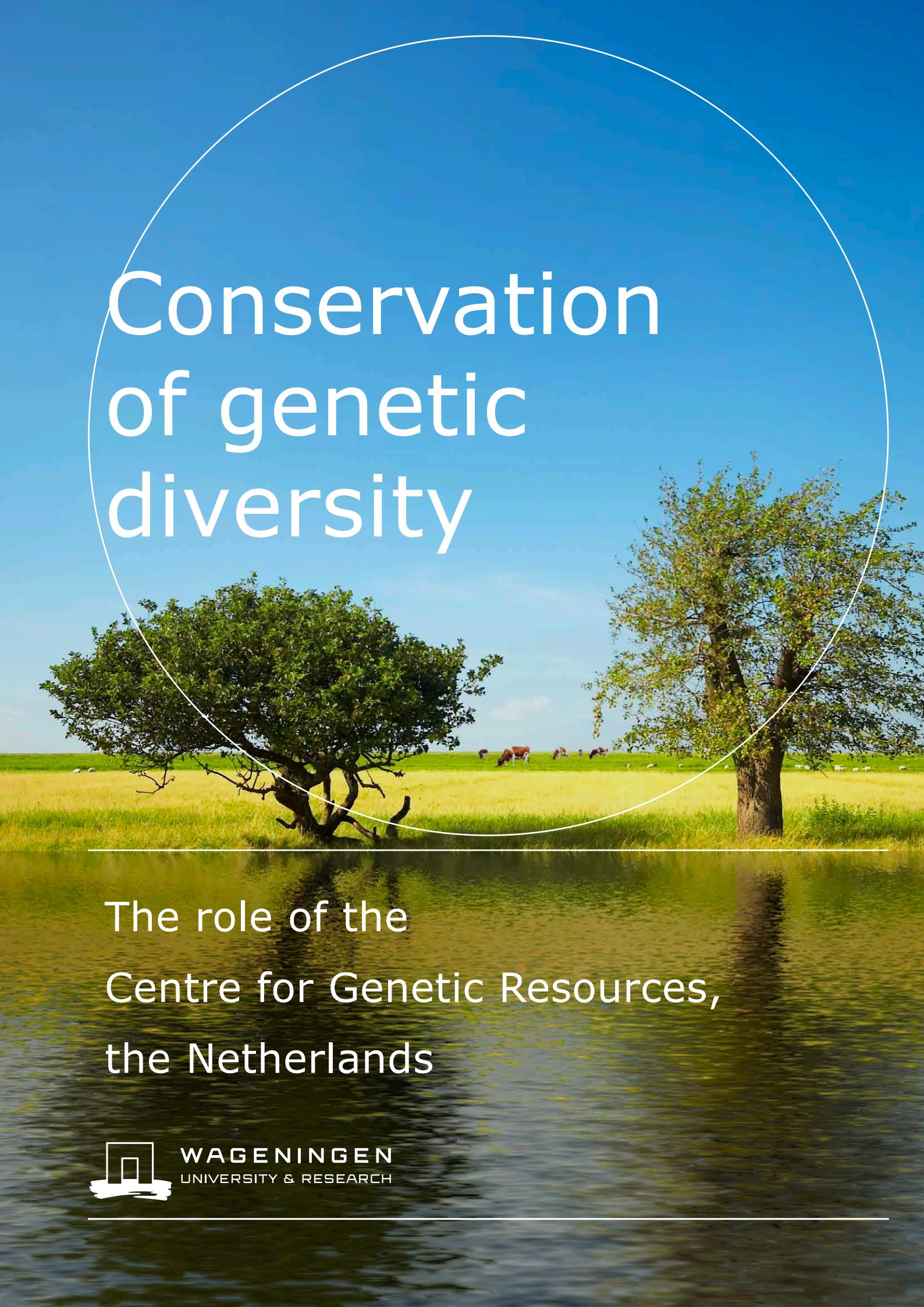

Conservation of genetic diversity

The role of the Centre for Genetic Resources, the Netherlands

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'Genetic resources' means material of plant, animal, microbial or other origin containing functional units of heredity that is of actual or potential value.

(Convention on Biological Diversity)

The aim of the Centre for Genetic Resources, the Netherlands (CGN), of Wageningen University & Research is to contribute to the long-term conservation of the genetic diversity of crops, farm animals and trees.

CGN maintains genetic diversity in gene bank collections (*ex situ*) and stimulates the sustainable valorisation of genetic diversity in agriculture and forestry. It works together with many different actors, such as breeders' organisations, networks of farmers, nature reserve managers and civil society organisations in order to better utilise and conserve genetic diversity.

CGN is an internationally recognised and leading centre of expertise. It has developed new methods, tools and knowledge that have contributed to making conservation and the utilisation of genetic diversity more effective and efficient.

In the future, CGN will continue to adopt and implement the latest modern technologies, such as DNA technology (genomics), seed storage technology, reproductive technologies and bio-informatics, in close partnership with its scientific partners.

Why are genetic resources important?

Genetic resources are required to provide sufficient food of good quality to feed the world's population. The continued development of efficient, adapted, resistant and environmentally friendly varieties and breeds will contribute to future global food security. The optimal use and exploitation of genetic diversity in crops and farm animals will result in more sustainable agriculture and could increase the diversity of human diets.

Maintaining a broad genetic base is important to anticipate future changes in climate, market or production systems. Breeding is impossible without genetic diversity. A broad genetic base is essential for the development of new and improved breeds and varieties in the future.

