity, in particular of tall-stemmed trees, focusing mostly (but not exclusively) on the Dutch province North Holland. Its activities include training courses on tree management, excursions, advice, and inventories of plantings.

Wageningen University & Research (WUR; www.wur.nl)

The mission of Wageningen University & Research (WUR) is 'to explore the potential of nature to improve the quality of life'. WUR focuses on the domain 'healthy food and living conditions' and is one of the leading organisations in this domain worldwide. WUR focuses on three related core areas: Food, feed & biobased production; Natural resources & living environment; and Society & well-being. WUR is a collaboration between Wageningen University (around 3100 staff fte and 13,000 students) and the Wageningen Research foundation (around 3300 staff fte). It is divided into five Departments: Agrotechnology and Food Sciences; Animal Sciences; Environmental Sciences; Plant Sciences; and Social Sciences.

The 'Zaadgoed' foundation (www.zaadgoed.nl)

The '*Zaadgoed*' ('Good seed') foundation, founded in 1998, is a not-for-profit civil society organisation that supports farmer and community based plant breeding and the conservation of traditional varieties for organic agriculture. It has assessed breeding methods for their suitability for organic breeding and supported plant breeding activities of professional organic breeders as well as participative breeding by groups of farmers in collaboration with breeding professionals. It has also supported the maintenance of traditional varieties. The '*Zaadgoed*' foundation has been promoting organic breeding through publications, lectures and extension days for a wide audience, including breeders, farmers, consumers, retailers, wholesalers and scientists.

Abbreviations

ABS	Access and Benefit-Sharing
CBD	Convention on Biological Diversity
CGN	Centre for Genetic Resources, the Netherlands
CWR	Crop Wild Relatives
ECPGR	European Collaborative Programme on Plant Genetic Resources
ERFP	European Regional Focal Point for Animal Genetic Resources
EU	European Union
EUFORGEN	European Forest Genetic Resources Programme
FAO	Food and Agriculture Organization of the United Nations
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
KVBC	<i>Koninklijke Vereniging voor Boskoopse Culturen</i> (Royal Association of Boskoop Cultures)
LBI	Louis Bolk Institute
NAK	<i>Nederlandse Algemene Keuringsdienst voor zaaizaad en pootgoed van landbouwgewassen</i> (Dutch General Inspection Service for agricultural seeds and seed potatoes)
NVBT	<i>Nederlandse Vereniging van Botanische Tuinen</i> (Dutch Association of Botanical Gardens)
MLS	Multilateral System
NI	National Inventory
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
SMTA	Standard Material Transfer Agreement
WUR	Wageningen University & Research

General introduction

Background

Genetic diversity provides the basis for crop breeding, including the development of new varieties and adaptation to changing ecological conditions. The Food and Agriculture Organization of the United Nations (FAO) requests countries to report periodically on the conservation and sustainable use of plant genetic resources (PGR) on the national level, including data on *in situ* conservation, *ex situ* conservation, sustainable use and capacity building.

The present country report is the third report, after earlier reports having been published in 1995 (Ministry of Agriculture, Nature Management and Fisheries, 1995) and 2008 (Visser, 2008). It is based on national reporting on the implementation of the FAO Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture over the period 2012-2019, through the FAO World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS; www.fao.org/wiews/en/), completed in 2021.

The information entered into WIEWS will form the basis of FAO's Third Report on the State of the World's Plant Genetic Resources for Food and Agriculture, which is planned for publication in 2023. The First and Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture were published in 1998 and 2010, respectively (FAO 1998, 2010).

The present standalone country report on the state of plant genetic resources for food and agriculture aims to make the information available in a concise form. As it is based on the WIEWS reporting, it also focuses on the period 2012-2019.

Preparation of the Country Report

On the basis of the data reported in WIEWS and further literature search, a first draft of the country report was prepared. This draft was shared with stakeholders, and based on their comments the final version was prepared.

The WIEWS reporting covered data on 18 priority activities, grouped in four main categories:

I. *In Situ* Conservation and Management

1. Surveying and inventorying plant genetic resources for food and agriculture
2. Supporting on-farm management and improvement of plant genetic resources for food and agriculture
3. Assisting farmers in disaster situations to restore crop systems
4. Promoting *in situ* conservation and management of crop wild relatives and wild food plants

II. *Ex Situ* Conservation

5. Supporting targeted collecting of plant genetic resources for food and agriculture
6. Sustaining and expanding *ex situ* conservation of germplasm
7. Regenerating and multiplying *ex situ* accessions

III. Sustainable Use

8. Expanding the characterization, evaluation and further development of specific collection subsets to facilitate use
9. Supporting plant breeding, genetic enhancement and base-broadening efforts
10. Promoting diversification of crop production and broadening crop diversity for sustainable agriculture
11. Promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species
12. Supporting seed production and distribution

IV. Building Sustainable Institutional and Human Capacities

13. Building and strengthening national programmes
14. Promoting and strengthening networks for plant genetic resources for food and agriculture
15. Constructing and strengthening comprehensive information systems for plant genetic resources for food and agriculture
16. Developing and strengthening systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of plant genetic resources for food and agriculture
17. Building and strengthening human resource capacity
18. Promoting and strengthening public awareness of the importance of plant genetic resources for food and agriculture

In the WIEWS reporting system as well as in this report, the information on each of these 18 priority activities is grouped into three subsections: 'Key achievements since January 2012', 'Changes and trends since January 2012', and 'Gaps and needs as of December 2019'.

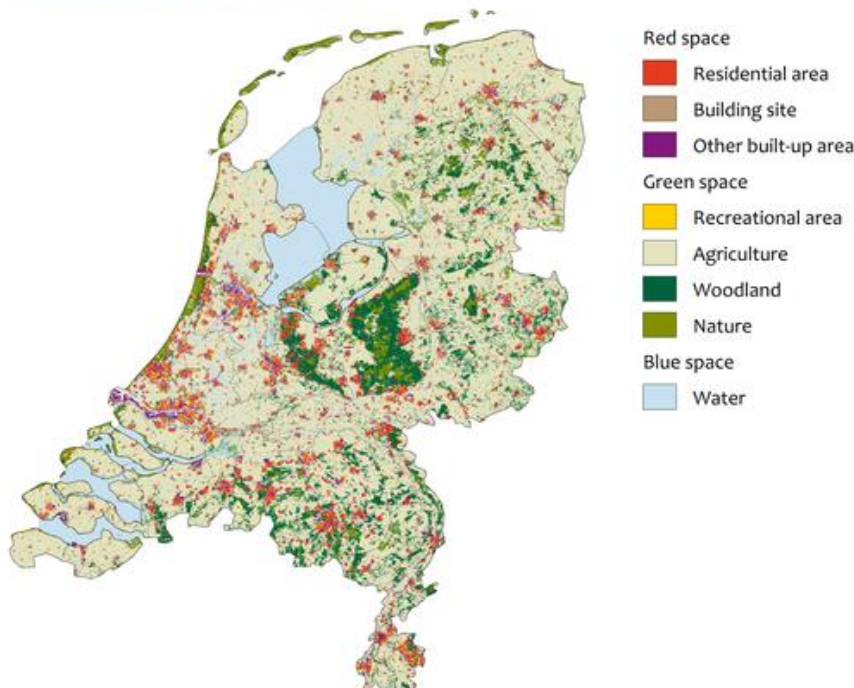
1 Agriculture in the Netherlands

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).

The total area of the Netherlands is about 41,500 km². About 19% of this area concerns water. In 2015, in the middle of the reporting period (2012-2019), 66.4% (22,363 km²) of the total land area (33,671 km²) was used for agricultural purposes (including not only cultivated land, but also gardens, scattered buildings and water courses less than 6 m wide), 10.1% (3,413 km²) was occupied by forest and 4.7% (1,577 km²) by open natural terrain, while 12.2% (4,108 km²) was used for buildings, 3.4% (1,156 km²) for road, train and air traffic, and 3.1% (1,054 km²) for recreation terrain (CBS, 2022). Distinct clusters of urban land use functions are present in the west of the country (Figure 1.1).

Land use in the Netherlands, 2015



Source: Statistics Netherlands, Cadastre

CBS/jan20
www.clo.nl/en006111

Figure 1.1 Land use in the Netherlands, 2015 (source: CBS, PBL, RIVM & WUR, 2022).

The population increased from 16.7 million in 2012 to 17.3 million in 2019, the population density from 496 to 513 people per km² of land in the same period (CBS, 2022). However, developments in population size have been uneven, with some regions having an increase in population, while others experienced a decrease. With about 500 people per km² of land, the Netherlands is a densely populated country.

The gross domestic product of the Netherlands increased from € 652,966 million in 2012 to € 813,055 million in 2019. The combined value added of agriculture, forestry and fisheries increased from € 10,836 million (1.7% of the gross domestic product) in 2012 to € 13,300 million (1.6% of the gross domestic product) in 2019. The sectors contributing most to the gross domestic product in 2019 were government and care (18.8%), the trade, transport, hotels and catering industry (18.7%), business services (13.6%) and industry (13.1%) (CBS, 2022).

1.2 Agriculture

In 2012, the total area of cultivated land in the Netherlands was 1.84 million ha, of which 1,225,000 ha was used for grassland and green fodder crops, 521,000 ha was used for arable crops, and 96,000 ha for horticultural crops (of which 10,000 ha under glass). In 2019, the total area of cultivated land in the Netherlands was 1.82 million ha, of which 1,182,000 ha was used for grassland and green fodder crops, 532,000 ha was used for arable crops, and 103,000 ha for horticultural crops (of which 10,000 ha under glass (CBS, 2022)). The total number of farms declined from 69,000 in 2012 to 53,000 in 2019 (CBS, 2022). So, while between 2012 and 2019 the area of cultivated land decreased only slightly, the number of farms decreased with 23%, resulting in an increase in average farm size. The number of people working regularly in agriculture decreased from 198,000 in 2012 to 180,000 in 2019. Of the 180,000 people regularly working in agriculture in 2019, 66% could be classified as family labour and 34% as non-family labour (CBS, 2022).

The number of organic farms increased with 25% from 1,448 in 2012 to 1,809 in 2019, and their area increased, also with 25%, from 48,300 ha in 2012 to 60,400 ha in 2019 (3.2% of total cultivated land) (CBS, 2022). According to European statistics, the organic crop area in the Netherlands increased from 48,038 ha in 2012 to 68,068 ha in 2019 (Eurostat, 2022), corresponding to 3.7% of the total utilised agricultural area in 2019 (Eurostat, 2021). In 2019, the total area under organic agriculture in the European Union was 13.8 million ha, which corresponds to 8.5% of the total utilised agricultural area. This represents an increase of 46% between 2012 and 2019. In 2019, the EU countries with the relatively largest areas under of organic agriculture were Austria (25.3% of the total utilised agricultural area), Estonia (22.3%) and Sweden (20.4%), followed by Czechia and Italy (both 15.2%), Latvia (14.8%) and Finland (13.5%) (Eurostat, 2021).

The Dutch agricultural sector is highly focused on exports, and the Netherlands ranks second worldwide in the value of agricultural exports behind the United States. In 2019, the estimated value of Dutch exports of agricultural products (primary, unprocessed goods, as well as secondary, processed goods) was € 94.5 billion. This can be subdivided into € 68.5 billion worth of exports of goods of Dutch origin and € 26 billion worth of re-exports of agricultural goods of foreign origin.