Breeds or varieties often have unique features which are particularly suited to certain agro-ecosystems: for instance, heath sheep are good at grazing on heathland. The loss of genetic diversity goes hand in hand with an impoverishment of our cultural heritage, nature, forest and landscapes. In addition to plant and animal genetic resources that provide us with food, forest genetic resources give us timber, shape our landscapes, enhance recreation and offer a range of wider environmental services.

Domestication and breeding

Thousands of years ago, useful wild plants and animals were selected by humans and subsequently improved, stored and exchanged. This development (i.e. domestication) permitted humans to gradually change from hunter gatherers to farmers. Genetic resources represent the basis of our resources in food, textiles, timber and herbal medicines, and provide us with draught animals.

The Poultry Seller (De vogelverkoper), Gabriël Metsu, 1662. Dresden, Staatliche Kunstsammlungen, Gemäldegalerie. Photo: Hans Peter Klut.

Over time, farmers developed improved knowledge about the properties of their crops and farm animals, learning how to utilise them for food and other purposes. Farmers continued to shape crops and farm animals until the 20th century, when specialised breeders partially took over this role.

Genetic resources: valuable and vulnerable

Above: Groningen Whiteheaded (Groninger Blaarkop), one of the unique, threatened Dutch cattle breeds, also sometimes called the 'polder panda' (www.szh.nl). Photo: Veeteelt.
Left: Good-King-Henry (de Brave Hendrik), a less popular precursor of spinach: a typical 'forgotten vegetable'.

Genetic resources have an economic value and a value to society. Modern agriculture and globalisation have led to more genetically uniform varieties and breeds in the fields, and to increased uniformity of human diets at a global level.
In many parts of the world, a relatively small number of high-yielding, uniform crop varieties and animal breeds have largely replaced the many landraces and local animal breeds that were a feature of earlier times. Many local breeds and varieties and their wild relatives are at risk of disappearing.

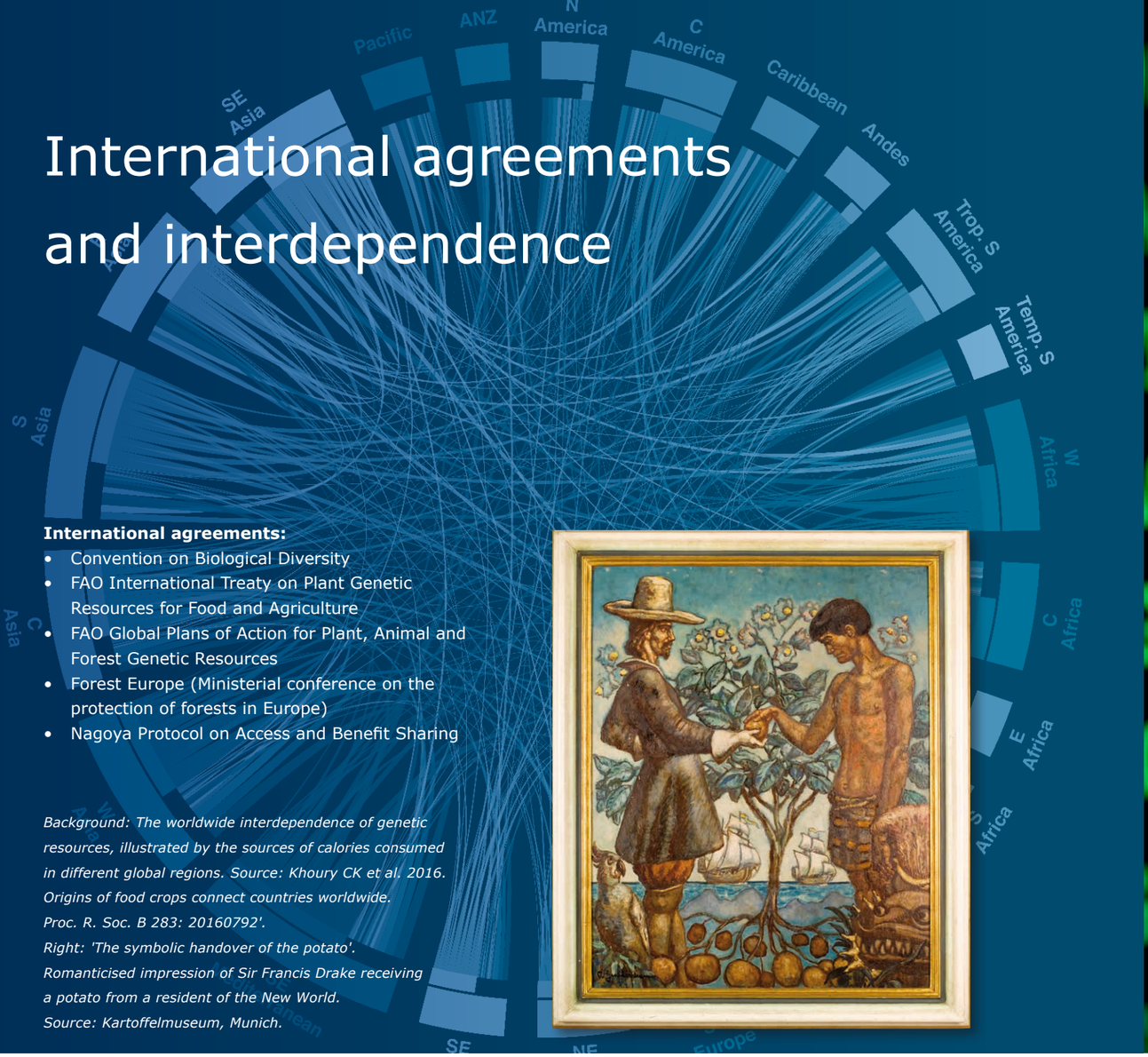
Gene banks (*ex situ* conservation) store seeds, semen and other reproductive material, which is crucial for the long-term conservation of genetic diversity. Maintaining breeds and varieties *in situ*/on farms also contributes to the conservation of genetic diversity.

Development of regional food products or promotion of the use of rare breeds in nature management are relevant strategies that support the *in situ* conservation of genetic diversity. Moreover, visible genetic diversity in crops, farm animals and forests *in situ* or on farms will contribute to increased awareness in society at large of the value of agro-biodiversity. *Ex situ* and *in situ* conservation are complementary strategies for preventing genetic erosion.

Enhanced use of genetic diversity is needed for the development of new, improved and adapted breeds and varieties, and will contribute to innovation in agriculture and global food security. Genetic resources could be essential for responding to new diseases and creating more sustainable production systems.
Moreover, climate change will increasingly force farmers and breeders to adapt their breeds and varieties to changing circumstances even more quickly.

Above: Large-scale cultivation of one variety of wheat in North America.
Below: Specialised, large-scale production of uniform breeds and varieties goes hand in hand with more uniformity in the human diet.

International agreements and interdependence



International agreements:

- Convention on Biological Diversity
- FAO International Treaty on Plant Genetic Resources for Food and Agriculture
- FAO Global Plans of Action for Plant, Animal and Forest Genetic Resources
- Forest Europe (Ministerial conference on the protection of forests in Europe)
- Nagoya Protocol on Access and Benefit Sharing

Background: The worldwide interdependence of genetic resources, illustrated by the sources of calories consumed in different global regions. Source: Khoury CK et al. 2016. Origins of food crops connect countries worldwide. Proc. R. Soc. B 283: 20160792'.
Right: 'The symbolic handover of the potato'. Romanticised impression of Sir Francis Drake receiving a potato from a resident of the New World. Source: Kartoffelmuseum, Munich.

The government of the Netherlands has ratified a number of international agreements related to the conservation and sustainable use of genetic resources (and biodiversity in a wider sense). The aim to conserve and sustainably use genetic diversity in crops, farm animals and trees is of importance to Dutch society and the implementation of international agreements is a government responsibility. CGN supports the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) in implementing and further development of those international agreements.

CGN also acts as the National Focal Point (NFP) for the purposes of Access and Benefit Sharing (ABS) of genetic material. The NFP provides information on this topic to relevant stakeholders and raises awareness among users of genetic resources (www.absfocalpoint.nl).

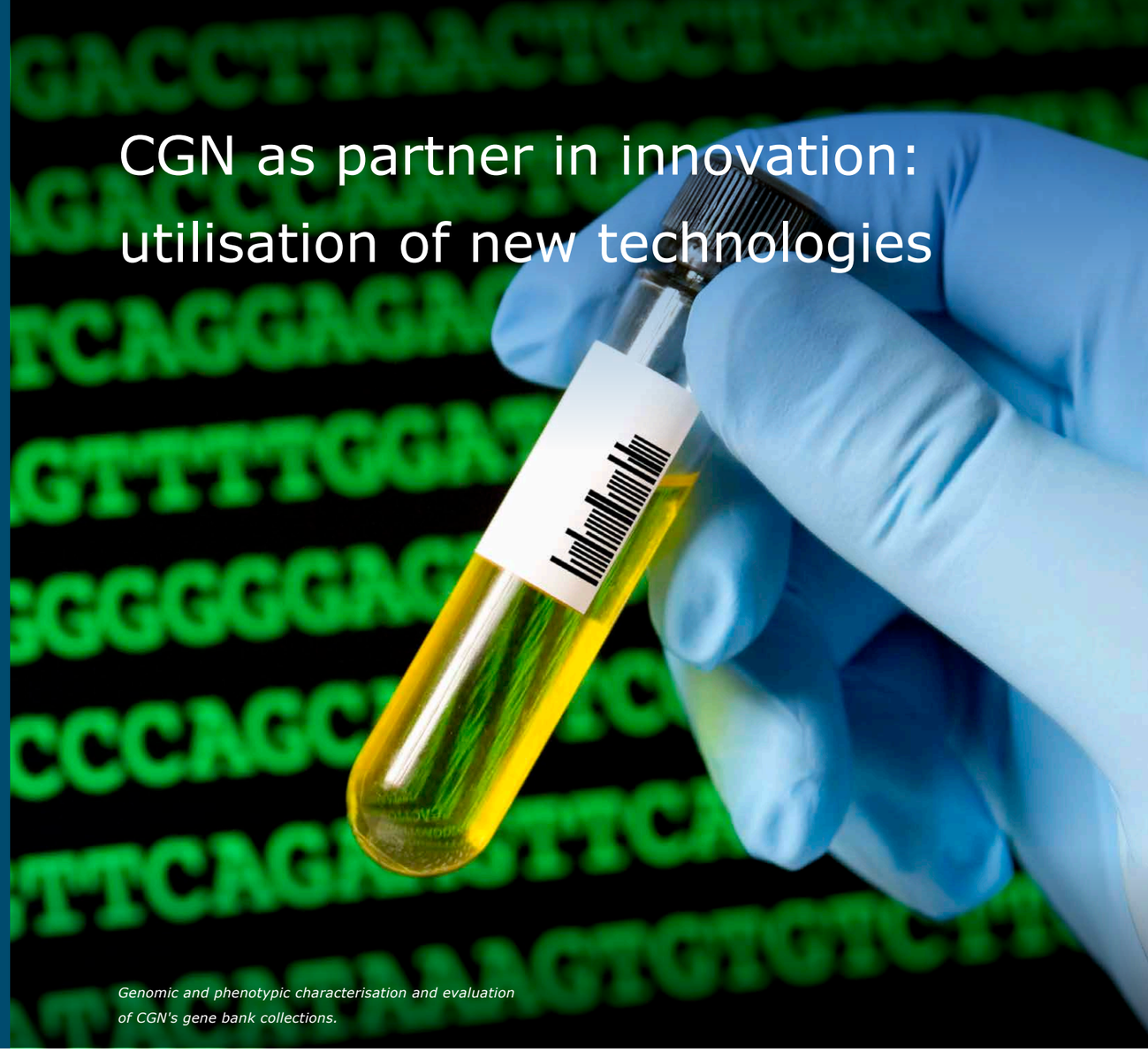
CGN actively participates in the European plant, animal and forest genetic resources networks (respectively ECPGR, ERFP and EUFORGEN). These networks aim to coordinate activities on a European level in the domains of plant, animal and forest genetic resources.