The most important export commodities were ornamentals (€ 9.5 billion euros), meat (€ 8.8 billion), dairy and eggs (€ 8.6 billion), vegetables (€ 7.3 billion) and fruit (€ 6.2 billion). Looking at the export value minus the value of the import of goods and services needed to export and, where necessary, produce the goods, the export earnings were highest from ornamental flowers, plants, bulbs and tree nursery products (€ 5.8 billion), dairy and eggs (€ 4.3 billion), meat (€ 4.0 billion) and vegetables (€ 3.5 billion) (Jukema, Ramaekers & Berkhout, 2020).

1.3 Agricultural production systems

The occurrence of various types of agricultural production systems in the country is shown in Figure 1.2. 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 and East. Mixed farms became less important in the past decades.

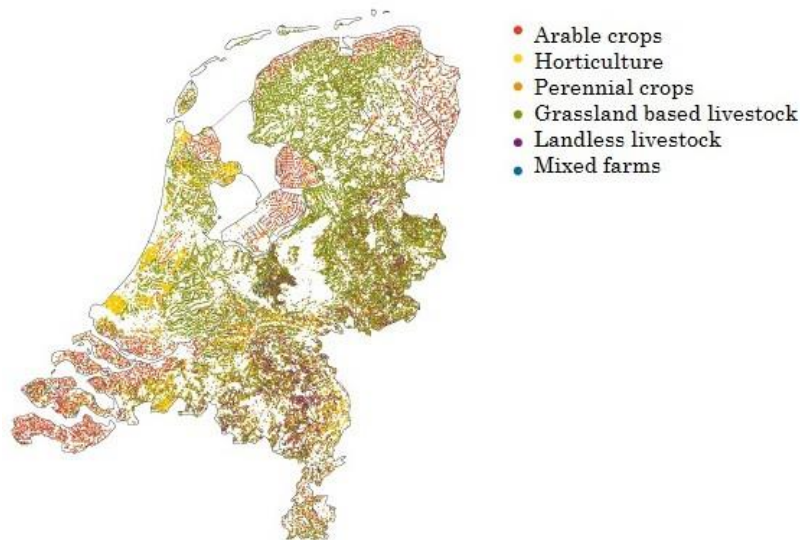


Figure 1.2 Distribution of farms according to main farming activity, 2013 (source: CBS, PBL, RIVM & WUR, 2022).

During the past decades, the biodiversity in and around Dutch agricultural production systems has declined. Important drivers causing changes in biodiversity in agricultural production systems in the Netherlands are the high inputs of nutrients, reduced groundwater tables, the use of chemical crop protection products, and changed landscape configuration (Brink, 2015). The Netherlands has been struggling with too high emissions of nitrogen, which threaten the nature and biodiversity in the country. In the period 2010-2015, European countries had an average positive nitrogen balance of 68 kilograms of nitrogen per hectare, but the average nitrogen balance in the Netherlands was two times as much (Van Halm, 2022). In May 2019, the Council of State ruled that the measures of the Dutch government to reduce nitrogen pollution were in breach of EU directives on the protection of vulnerable habitats. This decision meant that all activities which led to nitrogen being emitted needed a permit, and resulted in building projects being put on hold, reduced speed limits on roads and plans to decrease the size of the intensive farming sector, causing considerable protests in the country (Pascoe, 2022).

Although the effects of climate change on biodiversity 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 (Brink, 2015). This may make it necessary to develop agricultural production systems based on other varieties or even crops than those that are presently grown, with resilience to new pests and diseases.

2 *In Situ* Conservation and Management

2.1 Surveying and inventorying plant genetic resources for food and agriculture (Priority activity 1)

Key achievements since January 2012

In 2014, the CWRnl website on Crop Wild Relatives (CWR) in the Netherlands (www.cwrnl.nl) was established. This website (in Dutch and English) presents an overview of CWR described as native or introduced to the Netherlands before the year 1900. The species are classified per crop, by their common name and by their botanical name. Information about the species is organized in fact sheets, including data on crop relationship, conservation status and distribution.

CWRnl focusses on the economically most important agricultural and horticultural crops. For crops important at the global scale, the world primary crop list of the Food and Agriculture Organization of the United Nations was used. This list was supplemented with crops of economic importance to the Netherlands based on data concerning crop production areas published by Statistics Netherlands (www.cbs.nl) combined with data about economic revenues per hectare published by Wageningen Economic Research. The list was further supplemented with crops or taxa included in Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture and crops occurring in the European Union database of registered plant varieties or the Dutch variety list of the Netherlands Inspection Service for Horticulture. Because of the focus on agricultural and horticultural crops, the inventory does not include species that may be relevant to other crop domains, such as forestry, ornamentals or medicinal crops.

Based on the botanical genus name of a crop, the 'Verspreidingsatlas' of Floristic Research in the Netherlands (accessed 14-10-2014) was used to examine which taxa of the genus occur in the Netherlands. Synonyms, non-accepted names and combinations of taxa, as indicated by the 'Verspreidingsatlas', were disregarded. Relevant information, including data on indigeneity, occurrence and Red List status (Sparrius, Odé & Beringen, 2014), were also obtained from the 'Verspreidingsatlas'. In case of missing data, information was obtained from the Dutch Species Register, the website 'Wild Plants in the Netherlands and Belgium' and Heukels' Flora of the Netherlands. A total number of 453 CWR were identified, of which 214 were described as native or introduced to the Netherlands before the year 1900. These 214 taxa, of which 53 with Red List status, were included in CWRnl (Van Treuren, Hoekstra & van Hintum, 2017).

The CWRnl website also includes distribution maps which show the expected changes for the year 2070 according to an optimistic and a pessimistic climate change scenario. These two scenarios are based on different courses of the emission of greenhouse gasses in the next decades, and the presented distribution maps are based on the expected suitability of geographic locations as a result of climatic conditions. As indicated by Van Treuren et al. (2019), the modelling studies showed that climate change is expected to affect red list species as well as species that are of least concern. In general, reduced distribution areas show a shift to more northern locations in the Netherlands. According to the authors, it is particularly worrisome that already critically endangered CWR show the largest expected loss of distribution area.

As for on-farm diversity, the Orange List of Dutch bio-cultural heritage (www.deoerakker.nl/nl/oerakker/oranje-lijst.htm) was completed. This list now contains some 6600 agricultural and horticultural varieties (of 63 crops) that were grown in the period from 1850 until the Second World War, and also shows where old varieties are still available. Of the 6600 varieties in the Orange List, about 900 are still commercially available. For each variety on the list various sources have been searched for information. The list is considered as a unique source on the Dutch crop biocultural heritage.

Changes and trends since January 2012

Because of the establishment, in 2014, of the CWRnl website, an overview is now available of the existing diversity and distribution of CWR in the Netherlands. Although this website does not provide information on changes and trends since January 2012, it does provide detailed distribution maps for CWR included in the Dutch Red List of plant species, as well as expected distribution maps for the year 2070 based on two climate change scenario's. In addition to the CGN fact sheets, the foundation 'The Living Archive' (*Het Levend Archief*; hetlevendarchief.nl), established in September 2018, will develop fact sheets (so-called species passports) for all species of the Dutch Red List of plant species, including 53 CWR.

As for inventorying the on-farm diversity, an important development since January was the extension and completion of the Orange List (on which work had started in 2008 already), with the number of varieties included in the Orange List having increased from 2000 in 2012, through 4000 in 2014, to 6600 at its completion in 2019.

Gaps and needs as of December 2019

While more information has been gathered on the distribution and conservation status of crop wild relatives and on on-farm crop diversity from 1850 until the Second World War, information on existing on-farm crop diversity is still incomplete. It is known that few traditional varieties are still produced by commercial farmers, mainly potatoes and fruit species, and that traditional diversity is maintained in gardens rather than on farms.

2.2 Supporting on-farm management and improvement of plant genetic resources for food and agriculture (Priority activity 2)

Key achievements since January 2012

One of the key achievements was the further development of the foundation 'De Oerakker', which aims at the maintenance of the Dutch crop biocultural heritage (www.deoerakker.nl). Next to a section focused on vegetables, which existed already before 2012, a section on grains and accompanying species and a section on fruit (mainly apples) are active. Presently, over 100 people are involved in 'De Oerakker' of which ca. 25 are active members involved in multiplication and description of the various varieties.

Also active in promoting on-farm diversity is the 'Zaadgoed' foundation, founded in 1998, and supporting farmer and community based plant breeding and the conservation of traditional varieties for organic agriculture. It has assessed breeding methods for their suitability for organic breeding and supported plant breeding activities of professional organic breeders as well as participative breeding by groups of in collaboration with breeding professional. It has also supported the maintenance of traditional varieties.

Changes and trends since January 2012

On-farm genetic crop diversity, particularly of vegetables and fruits, have continued to be mainly maintained by home gardeners and a small number of NGOs, which have gradually strengthened their positions. Members of foundation 'De Oerakker' give information on old varieties, distribute old varieties free of charge and/or sell material. Market incentives have been taking place through various organisations which focus on the cultivation of old varieties.

In the period 2012-2014, on average about 10 farmers' varieties/landraces per year were distributed from the national genebank to farmers (either directly or through intermediaries). In the period 2014-2019, this had risen to about 17 per year.

Gaps and needs as of December 2019

Although on-farm management and on-farm improvement of plant genetic resources for food and agriculture are supported by various organisations, in their turn supported by CGN, there would be room for more coordination and funding of activities with respect to the maintenance of the Dutch crop biocultural heritage and the promotion of its use.

2.3 Assisting farmers in disaster situations to restore crop systems (Priority activity 3)

The Netherlands does not have explicit disaster risk management policies for restoring crop systems, as these policies are considered unnecessary. There are numerous breeding companies, each having their own well-kept stocks. The stocks of these companies are kept in different places worldwide, which gives additional security. For the most successful crop varieties these stocks are sufficient to have sowing material for several years. The national plant genebank (CGN) has a collection of seeds of commercial varieties, landraces and farmer varieties, and wild relatives of crops, with safety duplications of its accessions in other European genebanks and in the Svalbard seed vault. CGN also stores safety backups of material from seed companies, traditional seed material from farmers and farmers' organisations such as 'De Oerakker' and 'Het Werkverband Friese rassen', and materials from the 'Heritage seeds project'.

2.4 Promoting *in situ* conservation and management of crop wild relatives and wild food plants (Priority activity 4)

Key achievements since January 2012

National *in situ* conservation sites can be found in 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. The Dutch contribution to the Natura 2000 network comprises 161 areas, on land (about 300,000 ha) as well as on sea (about 1,700,000 ha). However, there were no national *in situ* conservation sites with management plans specifically addressing crop wild relatives and wild food plants.