Convention on Biological Diversity

The International Treaty on Plant Genetic Resources for Food and Agriculture

Forest Europe growing life

CGN as partner in innovation: utilisation of new technologies

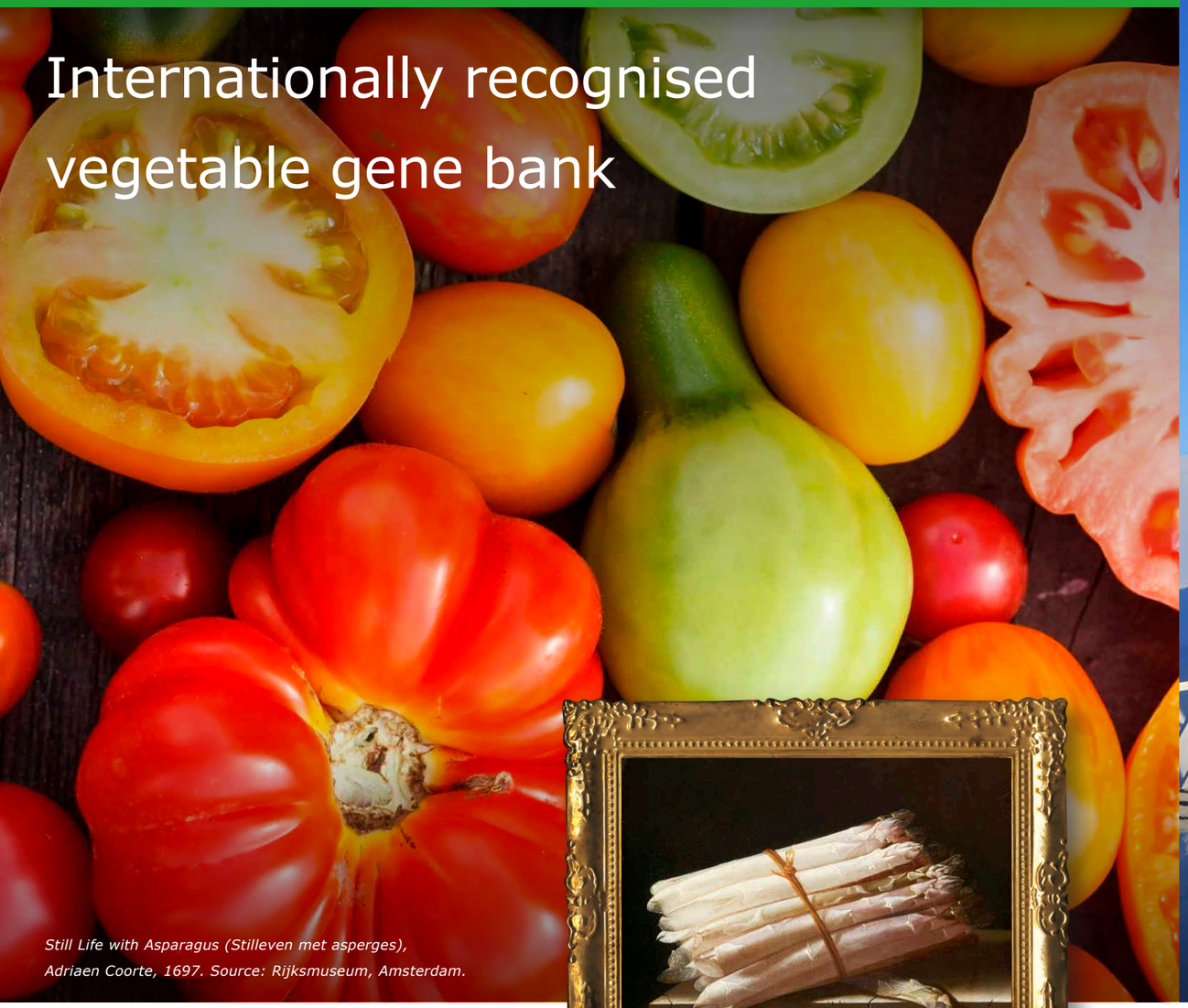


Genomic and phenotypic characterisation and evaluation of CGN's gene bank collections.