An important action was the establishment of the foundation 'Het Levend Archief' ('The Living Archive'; hetlevendarchief.nl) in September 2018. Its main objective is the establishment, maintenance, and keeping alive of an *ex situ* seed collection of all wild plants in the Netherlands (including crop wild relatives and wild food plants), but it also supports initiatives aimed at *in situ* conservation and the prevention of extinction of indigenous species or autochthone populations (hetlevendarchief.nl). 'Het Levend Archief' works together with, among others, the NVBT (the Dutch Association of Botanical Gardens), FLORON (the organization which coordinates the research on the distribution of wild plants in the Netherlands) and CGN (the Centre for Genetic Resources, the Netherlands, which holds the national genebank). CGN is a board member of 'Het Levend Archief'.

Changes and trends since January 2012

Because of the establishment, in 2014, of the CWRnl website, an overview is now available of the existing diversity and distribution of CWR in the Netherlands. Although this website does not provide information on changes and trends since January 2012, it does provide detailed distribution maps for CWR included in the Dutch Red List of plant species, as well as expected distribution maps for the year 2070 based on climate change.

With respect to agricultural fields, the Dutch national government initiated the policy to develop "Nature inclusive agriculture". Though the regulatory framework is not entirely clear, it offers opportunities to prevent a further decay of plant species in rural areas.

Gaps and needs as of December 2019

Until recently, crop wild relatives and wild food plants were not known to be actively conserved *in situ* on the basis of specific management plans. The establishment of 'Het Levend Archief', which supports initiatives aimed at *in situ* conservation and the prevention of extinction of indigenous species or autochthone populations is a good step towards more active conservation, but more steps may be needed.

In-situ conservation plans typically focus on natural areas, or on rural areas where agriculture serves nature conservation. In rural areas dedicated to agricultural production, species diversity has been decreasing rapidly. Therefore, it is recommended that policies promote the re-introduction of landscape elements with a permanent character, dedicated to active conservation of wild species within rural habitats.

3 Ex Situ Conservation

3.1 Supporting targeted collecting of plant genetic resources for food and agriculture (Priority activity 5)

Key achievements since January 2012

To fill gaps in its collection, the national genebank held by the Centre for Genetic Resources, the Netherlands (CGN) collected 42 wild accessions in the Netherlands in the period from January 2012 to December 2019: allium (*Allium schoenoprasum*, 4 accessions); asparagus (*Asparagus officinalis*, 13 accessions); caraway (*Carum verticillatum*, 1 accession); carrot (*Daucus carota*, 8 accessions); wild cabbage (*Brassica oleracea*, 4 accessions); lamb's lettuce (3 accessions of *Valerianella locusta*, 2 accessions of *Valerianella carinata*, 1 accession of *Valerianella dentata* and 1 accession of *Valerianella rimosa*); *Scorzonera humilis* (1 accession); *Tragopogon pratensis* (2 accessions); and *Tragopogon porrifolius* (2 accessions). Not all the collected accessions have already been included in the genebank, as for some the seed quantity collected was insufficient. They will be included in the genebank after multiplication.

In the period 2012-2019, CGN also carried out international collecting missions, and in total 474 accessions of predominantly crop wild relatives were collected during these missions. In Armenia, asparagus and lettuce were collected, in Azerbaijan asparagus and lettuce, in Jordan lettuce, in Kyrgyzstan carrot, and in Uzbekistan carrot, melon and lettuce. These international collecting expeditions were carried out with financial support from Dutch breeding companies.

Changes and trends since January 2012

The number of accessions collected abroad in the period 2012-2019 (474) represented an increase compared to the years before 2012. For instance, in the period 2008-2012 a total of 212 accessions (spinach and leek) were collected (pers. comm. Chris Kik).

In September 2018 the foundation '*Het Levend Archief*' (hetlevendarchief.nl) was established, aiming at, among other things, the establishment, maintenance, and keeping alive of an ex-situ seed collection of all wild plants in the Netherlands, including crop wild relatives and wild food plants. CGN has offered the long-term storage of the seed collection (at -20 °C), as a back-up for the botanical heritage of the Netherlands. Furthermore, CGN has started (in 2022) a programme to collect seeds of a selection of in-situ populations of the most threatened CWR in the Netherlands, in close collaboration with the foundation '*Het Levend Archief*'.

Apart from CWR, CGN has started a programme to collect seeds of indigenous trees and shrubs in the Netherlands, as a new task within the governmental obligations. The national government was asked, in an exploratory study of statutory obligations on the conservation of botanical biodiversity in the Netherlands arising from international conventions (Schaminée & Van Rooijen, 2022), to extend its responsibility towards a wider set of species, including all (about 500) Red List vascular plant species.

Gaps and needs as of December 2019

Material collected by CGN and incorporated in the national genebank is available for breeding and research, mostly after a short embargo period. As still large gaps are present in vegetable collections worldwide and the need for new sources of biodiversity for breeding and research remains, future collecting missions remain important. It would also be useful if crop wild relatives collected in the framework of the activities of '*Het Levend Archief*' would be made available for commercial breeders, making possible the incorporation of this material in new crop varieties.

3.2 Sustaining and expanding *ex situ* conservation of germplasm (Priority activity 6)

Key achievements since January 2012

The Dutch Ministry of Agriculture, Nature and Food Quality established a national genebank in 1986, held by the Centre for Genetic Resources, the Netherlands (CGN), which is administered by Wageningen University & Research (WUR). Until 1999, CGN was only active in the domain of plant genetic resources, but since 1999 and 2004, respectively, CGN has also acquired the mandate to contribute to the conservation of farm animal species and indigenous trees and shrubs. The number of accessions in the national genebank of the Netherlands, held by CGN, increased from 22,447 on 1 January 2012 to 23,289 on 31 December 2019. In the period 2012-2019, four new crops were added to the collection: black salsify (*Scorzonera hispanica*, *Tragopogon porrifolius*), caraway (*Carum carvi*), carrot (*Daucus* spp.), and lamb's lettuce (*Valerianella* spp.).

In addition to CGN's collection, which is in the public domain, other collections are maintained as well. These include collections established in the private sector, mainly by plant breeding companies, collections maintained by botanical gardens and other public institutions, and collections maintained by non-governmental organizations.

An important collection of living fruit trees is held by the 'Fruithof Frederiksoord' (www.fruithof-frederiksoord.nl). No precise information is available for 1 January 2012 and 31 December 2019, but in October 2022, the collection consisted of 437 apple trees (273 varieties), 301 pear trees (119 varieties), 127 peach trees (78 varieties) and 7 quince trees (7 varieties).

The database of the 'Pomological Society North-Holland' ('*Pomologische Vereniging Noord-Holland*'), established in 2002 to promote the conservation of fruit tree diversity, in particular of tall-stemmed trees, contains detailed information on fruit trees planted in the provinces of North-Holland, South-Holland, Utrecht, Gelderland, Groningen and Flevoland, with information on the varieties (origin, parents, pictures, tree characteristics, fruit characteristics), the number of planted trees of each variety included in the database, and their location. In October 2022 it contained information on 316 apple varieties, 180 pear varieties, 49 plum varieties, 22 cherry varieties, 9 quince varieties and 8 walnut varieties (www.pominventarisatie.nl).

As for ornamental plants, the 'Dutch Plant Collections' (*Nederlandse Planten Collecties*, NPC), initiated by the 'Koninklijke Vereniging voor Boskoopse Culturen' (KVBC), exist since 1995. The NPC comprise around 100 plant collections, signed up and held by specialist growers of often a single species. The collections are accessible and serve as a living database of ornamental plants, as a reference for trials and research, and as a source of motivation and inspiration. Information on the collections can be found on the website of the Dutch Plant Collections (www.plantencollecties.nl/collecties/).

Although PGRFA are often present in botanical gardens, these gardens have a much wider scope and usually focus on species instead of varieties or cultivars. The website of Dutch Association of Botanical Gardens (*Nederlandse Vereniging van Botanische Tuinen*, NVBT) contains a search module where the plants present in the 27 affiliated botanic garden collections can be found (www.botanischetuinen.nl/en/plants).

Changes and trends since January 2012

Until 2019, the Dutch national genebank collections, as also reported to the European Search Catalogue for Plant Genetic Resources (EURISCO), consisted of the collection of CGN and the Solanaceae collection of the Radboud University Nijmegen. However, in 2019 the Radboud University decided to discontinue its Solanaceae collection. Subsequently, this collection has not been part of the Dutch EURISCO upload (National Inventory, NI) since June 2019. Since that time, only the CGN collection forms part of the Dutch NI. Since January 2012, the number of accessions held in the CGN genebank increased from 22,447 on 1 January 2012 to 23,289 on 31 December 2019 (Table 3.1). In the period 2012-2019, four new crops were added to the collection: black salsify (*Scorzonera hispanica*, *Tragopogon porrifolius*; 34 accessions), caraway (*Carum carvi*; 20 accessions), carrot (*Daucus* spp.; 14 accessions), and lamb's lettuce (*Valerianella* spp.; 46 accessions).

During the same period, the capacity of CGN in terms of human and financial resources and infrastructure remained more or less stable¹.

Because of the discontinuation of the Solanaceae collection of the Radboud University, the total number of accessions reported as being conserved *ex situ* under medium- or long-term conditions in national genebank collections declined from over 25,000 to 23,289 in the same period.

Table 3.1 Total number of accessions in the CGN genebank on 1 January 2012 and 31 December 2019.

Name of crop/crop group	1 January 2012	31 December 2019
Agrostis	11	11
Allium	398	431
Apple	129	163
Barley	2664	2665
Black salsify	0	34
Caraway	0	20
Carrot	0	14
Clover	263	263
Cocksfoot	41	42
Cruciferae	1783	1795
Cucumber	924	924
Eggplant	510	510
Faba beans	715	717
Fescue	76	78
Flax	951	951
Lamb's lettuce	0	46
Lettuce	2339	2535
Lily	40	40
Lolium	397	698
Lupin	68	68
Maize	487	487
Meadow grass (Poa)	76	135
Melon	59	79
Oats	394	398
Peas	1002	1011
Pepper	1008	1141
Potato	1418	1471
Spinach	375	507
Timothy	108	108
Tomato	1307	1337
Wheat	4904	4910
Total	22447	23289

In the Second National Report on Plant Genetic Resources for Food and Agriculture, published in 2008, the number of accessions held in the CGN collection in 1996 was reported to amount to 18,428, and that in 2008 to amount to 24,068 (Visser, 2008). This means that the number of accessions in this collection increased from 1996 to 2008, slightly declined in the period 2008-2012, and increased again in the period 2012-2019.

Gaps and needs as of December 2019

Following the coming into force of the Convention on Biological Diversity in 1993 and the Nagoya Protocol in 2014, many countries established national access legislations for their genetic resources. As a result, adding material to genebank collections has become more difficult, not only because collecting missions need to be negotiated with national and local authorities, but also because acquiring material from other collections is

¹ For the period 2022-2026 the Ministry of Agriculture, Nature and Food Quality increased the budget for the Statutory Research Tasks of CGN (including genebank maintenance, the support of *in situ* and on-farm activities, and policy support) considerably, compared to the period 2016-2021.

only possible if the origin of the material is properly documented and is done in compliance with regulations (Brink and van Hintum, 2020). Because of the increasing difficulty to obtain PGRFA and the small size of the national genebank held by CGN relative to the Dutch breeding industry, there is a need to expand the CGN collection.

Information on the presence of seeds and/or living plants of agricultural and horticultural species and varieties in many collections of breeding companies, research institutes or others is not available. It would be worthwhile to get a better picture of the material present in these collections.

3.3 Regenerating and multiplying *ex situ* accessions (Priority activity 7)

Key achievements since January 2012

In the period January 2012 to December 2019, more than 2100 accessions in the CGN genebank were regenerated. During the whole period ca. 80% of the regenerations were done by CGN itself, but since 2016, when seed companies became actively involved in the regeneration of CGN accessions, only ca. 43% of the regenerations were carried out by CGN. The regenerations are usually taking place in the Netherlands, but also in other countries, such as France, Spain, Slovakia and Morocco.

Changes and trends since January 2012

The number of accessions that were regenerated declined from 400 per year in the first reporting period (1 January 2012 to 30 June 2014) to 200 per year in the second reporting period (1 July 2014 to 31 December 2019). As no quantitative information on regeneration/multiplication was given in the Second National Report on Plant Genetic Resources for Food and Agriculture published in 2008 (Visser, 2008), changes and trends over a longer period cannot be compared.

The increasing trend to develop niche products out of ancient cereal crop species also stimulated some farmers to test genebank accessions in their fields.

Gaps and needs as of December 2019

As regeneration is time-consuming and expensive, more capacity for regeneration would be welcome. The levels of regeneration of CGN material in the period 2012-2019 were only possible because of the willingness of companies to participate in this activity.

4 Sustainable Use

4.1 Expanding the characterization, evaluation and further development of specific collection subsets to facilitate use (Priority activity 8)

Key achievements since January 2012

Characterization and evaluation, including by the use of molecular markers and omics technology, is important for a proper assessment of the potential value of genebank accessions. On 31 December 2019, the CGN national collection contained more than 23,000 accessions, with on average 13 traits characterized per accession. During the period 1 January 2012 to 31 December 2019, 512 sets with accessions possessing a certain trait were documented.

Characterization data for accessions in the CGN national collection were usually generated during regenerations of the genebank material and during experimental field trials. Evaluation data, mostly on diseases, were mainly generated by users of the material, particularly breeding companies. Evaluation data for eggplants, peppers and tomatoes were also obtained in the EU-funded Horizon 2020 project G2P-SOL.

Molecular information was obtained in the framework of the '150 Tomato Genome Sequencing Project' (genome sequencing of tomato), the 'International Lactuca Genomics Consortium (ILGC)' project (genome sequencing of lettuce), the 'Capsicum Genome Initiative' (genome sequencing of peppers), the NW30-funded project 'Healthier lettuces for healthier food' (lettuce metabolomics), the 'LettuceKnow' project (lettuce transcriptomics), and a cooperative project with the Beijing Genomics Institute (BGI) in Shenzhen, China (genome sequencing of lettuce). Single-seed descent (SSD) lines of lettuce and tomato obtained in these projects were made available by CGN as 'special collections'.

Since January 2012, about 20 publications on germplasm evaluation and molecular characterization were produced by the national genebank and by germplasm recipients (as reported to the national genebank).

In the period January 2012 to June 2014, the CGN national collection distributed 17,509 samples from 7829 accessions (7004 samples per year), and in the period July 2014 to December 2019 the collection distributed 23,337 samples from 10,199 accessions (4243 samples per year).

Changes and trends since January 2012

The average number of traits characterized for the CGN national collection slightly increased from 12.9 per accession on June 2014 to 13.0 per accession on December 2019. From 1 January 2012 to 30 June 2014, a total of 436 sets with accessions possessing a certain trait were documented, from 1 July 2014 to 31 December 2019 an additional 76 sets were documented. On 30 June 2014, 81% of the accessions in the national genebank had characterization and evaluation data available through the publicly available information system. This percentage remained stable over the period from 30 June 2014 to 31 December 2019.

The number of publications on germplasm evaluation and molecular characterization produced per year by the national genebank and by germplasm recipients (as reported to the national genebank) declined from 4.4 in the period January 2012 to June 2014, to 1.5 in the period July 2014 to December 2019. The reasons for this decline are unknown, but it is very well possible that not all publications produced by germplasm recipients were reported to the national genebank.

The number of accessions distributed to users showed a decline, from 7004 samples per year in the period January 2012 to June 2014, to 4243 samples per year in the period July 2014 to December 2019. According to the Second National Report on Plant Genetic Resources for Food and Agriculture (Visser, 2008), the

number of samples distributed by CGN was 59,647 (5187 per year) in the period from 1997 to July 2008. This indicates that the number of samples distributed per year has remained relatively stable. Year-to-year fluctuations of genebank distributions are normal, as they depend on requests by potential users.

Gaps and needs as of December 2019

Most of the accessions in the CGN collection have been partly characterized and evaluated for a number of traits. However, large characterization and evaluation gaps still exist in the collection. Therefore, continued characterization and evaluation is of great importance.

4.2 Supporting plant breeding, genetic enhancement and base-broadening efforts (Priority activity 9)

Key achievements since January 2012

The breeding sector has continued to develop new varieties, as demonstrated in the numbers of varieties that have been admitted (see 4.5). Due to intensive breeding activities, the number of new varieties in agricultural field crops, vegetable crops and fruit crops is still rising, and the genetic diversity of these crops is increasing. This is illustrated by Schouten et al. (2019), who demonstrate how plant breeding increased the diversity of cultivated tomato since 1960s. The focus of plant breeding has extended to sustainability, and new varieties contain resistances and tolerances to pests and diseases, thus reducing the need for chemical plant protection products. Breeding companies are interested to introduce characteristics such as disease resistance from wild ancestors of modern food plant varieties into their breeding programmes.

On the basis of information on the websites of private breeding companies in the Netherlands, it was estimated that varieties of about 50 crops, mainly vegetables, had been developed and were marketed by private breeding companies in the Netherlands in 2019. In fruit crops, especially new varieties in soft fruits, such as strawberry and raspberry, are introduced. The amount of new varieties of ornamental crops introduced in the Netherlands is estimated annually at 800-1000. Vegetable seeds and seed potatoes remained important export products of the country. For 2010 it was estimated that 40% of the international trade in seeds for the horticulture sector originated in the Netherlands, while for seed potatoes this percentage was even 60% (Bakker, Dijkxhoorn & van Galen, 2011). For 2017, the estimates were 38.5% for vegetable seeds and more than 50% for seed potatoes (KPMG, 2019). Breeding programmes in the Netherlands are not specifically oriented to small scale farmers, villages or traditional communities, but some breeding specific for organic farming has been done.

While breeding programmes in the Netherlands are typically carried out by private breeding companies, public organizations (particularly Wageningen University & Research) carry out more fundamental research contributing to breeding activities. The Plant Breeding group of Wageningen University & Research had various programmes in the period 2012-2019, with the crops researched including apple, *Brassica* spp., fibre hemp, miscanthus, quinoa, potatoes and tomatoes.

Changes and trends since January 2012

The breeding sector remained a well-developed and economically important sector in the Netherlands. According to Statistics Netherlands, the exports of vegetable seeds (excluding red beet seeds) in the period 2012-2019 fluctuated from 10.7 to 13.1 million kg per year, while the export value gradually increased from € 977 million in 2012 to € 1617 million in 2019. For seed potatoes, exports in the period 2012-2019 fluctuated from 850 to 1040 million kg per year, while the export value gradually increased from € 374 million in 2012 to € 523 million in 2019 (CBS, 2022). Data over the period 2012-2019 indicate that the number of breeding companies in the Netherlands remained around 50 (CBS, 2022). According to Plantum, the Dutch association for the plant reproduction material sector, more than 350 companies in the Netherlands are active in the breeding, propagation and/or production of planting material (www.plantum.nl).

Gaps and needs as of December 2019

The vegetable breeding sector in the Netherlands is very well developed, and no major gaps and needs with respect to plant breeding, genetic enhancement and base-broadening activities in the Netherlands were identified. A complicating factor, however, is the reduced access to foreign material which can be used in breeding, genetic enhancement and base-broadening activities due to the complexity of domestic regulation of access in various countries following the coming into force of the Convention on Biological Diversity in 1993 and the Nagoya Protocol in 2014.

4.3 Promoting diversification of crop production and broadening crop diversity for sustainable agriculture (Priority activity 10)

Key achievements since January 2012

Under the motto "Better products, new crops", Wageningen University & Research (WUR) studied new crops as well as 'forgotten' crops for which there is renewed interest, often in collaboration with partners from the business community. WUR also provided advice to farmers and vegetable producers looking to introduce new crops, e.g. on cultivation, storage and processing. For instance, WUR has been researching the introduction of soya in the Netherlands for several years, examining the possibilities of producing this crop under Dutch growing conditions. The country is still dependent on imports from North and South America for soya used to make soya beverages, tofu and baked goods, but the demand for locally grown produce is on the rise. WUR has been testing the growing potential of foreign, early-ripening crop varieties in Dutch clay soils and sandy soils and are working to increase yields and protein levels. WUR has also contributed to the successful introduction of quinoa, working on the development of new quinoa cultivars suitable for cultivation in Europa, investigating how quinoa can best be grown, and studying the composition of quinoa.

WUR has also carried out research in the Netherlands on strip cropping in arable and vegetable crops, which has shown comparable yields, a lower pest and disease pressure and a higher biodiversity compared to monocultures. Practical testing and improving on organic farms has shown that strip cropping is feasible with a limited additional labour input.

Since 2017, WUR has participated in the EU-funded European Horizon 2020 project 'DiverIMPACTS' (Diversification through Rotation, Intercropping, Multiple Cropping, Promoted with Actors and value-Chains Towards Sustainability) project, which aims to achieve the full potential of diversification of cropping systems for improved productivity, delivery of ecosystem services and resource-efficient and sustainable value chains in Europe. WUR has also participated in the EU-funded European Horizon 2020 project 'ReMIX' (Species mixtures for redesigning European cropping systems), aimed at exploiting the benefits of species mixtures to design more diverse and resilient arable cropping systems in Europe. WUR also participated in the Horizon 2020 project G2P-SOL ('Linking genetic resources, genomes and phenotypes of Solanaceous crops'), which studied thousands of genetic accessions of the four major Solanaceous food crops (potato, tomato, pepper and eggplant) stored in genebanks worldwide.

From 2015 to 2019, the Louis Bolk Institute (LBI) participated in the EU-funded European Horizon 2020 'Diversifood' project, aimed at increasing diversity in crop production and food supply. A range of different crops were addressed, including traditional wheat varieties (such as einkorn, emmer and rivet wheat), and different varieties of broccoli and tomato. From 2016 on, LBI participated in the 'Libbio' project, aiming at the cropping of Andean lupin (*Lupinus mutabilis*, tarwi). LBI also participated in the 'Remix' and 'Liveseed' projects. The latter aimed at the development and availability of organic propagation material for multiple species, which has become urgent, because from 2036 onwards no derogations for the use of conventional seed for organic farming will be allowed anymore. The results of "Liveseed" will be elaborated and further brought into practice in the recently started "Liveseeding" project. LBI has also been investigating the possibilities for agroforestry (the integration of agriculture and tree production) in the Netherlands, for instance with respect to which combinations of trees, shrubs and livestock are most effective. They have also been developing new agroforestry concepts and assessing the environmental and biodiversity effects of these systems. From 2014 to 2017 LBI participated in the EU-funded European FP7 project 'Agforward'

(AGroFORestry that Will Advance Rural Development), which aimed at promoting agroforestry practices in Europe that will advance rural development. LBI and the Dune Farmers foundation have founded the Dutch Agroforestry Association.