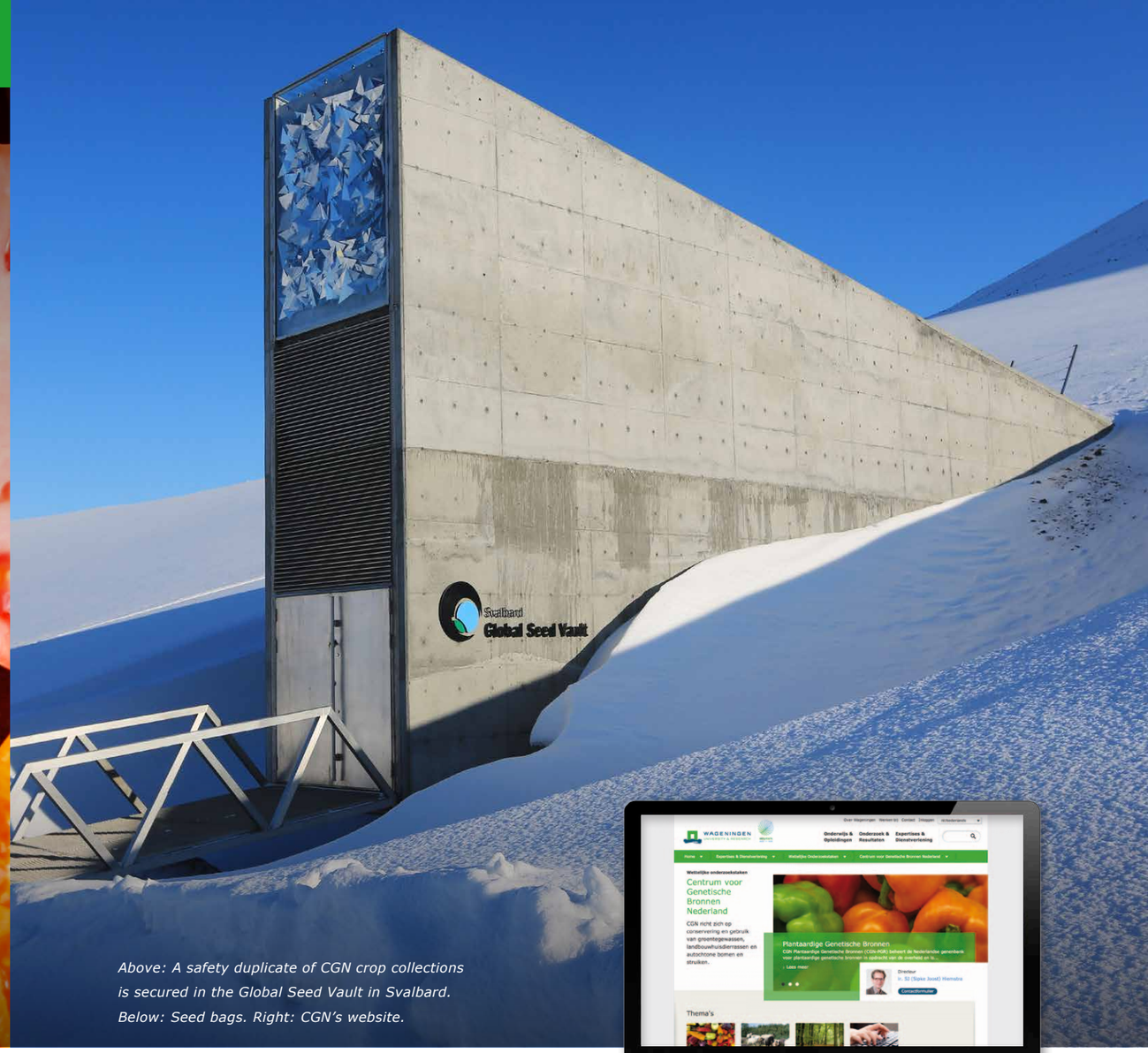
The characterisation and description of gene bank collections and breeding populations is a prerequisite to optimising the utilisation of available genetic diversity. Technological developments, in particular DNA technology (genomics), provide opportunities to better characterise and understand genetic diversity in crops, farm animals and trees.

CGN works with partner scientists and industry to characterise and evaluate its gene bank collections genetically and phenotypically. The generated data is highly relevant for those who rely on genetic diversity in breeding or research. Moreover, CGN contributes to further methodological development so as to facilitate the valorisation of genetic diversity, support the maintenance of genetic diversity in live populations, and make better use of the data for optimising gene bank collections. CGN's ambition is to fully anticipate revolutionary developments in genomics and bioinformatics. In the future, the use of digital data associated with gene bank collections may become even more important than the physical gene bank collections themselves. Besides being an internationally recognised gene bank with valuable physical collections, CGN will also develop as a 'digital gene bank' in the future.

Internationally recognised vegetable gene bank



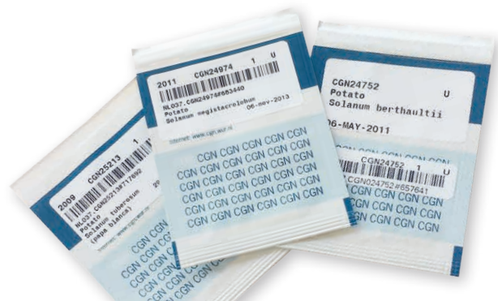
Still Life with Asparagus (Stilleven met asperges), Adriaen Coorte, 1697. Source: Rijksmuseum, Amsterdam.



Above: A safety duplicate of CGN crop collections is secured in the Global Seed Vault in Svalbard. Below: Seed bags. Right: CGN's website.

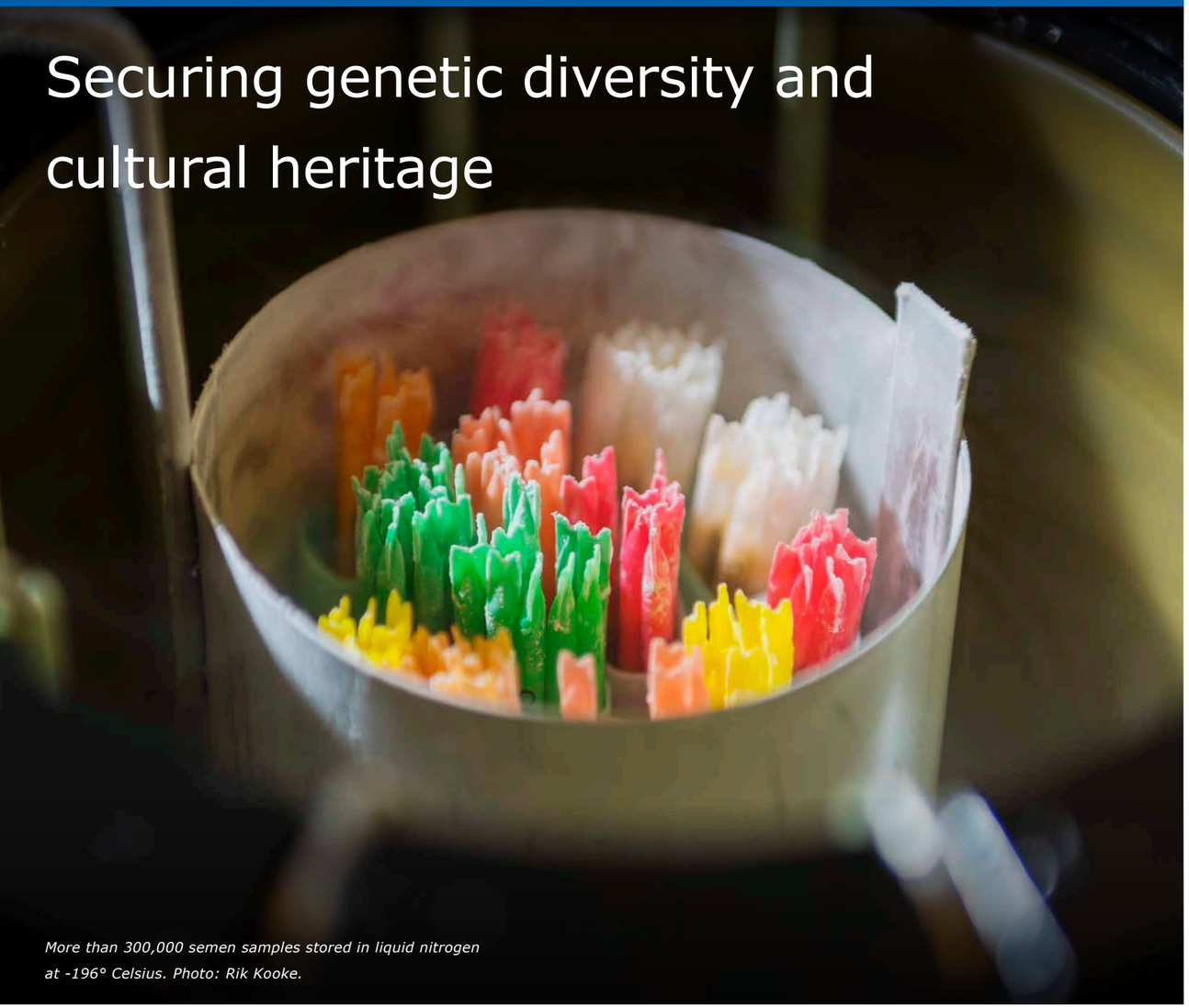
As the majority of Dutch crop breeding is devoted to horticulture, CGN focuses primarily on vegetable crops. In addition to the genetic resources of major vegetables such as lettuce, tomato, cabbage and onion, the collections also include less common species such as asparagus and salsify.
While the breeding industry and research are the main clients of CGN, the centre also supports Dutch farmers, gardeners, breeders and hobbyists interested in working with traditional crop diversity.

Currently, CGN holds approximately 23,000 accessions belonging to over 30 different crops. Collections include commercial varieties, landraces and farmers' varieties, and wild crop relatives, originating from more than 100 countries. Genetic materials are carefully selected for inclusion in the collections, accurately described, optimally stored, and evaluated for useful traits in close partnership with breeders.



Information about the background and properties of the materials is collected, verified and stored in the CGN databases. A well-managed website allows online searches in the databases and includes an electronic ordering system that further facilitates the use of the collections. Materials are distributed across the world under the Standard Material Transfer Agreement of the International Treaty on Plant Genetic Resources for Food and Agriculture (SMTA). CGN distributed more than 6,000 samples to users annually from 2013 to 2017.

Securing genetic diversity and cultural heritage



More than 300,000 semen samples stored in liquid nitrogen at -196° Celsius. Photo: Rik Kooke.

The gene bank for farm animals consists of genetic material (mainly semen) of more than 100 breeds/ lines of different species. The main focus of CGN is on the farm animal species which have the most relevance for food production, and for which the Netherlands is recognised as a leading breeding country: cattle, sheep, goats, pigs and chickens. In addition, CGN supports the conservation of diversity in other livestock species which belong to our living cultural heritage: horses, ducks, geese, dogs, pigeons and rabbits.