An example of an initiative aimed at the conservation of indigenous cereal species originating from domestication, maintenance and selection by farmers, is 'Doornik Natuurakkers'. For this initiative, funded by the 'Diversifood' project, LBI evaluated the cultivation value and suitability for artisan bakers of, among others, *Triticum dicoccon*, *T. monococcum* and *T. turgidum*. Nature conservation organisations grow cereals in natural areas, to sustain birds and other wildlife. Here, modern varieties of crops such as rye are being replaced by ancient cereal species and landraces, which perform better under less fertile soil conditions. Conservation and cultivation of these traditional crop species is important to broaden crop diversity, but they also host rare arable field herb species. In 2019, the project 'Buitenland van Rhooon' started, with the aim of combining 'nature inclusive agriculture' with business models for recreation and niche-branded food products such as bread and beer.

Changes and trends since January 2012

Crops that have been introduced or reintroduced into commercial cultivation in the past decade include Dyer's Rocket (*Reseda luteola*), lupins (*Lupinus* spp.), quinoa (*Chenopodium quinoa*), Russian dandelion (*Taraxacum kok-saghyz*), sorghum (*Sorghum bicolor*), soybeans (*Glycine max*), spelt (*Triticum spelta*) and yacon (*Smallanthus sonchifolius*). New genetic material, not yet grown or otherwise present in the Netherlands, was introduced with new varieties from abroad.

Gaps and needs as of December 2019

For new crops, there is a need of varieties suited to the climate of the Netherlands, ripening in time and giving sufficient production. For instance, the first soybeans varieties available on the Dutch market do not ripen until early October, and varieties harvestable in September would be preferable. At the same time, yields need to increase, as the cultivation of soybeans is considered to only be profitable with yields over 3.5 tons per hectare.

4.4 Promoting development and commercialization of all varieties, primarily farmers' varieties/landraces and underutilized species (Priority activity 11)

Key achievements since January 2012

The foundation 'De Oerakker' is present at fairs and on the internet, to give information on old varieties, distribute old varieties free of charge and/or sell material. In October 2015, 'De Oerakker', with support of CGN, started the 'Heritage seeds project'. Seeds of heritage varieties (such as the old bitter Brussels sprouts, tomato, pea, bean and wheat) are multiplied and made better available to the public for cultivation and consumption.

The 'Zaadgoed' ('Good seed') foundation (www.zaadgoed.nl), founded in 1998, is a not-for-profit civil society organisation that supports farmer and community based plant breeding and the conservation of traditional varieties for organic agriculture. It has assessed breeding methods for their suitability for organic breeding and supported plant breeding activities of professional organic breeders as well as participative breeding by groups of farmers in collaboration with breeding professionals. The 'Zaadgoed' foundation has been promoting organic breeding through publications, lectures and extension days for a wide audience, including breeders, farmers, consumers, retailers, wholesalers and scientists. Some commercial breeding companies, such as 'De Bolster' and 'Vitalis Organic Seeds' focus specifically on the breeding and sale of organic seeds, especially aimed at organic farmers and gardeners. Other breeding companies breed and sell conventional as well as organic seeds.

The Bioimpuls programme (from 2009 onwards), funded by the Dutch Ministry of Economic Affairs and coordinated by the Louis Bolk Institute, aims at breeding new disease resistant potato varieties for the organic sector. In this programme, the Louis Bolk Institute works closely together with Wageningen University & Research (WUR), commercial breeders and farmer-breeders.

The Orange List (www.deoerakker.nl/nl/oerakker/oranje-lijst.htm), completed in 2019, gives an overview of agricultural and horticultural varieties that were grown in the period from 1850 until the Second World War. To promote the cultivation and use of these varieties, the list also shows where old varieties are still commercially available and/or in which genebank they are conserved.

Of the old varieties listed by the 'Heritage seeds project' and in the Orange List, about 1000 are still commercially available, and the lists indicate where they can be acquired.

Changes and trends since January 2012

The main developments since 2012 are the start of the 'Heritage seeds project', in October 2015, and the extension and completion of the Orange List (on which work had started in 2008 already), with the number of varieties included in the Orange List having increased from 2000 in 2012, through 4000 in 2014, to 6600 at its completion in 2019.

Gaps and needs as of December 2019

The 'Heritage seeds project' and the Orange List provide information on the old varieties from which seeds are commercially available. No quantitative information is available on the commercialization of products from traditional varieties, but this is a niche market with low volumes compared to sales of products from modern varieties.

The development of business models as a driver for the conservation of ancient crops and traditional varieties deserves support from local, national and EU government bodies.

4.5 Supporting seed production and distribution (Priority activity 12)

Key achievements since January 2012

Under the regulations of the European Union, only approved varieties of agricultural and vegetable material may be marketed. The acceptance of varieties is the responsibilities of the Member States of the European Union. In the Netherlands this is done by the Board for plant varieties ('*Raad van plantenrassen*') under the 'Seeds and Planting Materials Act 2005'. In order to market a variety within the EU, it must be listed first, and when a variety is listed in the national list of at least one EU Member State this variety can be marketed in the whole EU. Admission of varieties in the national list of the Netherlands is the responsibility of the Board for Plant Varieties. In the first reporting period (1 January 2012 - 30 June 2014), a total of 2748 varieties were admitted to the national list of the Netherlands, while in the second reporting period (1 July 2014 - 31 December 2019), a total of 3690 varieties were admitted (Raad voor plantenrassen, 2021). Table 4.1 shows the varieties per crop admitted in the two periods.

Table 4.1 The number of varieties per crop admitted to the national list of the Netherlands in the periods 1 January 2012 - 30 June 2014 and 1 July 2014 – 31 December 2019.

Name of crop	Varieties admitted	
	1 January 2012 - 30 June 2014	1 July 2014 – 31 December 2019
Almond	1	
Apple	411	19
Apricot	8	
Artichoke	1	1
Asparagus	4	18
Avena strigosa	2	2
Barley	2	27
Birdsfoot		1
Black radish	1	3
Blackberry	23	1
Blackcurrant	38	1
Blueberry	50	14
Broad bean	1	7
Broccoli	12	23
Brussels sprouts	15	17
Butternut squash	3	2
Calabash	2	1
Caraway	1	
Carrot	17	64
Cauliflower	50	74
Celeriac	1	8
Celery	7	10
Cherry plum	2	
Chicory	4	5
Chicory root		5
Chinese cabbage	4	3
Climbing French bean	6	17
Common bent		6
Courgette	23	50
Cranberry	5	
Cucumber	67	156
Cucurbita maxima x C. moschata	5	2
Curled-leaved endive	9	20
Dwarf French bean	36	74
Eggplant	11	25
Endive	12	11
European plum	1	
Festulolium		1
Ficus benghalensis	1	
Ficus lyrata	1	
Flax	5	15
Florence fennel	6	12
Fodder beet		2
Fodder cabbage		1
Fodder kale		4
Fodder radish	4	12
Fragaria vesca	1	
Fragaria moschata	1	
Gherkin	15	45
Gooseberry	24	2
Hazel	23	
Hemp	3	1
Hybrid ryegrass		2
Indian mustard	1	

Name of crop	Varieties admitted	
	1 January 2012 - 30 June 2014	1 July 2014 – 31 December 2019
Italian ryegrass		1
Jostaberry	2	
Kale	1	1
Kentucky bluegrass	1	5
Kohlrabi	8	15
Lamb's lettuce	5	10
Leaf beet		9
Leaf chicory	3	15
Leek	15	30
Lettuce	165	586
Maize	49	174
Melon	49	147
Morello	11	
Nectarine	3	
Oat		6
Onion	51	148
Palm cabbage	1	
Parsley	3	10
Pea	14	68
Peach	21	
Pear	81	2
Plum	78	2
Popcorn		3
Potato	96	212
Prunus	10	3
Prunus ×gondouinii	1	
Prunus salicina	4	
Pumpkin		13
Pyrus pyrifolia	12	
Quince	21	
Radish	13	27
Rapeseed		24
Raspberry	86	27
Red beet	2	15
Red cabbage	8	12
Red clover		2
Red currant	26	
Red fescue	2	9
Ribes divaricatum	1	
Rubus subgenus Rubus	3	
Runner bean	3	2
Ryegrass	25	114
Savoy cabbage	5	12
Shallot		6
Sheep's fescue		1
Snow pea	4	6
Solanum melongena x Solanum torvum	2	
Solanum torvum	2	1
Soybean	2	
Spinach	41	95
Strawberry	411	51
Sugar beet	14	69
Sunflower		1
Swede	4	10
Swedish clover		1
Sweet and chilli pepper	99	230
Sweet cherry	67	

Name of crop	Varieties admitted	
	1 January 2012 - 30 June 2014	1 July 2014 – 31 December 2019
Sweet chestnut	3	
Sweet corn	14	33
Tayberry	3	
Timothy		2
Tomato	151	489
Tomato rootstock	5	15
Turnip	2	5
Vaccinium virgatum	1	2
Walnut	60	1
Watermelon	12	70
Welsh onion	2	6
Wheat	5	53
White cabbage	32	64
White clover		5
White currant	10	
White mustard	3	6
Total	2748	3690

On 30 June 2014, in total around 7900 varieties had been admitted and released through a formal procedure and documented in the Dutch variety register. On 31 December 2019, this had increased to around 11,600, belonging to around 135 different crops (Raad voor plantenrassen, 2021).

Changes and trends since January 2012

At the end of the first reporting period (2014) as well as at the end of the second reporting period (2019), the five crops with the highest harvested area in the Netherlands were maize (*Zea mays*), potatoes (*Solanum tuberosum*), wheat (*Triticum aestivum*), sugar beet (*Beta vulgaris* subsp. *vulgaris*) and barley (*Hordeum vulgare*), according to data from CBS Statistics Netherlands. From 2014 to 2019, the harvested area of maize and wheat decreased, while the harvested area of potatoes, sugar beet and barley increased (Table 4.2).

Table 4.2 *The five crops with the highest harvested area in the Netherlands in 2014 and 2019 (source: CBS Statistics Netherlands).*

Crop	Harvested area 2014 (ha)	Harvested area 2019 (ha)
Maize	243,675	205,235
Potatoes	155,502	165,733
Wheat	142,212	120,546
Sugar beet	75,094	79,176
Barley	243,675	33,389

It can be assumed that in both years 100% of the area for the five most widely cultivated crops is supplied with seed meeting the quality standard of the formal seed sector, as this is an official requirement in the Netherlands.

The 2005 Seeds and Planting Materials Act (*'Zaai- en plantgoedwet 2005'*) is a framework law, which has not been changed since 2005. However, certain ministerial regulations under this law are changed regularly, following agreements at the EU-level.

With regard to the least number of varieties that together account for 80% of the total area for each of the five most widely cultivated crops (intraspecific diversity), data are only available for sugar beet: 10 in 2014 and 17 in 2019.

The number of companies registered at the Dutch General Inspection Service for agricultural seeds and seed potatoes (NAK) as providing planting material for agricultural crops declined from 380 in 2013 to 290 in 2019 (personal communication, NAK). With respect to the planting material producing enterprises registered at the Netherlands Inspection Service for Horticulture (*Naktuinbouw*), the number of enterprises providing planting material for flower crops slightly declined (from 293 in 2013 to 241 in 2019), the number of enterprises providing planting material for tree crops also slightly declined (from 2573 in 2013 to 2265 in 2019), while the number of enterprises providing planting material for vegetable crops slightly increased (from 295 in 2013 to 329 in 2019) (*Naktuinbouw* Annual Reports 2015 and 2019). Since 2018, also enterprises providing planting material for pot and bedding plants need to be registered at *Naktuinbouw*. Their numbers were 151 in 2018 and 934 in 2019 (*Naktuinbouw* Annual Report 2019).

Gaps and needs as of December 2019

There are no gaps and needs with regard to the availability of good quality seed of a wide range of varieties and crops and national seed policies and laws.

With respect to the least number of varieties that together account for 80% of the total area for each of the five most widely cultivated crops, data are available only for sugar beet. Therefore, the actual intraspecific crop diversity cannot properly be assessed.

5 Building Sustainable Institutional and Human Capacities

5.1 Building and strengthening national programmes (Priority activity 13)

Key achievements since January 2012

In response to the requirements of the CBD and the International Treaty, which have both been ratified by the Netherlands, the government of the Netherlands has developed a national policy on genetic resources, entitled 'Sources of Existence', that was adopted by Parliament in 2002 (Ministry of Agriculture, Nature Management and Fisheries, 2002). This policy document, which still served as a guideline for its programmes and activities in the field of genetic resources in the period 2012-2019, covers the following topics: legislation and regulations, *in situ* and *ex situ* management, commercial and non-commercial applications of genetic resources, and international cooperation.

In the framework of the policy adopted by Parliament the government has signed a series of five-year agreements with the Centre for Genetic Resources, the Netherlands (CGN) of Wageningen University & Research (WUR), to execute a work programme contributing to the conservation and utilization of genetic resources in international collaboration. The programme allows for the maintenance of the *ex situ* collections and the related information and documentation tools, as well as support of *in situ* (including on-farm) conservation by other actors, regional collaboration in the European networks, policy support for the government and educational activities aiming to reach a wider public.

Changes and trends since January 2012

The basic structure of the policy and institutional framework has not changed since 2012: the national policy outlined in the 'Sources of Existence' policy document, published in 2002, has remained applicable, and CGN has remained the national entity functioning as a coordination mechanism for PGRFA activities and/or strategies, with CGN not only holding the national genebank, but also being involved in activities related to on-farm conservation, crop wild relatives, indigenous trees and shrubs, and genetic resources policies.

The Nagoya Protocol (Implementation) Act of the Netherlands, a national law to implement EU Regulation 511/2014 (which regulates the compliance aspects of the Nagoya Protocol across the EU) in the Netherlands came into force on 23 April 2016. The explanatory memorandum accompanying the law states that no specific rules governing access to genetic resources occurring *in situ* in the Netherlands will apply. This is because the Dutch government considers it unnecessary to exercise its sovereignty regarding access to genetic resources occurring in the Netherlands in national legislation (section 6.2.1 of the Explanatory Memorandum of the Nagoya Protocol (Implementation) Act of the Netherlands).

Gaps and needs as of December 2019

No major gaps and needs with respect to national PGRFA programmes were identified.

5.2 Promoting and strengthening networks for plant genetic resources for food and agriculture (Priority activity 14)

Key achievements since January 2012

In the period 2012-2019 the Netherlands has remained a member of the European Collaborative Programme on Plant Genetic Resources (ECPGR), a regional network in which almost all European countries are participating. In this period, the country has continued to actively contribute to the functioning of the network, in particular to activities aimed at agreed standards and protocols for genebank activities, improved

use of information technology, and task sharing in collection management. During this period, 15 publications were produced by national stakeholders within the framework of the ECPGR network.

From 2013 to 2016, CGN participated in the EU-funded TRAF00N ('Traditional food network to improve the transfer of knowledge for innovation') project (www.trafoon.org), which brought together researchers, knowledge transfer agents and SME associations from 14 European countries, with the aim of fostering the transfer of sustainable innovation and entrepreneurship in the traditional foods sector for the benefit of European consumers

From 2013 to 2019, CGN was involved in two complementary 'preparatory actions' commissioned by the European Commission (Directorate-General for Agriculture and Rural Development). The first one had the objective to deliver inputs on how to improve communication, knowledge exchange and networking among the actors potentially interested in activities related to the conservation of genetic resources in agriculture. The second one aimed to better understand the stakes of European neglected genetic resources in agriculture and to tap onto their economic potential, and provided examples of how to make the conservation of neglected breeds and varieties economically viable and encourage farmers and other stakeholders to engage in similar projects across the EU (www.geneticresources.eu).

CGN was also active in GenRes Bridge project, which started in 2019. The aim of this project was to strengthen conservation and sustainable use of genetic resources, by accelerating collaborative efforts and widening capacities in plant, forest and animal genetic resources domains through sharing perspectives, exchanging best practices, harmonizing standards, trainings and sharing resources under the auspices of the three pan-European genetic resources networks: the European Collaborative Programme on Plant Genetic Resources (ECPGR), the European Forest Genetic Resources Programme (EUFORGEN) and the European Regional Focal Point for Animal Genetic Resources (ERFP). The project resulted in an overarching Genetic Resources Strategy for Europe, which was launched in November 2021 (www.genresbridge.eu).

Changes and trends since January 2012

In June 2014, the Netherlands was represented by CGN staff in the ECPGR working groups on Allium, Barley, Brassica, Cucurbits, Leafy Vegetables, Potato, Solanaceae, Wheat, Documentation and Information, On-farm Conservation and Management and Wild Species Conservation in Genetic Reserves, as well as in the ECPGR Steering Committee and the Advisory Committee of EURISCO.

On 31 December 2019, the Netherlands was represented by CGN staff in the ECPGR working groups on Allium, Barley, Brassica, Cucurbits, Leafy Vegetables, Malus/Pyrus, Potato, Solanaceae, Wheat, Documentation and Information, On-farm Conservation and Management, and Wild Species Conservation in Genetic Reserves, and, as in the previous reporting period, in the ECPGR Steering Committee and the Advisory Committee of EURISCO.

Gaps and needs as of December 2019

Although the genebank community in Europe is represented by ECPGR, this organization cannot provide all the services that genebanks need in terms of coordination, facilitation, training and advice. An organization such as IBPGR (later IPGRI and Bioversity) is missing, to provide help with practical questions genebanks may have (when new freezing equipment is needed, when the documentation system needs an upgrade, if GRIN-Global would be a good option if bar- or QR-code are used for the seed bags). An organization is needed to avoid genebanks reinventing the wheel, to avoid redundancy, and to set standards. A global organization, possibly CGIAR or FAO, could play this role to make the PGRFA community more effective. The European Commission could also have a role in increasing this effectiveness.

5.3 Constructing and strengthening comprehensive information systems for plant genetic resources for food and agriculture (Priority activity 15)

Key achievements since January 2012

With respect to *ex situ* conserved material, information on approximately 23,000 accessions held in the national genebank collection of CGN has remained publicly available through the CGN website (cgngenis.wur.nl/), EURISCO (eurisco.ipk-gatersleben.de) and Genesys (www.genesys-pgr.org). The information includes passport data (describing the identity and origin of the accessions) and phenotypic data (describing the traits of the accessions), with the latter including characterization and evaluation data. By the end of the reporting period (31 December 2019), CGN contributed information to various publicly accessible international PGRFA information systems: EURISCO (bi-monthly), Genesys (through EURISCO, annually) and the ECPGR Central Crop Databases (on request).

As for on-farm diversity, the Orange List of Dutch bio-cultural heritage (www.oranjelijst.nl) has been completed. This list now contains around 6600 agricultural and horticultural varieties (of 63 crops) that were grown in the period from 1850 until the Second World War, and also shows where old varieties are still commercially available and/or in which genebank they are conserved. Of the 6600 varieties in the Orange List, about 900 are still commercially available and an additional 1000 varieties are being conserved in genebanks.

As for crop wild relatives, the CWRnl website (www.cwrnl.nl) was established in 2014. The species are classified per crop, by their common name and by their botanical name. Information about the species is organized in fact sheets, including data on crop relationship, conservation status and distribution. For CWR included in the Dutch Red List of plant species, more detailed distribution maps for the Netherlands are presented as well as expected distribution maps for the year 2070 based on climate change. For CWR that are included in the Dutch Red List of plant species, CWRnl presents the occurrence in (protected) nature reserves and the presence of seed samples in gene banks, while also more detailed distribution maps for the Netherlands are presented with the Dutch network of protected areas as background. A total number of 453 CWR were identified, of which 214 were described as native or introduced to the Netherlands before the year 1900. These 214 taxa, of which 53 with Red List status, were included in CWRnl.

Changes and trends since January 2012

Since the previous Country Report (Visser, 2008), much more information on crop wild relatives and traditional varieties has become publicly available. Both the Orange List of Dutch bio-cultural heritage and the CWRnl website have been developed and have become publicly available on the internet (the Orange List in 2008, the CWRnl website in 2014).

Since the first reporting cycle of the Second GPA, the CWRnl website was published (in 2014), while the Orange List was extended and completed. The number of varieties included in the Orange List roughly increased from 2000 in 2012, through 4000 in 2014, to 6600 in 2019. Since the first reporting cycle of the Second GPA, the number of varieties that had been admitted and released through a formal procedure and documented in the Dutch variety register increased from about 8000 to about 11,600.

Gaps and needs as of December 2019

Although the Orange List gives much information on varieties that were grown in the past and their availability, information systems on the current cultivation of traditional varieties are lacking.

5.4 Developing and strengthening systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of plant genetic resources for food and agriculture (Priority activity 16)

Key achievements since January 2012

For on-farm diversity, the Orange List of Dutch bio-cultural heritage (www.oranjelijst.nl) has been extended and completed. This list now contains around 6600 agricultural and horticultural varieties (of 63 crops) that were grown in the period from 1850 until the Second World War, and also shows where old varieties are still commercially available and/or in which genebank they are conserved. For each variety on the list various sources have been searched for information. The list is considered as a unique source on the Dutch crop biocultural heritage.

In 2014, the CWRnl website on Crop Wild Relatives (CWR) in the Netherlands (www.cwrnl.nl) was established. This website (in Dutch and English) shows an overview of CWR described as native or introduced to the Netherlands before the year 1900. The species are classified per crop, by their common name and by their botanical name. Information about the species is organized in fact sheets, including data on crop relationship, conservation status and distribution. For CWR included in the Dutch Red List of plant species, more detailed distribution maps for the Netherlands are presented as well as expected distribution maps for the year 2070 based on two climate change scenario's. For these species also the occurrence in Dutch nature reserves is indicated and whether seed samples are conserved in the Dutch gene bank.