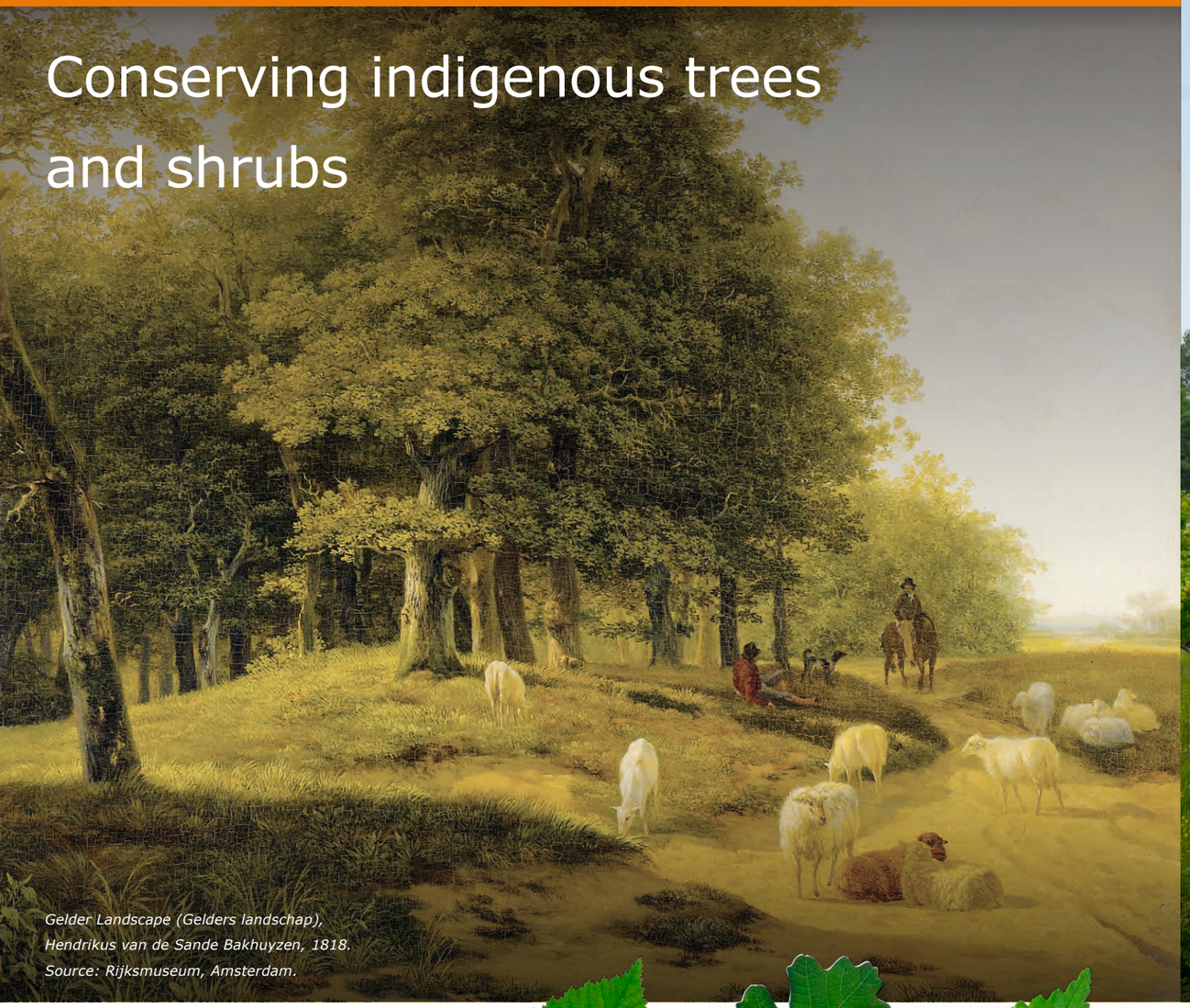
The main focus of the gene bank is on securing rare Dutch domestic animal breeds. In addition, CGN also supports the Dutch breeding industry and mainstream breed societies by cryopreserving a genetic backup of their breeding populations.

CGN stores more than 300,000 insemination doses of semen in liquid nitrogen containers at (-196° Celsius). The centre has implemented specific, optimised cryopreservation protocols for each species in order to guarantee successful future use of the genetic material.