FLORON coordinates the research on the distribution of wild plants in the Netherlands, with the help of hundreds of volunteers. Apart from providing direct support to these volunteers, FLORON gives training and advice, carries out ecological research for science, management and policy, and protects plant species and their habitats.

The Network Ecological Monitoring (NEM) programme, established in 1997, consists of over 30 measuring networks aimed at the systematic collection of nature data, to enable quantification of trends in the distribution and abundance of flora and fauna. NEM delivers the collected data to the CBS, which calculates trends and forwards these to the PBL, which uses the information for publications required by national and international agreements. NEM also forwards the data to the 'National Databank Flora and Fauna' (*Nationale Databank Flora en Fauna*), to ensure wide availability of the data.

Changes and trends since January 2012

FLORON, established in 1989, and the Network Ecological Monitoring (NEM) programme, established in 1997, were already in place at the time of the first reporting cycle of the second GPA. New, however, is the CWRnl website, established in 2014, which provides an up-to-date of the existing diversity and distribution of CWR in the Netherlands, as well as expected distribution maps for the year 2070 based on climate change. For on-farm diversity, the Orange List of Dutch bio-cultural heritage (agricultural and horticultural varieties) was extended and completed.

Gaps and needs as of December 2019

While monitoring systems for wild plants (including crop wild relatives) are well developed, monitoring of existing on-farm crop diversity is less developed. The Orange List gives information on traditional agricultural and horticultural varieties and shows where these varieties are commercially available and/or in which genebank they are conserved, but does not give information on their actual use cultivation.

5.5 Building and strengthening human resource capacity (Priority activity 17)

Key achievements since January 2012

Wageningen University offers a Dutch-language BSc programme in Plant Sciences, and English-language MSc programmes in Plant Sciences (with possible specialization in Crop Science, Greenhouse Horticulture, Natural Resource Management, Plant Breeding and Genetic Resources, and Plant Pathology and Entomology), Organic Agriculture (with possible specialization in Agroecology and Sustainable Food Systems), and an online (distance learning) MSc programme in Plant Breeding. WUR also offers tailor-made online plant courses for professionals. The Centre for Development Innovation (CDI) of WUR and the Centre for Genetic Resources, the Netherlands (CGN) annually organize short-term post-graduate courses on PGRFA conservation and use.

Various Universities of Applied Sciences offer BSc programmes related to PGRFA. HAS University of Applied Sciences in Den Bosch offers Dutch-language BSc programmes in Applied Biology and in Horticulture and Arable Farming, and an English-language BSc programme in Horticulture and Business Management. The Aeres University of Applied Sciences offers Dutch-language BSc programmes in Applied Biology and in Horticulture and Arable Farming, and English-language BSc programmes in International Horticulture and Management, in Plant Breeding and in Plant Production. The Van Hall Larenstein University of Applied Sciences offers a Dutch-language BSc programme in Horticulture and Arable Farming. Inholland University of Applied Sciences offers Dutch-language BSc programmes in Horticulture and Agribusiness and in Horticulture management.

At the end of 2019, the number of professional staff in the national genebank of CGN working on PGRFA conservation and use at the end of the reporting period was 8 fulltime-equivalents (fte).

Changes and trends since January 2012

The number of students enrolled in BSc and MSc programmes of Wageningen University has strongly increased. The total number of enrolled students increased from 7,473 in the academic year 2011/2012 to 12,819 in 2019/2020.

The number of professional staff in the national genebank of CGN working on PGRFA conservation and use at the end of the reporting period have remained stable at 8 fte over the period 2012-2019. The number of genebank staff whose skills have been upgraded, was 7 in the period from 1 January 2012 to 30 June 2014, and 6 in the period from 1 July 2014 to 31 December 2019.

Gaps and needs as of December 2019

Education and training on PGRFA conservation and use are well developed in the Netherlands, and no clear gaps and needs were identified.

The number of professional staff in the national genebank of CGN working on PGRFA conservation and use was adequate, but would need to be increased if the expected increase in the number of accessions held would materialize.

5.6 Promoting and strengthening public awareness of the importance of plant genetic resources for food and agriculture (Priority activity 18)

Key achievements since January 2012

CGN, the national genetic resources centre, is active in raising public awareness of the importance of plant genetic resources for food and agriculture. CGN has followed a two-pronged approach by targeting regular education (from primary schools to dedicated agricultural education) as well as a wider interested public. For regular education, new modules on genetic resources have been developed, offered, tested and integrated in

various programmes in close collaboration with sector organizations and teachers. CGN has produced and distributed brochures on topics such as forgotten vegetables, and the history of breeding of cabbage and potatoes in the Netherlands. CGN is also present on fairs to inform the general public.

An organisation very active in strengthening public awareness of the importance of plant genetic resources for food and agriculture is foundation 'De Oerakker' (www.deoerakker.nl), which has been active in awareness-raising and it is present at various fairs 2-5 times per year. Here, members of 'De Oerakker' give information on old varieties, distribute old varieties free of charge and/or sell material.

An important project to increase public awareness of the importance of plant genetic resources for food and agriculture and their diversity is the Orange List of Dutch bio-cultural heritage (www.deoerakker.nl/nl/oerakker/oranje-lijst.htm). The Orange List contains around 6600 agricultural and horticultural varieties (of 63 crops) that were grown in the period from 1850 until the Second World War, and also shows where these varieties are still commercially available and/or in which genebank they are conserved.

Various NGOs and farmers/gardeners in the Netherlands regularly organize field days so as to reach out to a wider public and to distribute seed and planting material to interested hobbyists. Local governments sometimes support these activities financially.

Changes and trends since January 2012

Greater attention to the bio-cultural heritage of the Netherlands has been developing amongst the wider public. Increased sales of traditional and regional products, directly by growers or through local shops contribute to the conservation and utilization of *in situ* managed crop genetic diversity. Since 2012, the Orange List of agricultural and horticultural varieties has been extended and completed.

Gaps and needs as of December 2019

No major gaps and needs with respect to public awareness creation of the value of PGRFA were identified.

6 Conclusions

In Situ Conservation and Management

1. An important development for the inventory of crop wild relatives (CWR), was the establishment of the CWRnl website (www.cwrnl.nl) in 2014. This website provides an overview of the existing diversity and distribution of CWR in the Netherlands. For CWR that are included in the Dutch Red List of plant species.
2. For the *in situ* conservation and management of CWR and wild food plants, another important development was the establishment, in 2018, of the foundation 'Het Levend Archief', which not only aims at creating an *ex situ* seed collection of all wild plants in the Netherlands (including crop wild relatives and wild food plants), but also supports initiatives aimed at *in situ* conservation and the prevention of extinction of indigenous species or autochthone populations.
3. While more information has been gathered on the distribution and conservation status of crop wild relatives, information on existing on-farm crop diversity is still incomplete. Ample information on traditional varieties can be found in the Orange List of Dutch bio-cultural heritage (www.deoerakker.nl/nl/oerakker/oranje-lijst.htm), which was extended and completed in the reporting period.
4. Important for the support of on-farm PGRFA management and improvement, was the further development of the foundation 'De Oerakker', which aims at the maintenance of the Dutch crop biocultural heritage. The 'Zaadgoed' foundation is supporting farmer and community based plant breeding and the conservation of traditional varieties for organic agriculture. The national genebank provided farmers' varieties/landraces to farmers (either directly or through intermediaries).
5. Although the Netherlands does not have explicit disaster risk management policies for restoring crop systems, the national plant genebank (CGN) has a collection of seeds of commercial varieties, landraces and farmer varieties to wild varieties of crops, with safety duplications of its accessions in other European genebanks and in the Svalbard seed vault. Breeding companies keep stocks in many different places in the world, which gives additional security.

Ex Situ Conservation

6. The number of accessions in the national genebank of the Netherlands, held by the Centre for Genetic Resources, the Netherlands (CGN), increased from 22,447 on 1 January 2012 to 23,289 on 31 December 2019. In the period 2012-2019, four new crops were added to the collection: black salsify (*Scorzonera hispanica*, *Tragopogon porrifolius*), caraway (*Carum carvi*), carrot (*Daucus* spp.), and lamb's lettuce (*Valerianella* spp.).
7. Because of the discontinuation of the Solanaceae collection of the Radboud University, the total number of accessions reported as being conserved *ex situ* under medium- or long-term conditions in national genebank collections declined from over 25,000 to 23,289 in the same period.
8. In the period 2012-2019, CGN collected 42 wild accessions in the Netherlands: allium (*Allium schoenoprasum*); asparagus (*Asparagus officinalis*); caraway (*Carum verticillatum*); carrot (*Daucus carota*); wild cabbage (*Brassica oleracea*); lamb's lettuce (*Valerianella* spp.), *Scorzonera humilis*; *Tragopogon pratensis*; and *Tragopogon porrifolius*. CGN also carried out collecting missions abroad: in Armenia, asparagus and lettuce were collected, in Azerbaijan asparagus and lettuce, in Uzbekistan carrot, melon and lettuce, in Kyrgyzstan carrot and in Jordan lettuce. In total 474 accessions of predominantly crop wild relatives were collected during these missions. In view of the size of the national genebank held by CGN relative to the Dutch breeding industry, combined with the increasing difficulty to

obtain PGR abroad (due to the complexity of domestic regulation of access in various countries following the coming into force of the Convention on Biological Diversity in 1993 and the Nagoya Protocol in 2014), there is a need to expand the CGN collection.

9. More than 2100 accessions in the CGN genebank were regenerated in the period 2012-2015. Over the whole period, ca. 79% of the regenerations were done by CGN, but since 2016, when seed companies became actively involved in the regeneration of CGN accessions, ca. 43% of the regenerations were carried out by CGN. The regenerations are usually taking place in the Netherlands, but also in other countries such as France, Spain, Slovakia and Morocco.
10. The foundation '*Het Levend Archief*', aiming, among other things, at the establishment, maintenance, and keeping alive of an *ex situ* seed collection of all wild plants in the Netherlands (including crop wild relatives and wild food plants) was established in 2018.