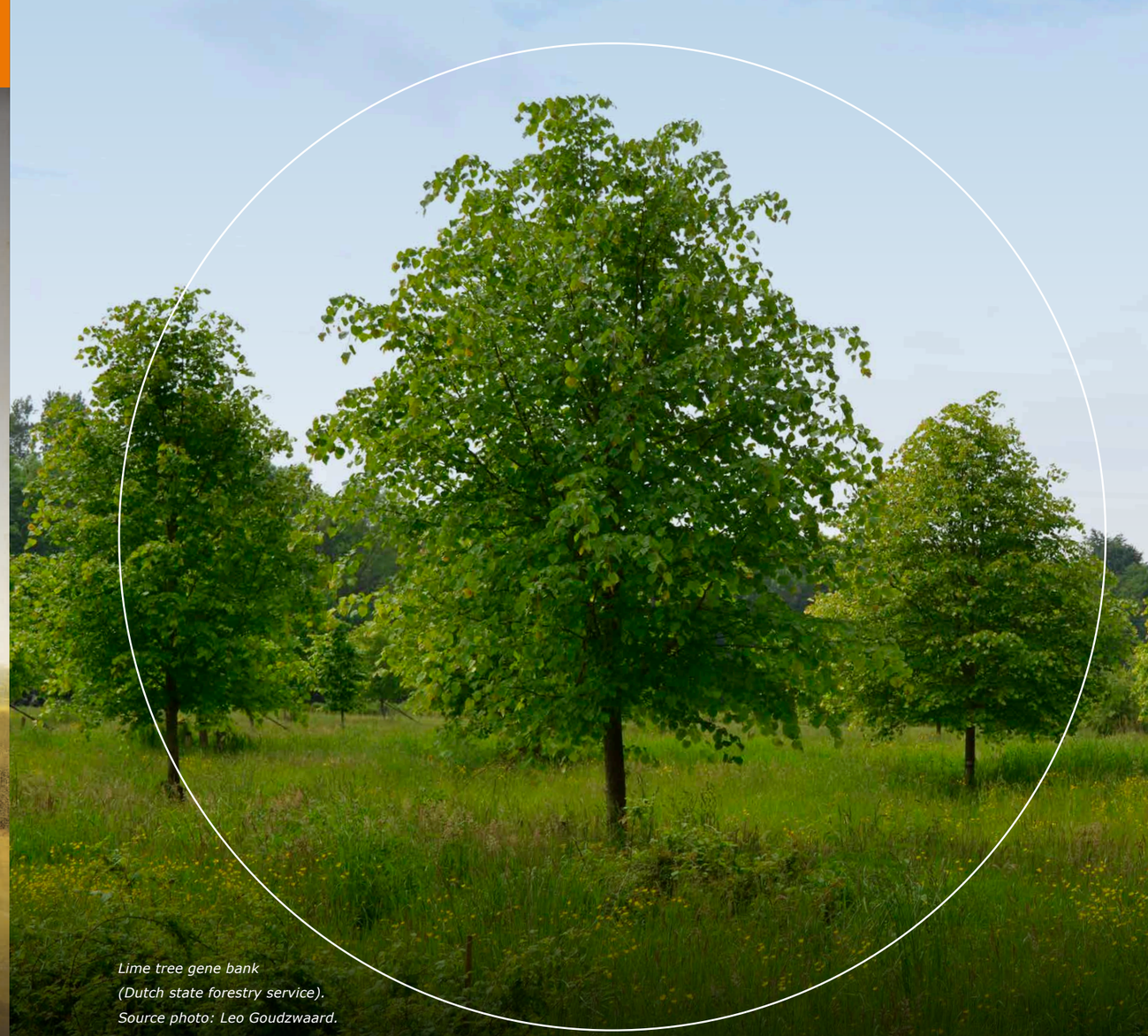
CGN works closely with the Dutch Rare Breed Survival Trust (SZH) and with a range of breed societies, breeding organisations and other stakeholders. In partnership with various stakeholders, CGN will further develop and implement strategies to improve the conservation of farm animal breeds both *in situ* and *ex situ*. Besides the further development and maintenance of gene bank collections, CGN gives advice to breed societies to support the development of their breeding programmes and the maintenance of genetic diversity within breeds.

CGN also further characterises gene bank collections and live breeding populations phenotypically and genetically, making optimal use of DNA technology. The centre keeps track of the status and trends for all breeds in the Netherlands. Breed information is uploaded to the European and global (FAO) databases.

Conserving indigenous trees and shrubs



Gelder Landscape (Gelders landschap), Hendrikus van de Sande Bakhuyzen, 1818. Source: Rijksmuseum, Amsterdam.



Lime tree gene bank (Dutch state forestry service). Source photo: Leo Goudzwaard.

Trees that naturally occur in Dutch ecosystems have evolved to adapt to local climatic conditions. Many indigenous trees and shrubs in the Netherlands have become rare, however, due to the use of poorly adapted genetic materials from abroad.

From left to right: leaf of the hornbeam, oak, elm, black alder, field maple and the leaved lime.

The Staatsbosbeheer (Dutch state forestry service) has established a field gene bank (*ex situ* and *in vivo*) of indigenous trees and shrubs, bringing together over 60 different species in more than 5,000 accessions. CGN gives advice on the maintenance of these Dutch gene bank collections for indigenous trees and shrubs, and also manages the database and website describing the accessions incorporated in the gene bank.

CGN monitors *in situ* populations in the Netherlands and has designated national gene conservation units for several species, which are also part of a pan-European strategy for the genetic conservation of forest trees.

Most forest species take a long time to grow, mature and produce progeny. Sustainable forest management therefore requires that well-adapted genetic material be chosen and used when new trees and shrubs are planted.

CGN informs target groups via the five-yearly *Rassenlijst Bomen* (list of recommended varieties and provenances of trees). The centre gives advice to users on the most suitable reproductive material for trees, based on its research into Value for Cultivation and Use (VCU). This research focuses on how well forest genetic resources adapt to Dutch environments, as reflected by their growth capacity, timber quality, health and level of genetic diversity.

CGN

The Centre for Genetic Resources, the Netherlands (CGN), carries out Statutory Research Tasks (WOT) for the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) in the domain of conservation and promotion of the sustainable use of plant, animal and forest genetic resources. This is based on the recognition that genetic resources have a current and future value for food production, agriculture and forestry.

The mission of Wageningen University & Research (WUR) is 'to explore the potential of nature to improve the quality of life'. A staff of 6,500 and 10,000 students from over 100 countries work for WUR all around the world in the domain of healthy food and the living environment for governments and the business community at large.

WUR's strength lies in its ability to join forces with specialised research institutes, as well as in its combination of efforts in a range of natural and social sciences. This union of expertise leads to scientific breakthroughs that can quickly be put into practice and incorporated in education. The scientific quality of WUR’s activities is confirmed by the prominent position it occupies in international rankings and citation indexes.

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