Sustainable Use

11. On 31 December 2019, on average 13 traits per accession had been characterized for the CGN national collection of PGRFA. During the period 2012-2019, more than 500 sets with accessions possessing a certain trait were documented.
12. In the period January 2012 to June 2014, the CGN national collection distributed 17,509 samples from 7829 accessions (7004 samples per year), and in the period July 2014 to December 2019 the collection distributed 23,337 samples from 10,199 accessions (4243 samples per year).
13. It was estimated that varieties of around 50 crops, mainly vegetables, had been developed and were marketed by private breeding companies in the Netherlands in 2019. The focus of plant breeding has extended to sustainability. Some commercial breeding companies focus specifically on the breeding and sale of organic seeds, especially aimed at organic farmers and gardeners. Other breeding companies breed and sell conventional as well as organic seeds.
14. While breeding programmes in the Netherlands are typically carried out by private breeding companies, public organizations carry out more fundamental research contributing to breeding activities. The Plant Breeding group of Wageningen University & Research had various programmes in the period 2012-2019, with the crops researched including apple, *Brassica* spp., fibre hemp, miscanthus, quinoa, potatoes and tomatoes.
15. In the first reporting period (1 January 2012 - 30 June 2014), a total of 2748 plant varieties were admitted to the national list of varieties of agricultural and vegetable material of the Netherlands, while in the second reporting period (1 July 2014 - 31 December 2019), a total of 3690 varieties were admitted in the country.
16. At the end of the first reporting period (2014) as well as at the end of the second reporting period (2019), the five crops with the highest harvested area in the Netherlands were maize (*Zea mays*), potatoes (*Solanum tuberosum*), wheat (*Triticum aestivum*), sugar beet (*Beta vulgaris* subsp. *vulgaris*) and barley (*Hordeum vulgare*). From 2014 to 2019, the harvested area of maize and wheat decreased, while the harvested area of potatoes, sugar beet and barley increased.
17. Crops that have been introduced or reintroduced into commercial cultivation in the Netherlands in the past decade include Dyer's Rocket (*Reseda luteola*), lupins (*Lupinus* spp.), quinoa (*Chenopodium quinoa*), Russian dandelion (*Taraxacum kok-saghyz*), sorghum (*Sorghum bicolor*), soybeans (*Glycine max*), spelt (*Triticum spelta*) and yacon (*Smallanthus sonchifolius*). There is a small but growing trend that farmers or farmers' groups re-introduce ancient cereal crops or varieties for economic development, e.g. by the development of artisan niche products and rural recreation activities (e.g. the projects "Buijtenland van Rhoon" and "Natuurkokers Doornik"). Besides contributing to broadened crop diversity, these initiatives also support rare rural herb species.

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18. Wageningen University & Research (WUR) studied new crops (e.g. soya bean) as well as 'forgotten' crops for which there is renewed interest, often in collaboration with partners from the business sector. WUR also provided advice to farmers and vegetable producers looking to introduce new crops, e.g. on cultivation, storage and processing. The Louis Bolk Institute has been investigating the possibilities for agroforestry in the Netherlands and participated in an EU-project, aimed at increasing diversity in crop production and food supply, and development and availability of organic propagation material. A range of different crops were addressed, including traditional wheat varieties (such as einkorn, emmer and rivet wheat), Andean lupin and different varieties of broccoli and tomato.
 19. The Louis Bolk Institute coordinated a programme aimed at breeding new disease resistant potato varieties for the organic sector, working closely together with Wageningen University & Research (WUR), commercial breeders and farmer-breeders.
 20. The foundation 'De Oerakker' distributes old varieties. With support of CGN, 'De Oerakker' started the 'Heritage seeds project', which focusses on the description, multiplication, and marketing of Dutch crop biocultural heritage. In the project, seeds of heritage varieties (such as the old bitter Brussels sprouts, tomato, pea, bean and wheat) are multiplied and made better available to the public for cultivation and consumption. The Orange List of Dutch bio-cultural heritage contains agricultural and horticultural varieties that were grown in the period from 1850 until the Second World War. Of the varieties listed by the 'Heritage seeds project' and in the Orange List, about 1000 are still commercially available, and the lists indicate where they can be acquired. The 'Zaadgoed' foundation supports farmer and community based plant breeding and the conservation of traditional varieties for organic agriculture.

Building Sustainable Institutional and Human Capacities

21. The national policy on PGRFA outlined in the 'Sources of Existence' policy document (Ministry of Agriculture, Nature Management and Fisheries, 2002) remained applicable. CGN has remained the national entity functioning as a coordination mechanism for PGRFA activities and/or strategies, with CGN not only holding the national genebank, but also being involved in activities related to on-farm conservation, crop wild relatives and genetic resources policies.
22. The Nagoya Protocol (Implementation) Act of the Netherlands, a national law to implement EU Regulation 511/2014 (which regulates the compliance aspects of the Nagoya Protocol across the EU) in the Netherlands came into force on 23 April 2016. The explanatory memorandum accompanying the law states that no specific rules governing access to genetic resources occurring *in situ* in the Netherlands will apply.
23. The Netherlands remained a member of the European Collaborative Programme on Plant Genetic Resources (ECPGR), a regional network in which almost all European countries are participating. In this period, the country has continued to actively contribute to the functioning of the network. From 2013 to 2016, CGN participated in the EU-funded TRAF00N ('Traditional food network to improve the transfer of knowledge for innovation') project (www.trafoon.org), which brought together researchers, knowledge transfer agents and SME associations from 14 European countries, with the aim of fostering the transfer of sustainable innovation and entrepreneurship in the traditional foods sector for the benefit of European consumers. From 2013 to 2019, CGN was involved in two complementary 'preparatory actions' commissioned by the European Commission, aimed at improved networking among those involved in the conservation of genetic resources in agriculture and to tap their economic potential. CGN was also active in GenRes Bridge project, which started in 2019, and resulted in an overarching Genetic Resources Strategy for Europe, which was launched in November 2021.
24. Information on *ex situ* conserved material held in the national genebank collection of CGN has remained publicly available through the CGN website, and CGN contributed information to various publicly accessible international PGRFA information systems: EURISCO, Genesys and the ECPGR Central Crop Databases. As for *in situ* and on-farm conservation, much more information on crop wild relatives and traditional varieties has become publicly available. Both the Orange List of Dutch bio-cultural heritage and the CWRnl website have been developed and have become publicly available on the internet.

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25. Education and training on PGRFA conservation and use are well developed in the Netherlands. Wageningen University & Research (WUR) offers a Dutch-language BSc programme in Plant Sciences, and English-language MSc programmes in Plant Sciences and Organic Agriculture. WUR also offers an online (distance learning) MSc Plant Breeding programme as well as tailor-made plant courses for professionals. Various Universities of Applied Sciences offer BSc programmes relevant to PGRFA.
26. Public awareness of the importance of PGRFA is promoted and strengthened by various organizations. CGN has followed a two-pronged approach by targeting regular education (from primary schools to dedicated agricultural education) as well as a wider interested public. 'De Oerakker' has been active in awareness-raising. Various NGOs and farmers/gardeners in the Netherlands regularly organize field days so as to reach out to a wider public and to distribute seed and planting material.

References

- Bakker, T., Dijkxhoorn, Y. & van Galen, M.A. (2011). Uitgangsmaterialen. Motor voor export en innovatie. LEI-publicatie 11-091. Landbouw Economisch Instituut (LEI), Wageningen UR. 23 pp.
- Brink, M. (2015). Country Report for The State of the World's Biodiversity for Food and Agriculture – The Netherlands. Centre for Genetic Resources, the Netherlands (CGN), Wageningen University & Research Centre (WUR), Wageningen, the Netherlands. pp. 92.
- Brink, M. & van Hintum, T. (2020). Genebank Operation in the Arena of Access and Benefit-Sharing Policies. *Frontiers in Plant Science* 10:1712. doi: 10.3389/fpls.2019.01712
- CBS (2022). Statline [<https://opendata.cbs.nl/statline/#/CBS/nl/>]. Centraal Bureau voor de Statistiek (CBS), the Hague, the Netherlands.
- CBS, PBL, RIVM & WUR (2022). Compendium voor de leefomgeving [www.compendiumvoordeleefomgeving.nl]. Centraal Bureau voor de Statistiek (CBS), Den Haag, Planbureau voor de Leefomgeving (PBL), Den Haag/Bilthoven, Rijksinstituut voor Volksgezondheid en Milieu (RIVM) en Wageningen University & Research (WUR), Wageningen, the Netherlands.
- Eurostat (2021). Organic farming area in the EU up 46% since 2012. *Eurostat News* 27/01/2021. [<https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210127-1>]
- Eurostat (2022). Eurostat Data Browser [<https://ec.europa.eu/eurostat/en/>]
- FAO (1998). The State of the World's Plant Genetic Resources for Food and Agriculture. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. 510 pp.
- FAO (2010). The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. 370 pp.
- Jukema, G.D., Ramaekers, P. & Berkhout, P. (2020). De Nederlandse agrarische sector in internationaal verband. Wageningen/Heerlen/Den Haag, Wageningen Economic Research and Centraal Bureau voor de Statistiek, Rapport 2020-001. 172 pp.
- KPMG (2019). Dutch seed breeding. Architects of global sustainable food supply. KPMG, the Netherlands. 23 pp.
- Ministry of Agriculture, Nature Management and Fisheries, 1995. The Netherlands: Country Report to the FAO International Technical Conference on Plant Genetic Resources (Leipzig, 1996). Ministry of Agriculture, Nature Management and Fisheries, the Hague, the Netherlands. 39 pp.
- Ministry of Agriculture, Nature Management and Fisheries (2002). Sources of Existence: conservation and the sustainable use of genetic diversity. Ministry of Agriculture, Nature Management and Fisheries, the Hague, the Netherlands. 48 pp.
- Pascoe, R. (2022). What's all the fuss about nitrogen in the Netherlands? *DutchNews.nl*, 5 June 2022 [<https://www.dutchnews.nl/features/2022/06/whats-all-the-fuss-about-nitrogen-in-the-netherlands/>].
- Raad voor plantenrassen (2021). Nederlands Rassenregister [<https://nederlandsrassenregister.nl/>]. Raad voor plantenrassen, Roelofarendsveen, the Netherlands.

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- Schaminée, J.H.J. & van Rooijen, N.M. (2022). Het heft in eigen hand. Een verkenning naar wettelijke verplichtingen voor het behoud van botanische biodiversiteit in ons land die voortkomen uit internationale verdragen. Wot-technical report 225. Wageningen Environmental Research, Wageningen, the Netherlands. 42 pp. doi 10.18174/571721.
- Schouten, H.J., Tikunov, Y., Verkerke, W., Finkers, R., Bovy, A., Bai, Y. & Visser, R.G.F. (2019). Breeding has Increased the Diversity of Cultivated Tomato in The Netherlands. *Frontiers in Plant Science* 10:1606. doi: 10.3389/fpls.2019.01606.
- Sparrius, L., Odé, B. & Beringen, R. (2014). Basisrapport Rode Lijst Vaatplanten volgens Nederlandse en IUCN-criteria. FLORON-rapport 57. 179 pp.
- Van Halm, I. (2022). The Dutch nitrogen crisis shows what happens when policymakers fail to step up. *Energy Monitor*, 16 August 2022 [<https://www.energymonitor.ai/policy/the-dutch-nitrogen-crisis-shows-what-happens-when-policymakers-fail-to-step-up>].
- Van Treuren, R., Hoekstra, R. & Van Hintum, T.J.L. (2017). Inventory and prioritization for the conservation of crop wild relatives in The Netherlands. *Biological Conservation* 216: 123-139. <https://doi.org/10.1016/j.biocon.2017.10.003>.
- Van Treuren, R., Hoekstra, R., Wehrens, R. & van Hintum, T. (2020). Effects of climate change on the distribution of crop wild relatives in the Netherlands in relation to conservation status and ecotope variation. *Global Ecology and Conservation* 23:e01054. <https://doi.org/10.1016/j.gecco.2020.e01054>.
- Visser, L. (2008). Second National Report on Plant Genetic Resources for Food and Agriculture. The Netherlands. Ministry of Agriculture, Nature Management and Food Quality, the Hague, the Netherlands. 56 pp.

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Wageningen University & Research
CGN Report 59

The mission of Wageningen University & Research is “To explore the potential of nature to improve the quality of life”. Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 7,200 employees (6,400 fte) and 13,200 students and over 150,000 participants to WUR’s Life Long Learning, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.

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