Management of agricultural genetic resources

An institutional analysis of trends in the Netherlands

LEI
WAGENINGEN UR

Management of agricultural genetic resources

An institutional analysis of trends in the Netherlands

D. Eaton
L. Aramyan

July 2009
Report 2009-058
Project code 21160
LEI Wageningen UR, The Hague

LEI Wageningen UR conducts research in the following areas:

- International policy
- Development issues
- Consumers and supply chains
- Sectors and enterprises
- Environment, nature and landscape
- Rural economy and use of space

This report is part of the research area Sectors and enterprises.

This research has been carried out within Policy-Supporting Research (BO-07-010) within the framework of programmes for the Dutch Ministry of Agriculture, Nature and Food Quality.

Photo: Guy Ackermans

Management of agricultural genetic resources; An institutional analysis of trends in the Netherlands

Eaton, D. and L. Aramya

Report 2009-058
ISBN/EAN: 978-90-8615-338-1
Price € 23,50 (including 6% VAT)
118 pp., fig., tab., app.

This report analyses the developments in the institutional environment of the statutory research tasks for conservation and use of agricultural genetic resources (WOT-GB) in the Netherlands. Attention focuses on the period since 2002, when the Netherlands Ministry of Agriculture, Nature Management and Food Quality (LNV) adopted its policy document, *Sources of Existence*, and likely future developments are described. A number of key stakeholders in the sector were interviewed in order to identify the relevant developments and their implications for the agreement on statutory research tasks between LNV and the Centre for Genetic Resources, the Netherlands (CGN) of Wageningen University and Research Centre.

In dit rapport worden de ontwikkelingen geanalyseerd in de institutionele omgeving van de wettelijke onderzoekstaken voor het behoud en gebruik van genetische bronnen voor de landbouw (WOT-GB) in Nederland. Het rapport is vooral gericht op de periode vanaf 2002, het jaar waarin het ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV) het beleidsdocument *Bronnen van ons bestaan* heeft aangenomen. Daarnaast worden mogelijke toekomstige ontwikkelingen beschreven. Er zijn een aantal belangrijke stakeholders in de sector ondervraagd om te bepalen welke ontwikkelingen relevant zijn en wat daarvan de gevolgen zijn voor de overeenkomst met betrekking tot wettelijke onderzoekstaken tussen het ministerie van LNV en het Centrum voor Genetische Bronnen Nederland (CGN) van Wageningen Universiteit en Researchcentrum.

Orders
+31.70-3358330
publicatie.lei@wur.nl

LEI is ISO 9000 certified.

Contents

Preface

Genetic resources constitute one of the basic building blocks of our agricultural systems, in both crop and livestock production. Farmers depend on the availability of high-quality genetic material, which flows right through to consumers who enjoy an expanding diversity of food goods. The diversity of genes that supports these benefits is less visible. But without them, meeting the continuous challenges posed by nature, or those that we have unwittingly created for ourselves, would be almost impossible. This is a principal reason for the existence in the Netherlands of the agreement between the Ministry of Agriculture, Nature and Food Quality (LNV) and the Agricultural Research Service (DLO) concerning the execution of statutory research tasks with respect to genetic resources, referred to here by its Dutch acronym, WOT-GB.

With the ending of the first WOT-GB agreement, LNV requested LEI to undertake an analysis of recent trends in the conservation and use of agricultural genetic resources, and to identify implications for a second agreement. Such an assignment is both interesting and relevant for LEI, which also implements a separate WOT agreement. This report identifies a number of relevant trends and highlights the challenges they pose for policy. A central message is the continued broadening of both the scientific and policy agenda concerning agricultural genetic resources, meaning that in a world of scarce public resources, choices will only become more difficult and contested. As pointed out by the authors here, increased attention to the design of governance systems is warranted.

LEI would like to acknowledge the time contributed by all of the stakeholders who agreed to be interviewed for this study, some of whom requested anonymity. In addition, the suggestions and review comments provided by Dr Jos Bijman of the Management Studies Group within the Social Sciences Group (SSG) of Wageningen UR were extremely useful. The authors also wish to thank Paul Thewissen, Hugo Lieffijn and Peter Voskuil of LNV-DK for their patience and positive encouragement.

This study was financed with a contribution from LNV made through the Functional Agrobiodiversity theme of the Sustainable Production and Transition cluster of policy support research (Project BO-07-010-801).

Prof. Dr R.B.M. Huirne
Director General LEI Wageningen UR

Summary

Genetic resources are one of the basic building blocks of agricultural systems. Ongoing development of a sustainable bioeconomy will depend on innovations that make use of, and indeed build on, the genetic code of life. This implies judiciously conserving and wisely managing the world's stock of agricultural genetic resources.

The use of genetic resources in agriculture continues to evolve quickly. Two driving forces can be identified: globalisation and technology. New plant varieties and especially animal breeds are increasingly developing global market shares. The developments in genomics and proteomics are rapidly revealing new possibilities, in both technical and economic terms. Such economic and technological developments have consequences for how the conservation and use of genetic resources is organised.

The conservation of genetic resources in the Netherlands is addressed by a special programme of statutory research tasks (WOT-GB). A first contractual agreement between the Netherlands Ministry of Agriculture, Nature Management and Food Quality (LNV) and the Agricultural Research Service (Stichting DLO) of the Wageningen University and Research Centre (Wageningen UR) came into force in 2004 and is being reviewed for a second five-year period. The tasks agreed upon in this contract are undertaken by the Centre for Genetic Resources, the Netherlands (CGN) of DLO.

This report analyses the developments in the institutional environment of the WOT-GB and attempts to answer the following questions:

1. What has changed in the institutional environment associated with the government policy document *Sources of Existence* since 2002 and what developments can be expected in the coming five years?
2. What are the implications of these changes for the choice of activities to be included in a subsequent statutory tasks agreement, given the general role of the government?

Public policies and the regulation of agricultural genetic resources

The economic case for public involvement in the management of genetic resources is based on the argument that the benefits provided by these resources are to a large extent public goods. Despite the efforts of farmers, companies, and non-governmental organisations, often acting on a voluntary basis, it cannot

be expected that this will lead to sufficient conservation and use of these critical resources.

There are though clear differences in the public good nature of genetic resources between the crop, livestock and forestry sectors. This has resulted in different institutional structures governing their use. Forest and crop genetic resources have less potential for users or breeders to develop profitable exclusive rights, which led to the creation of various intellectual property right (IPR) systems. These institutional structures include a variety of international agreements.

International agreements

The international exchange and use of agricultural genetic resources is actually influenced directly or indirectly by a wide range of international agreements spanning the domains of trade, intellectual property rights and biodiversity. The WOT-GB represents in part the implementation of the Netherlands' commitments under the Convention on Biological Diversity and the more recently concluded International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA). Ongoing uncertainty in many areas, including in the details of implementing some of these agreements, is a major characteristic of the institutional environment.

The implications of all these negotiations and agreements for stakeholders in the Netherlands provides a logical rationale for the relatively high degree of engagement and participation by the Government of the Netherlands in international discussions. CGN provides LNV with considerable policy support under the WOT-GB for these purposes, given this WOT agreement a mixed character. This can be justified by the fact that technical expertise in the area of genetic resources is concentrated among a limited number of individuals. This may pose challenges however for the the allocation of financial resources between the provision of such expertise and the provision of public goods through conservation and management of genetic resources.

Situation in selected other countries

It is relevant for policy purposes to understand how the Netherlands compares to other countries in both the manner in which public support is provided to the conservation and use of agricultural resources, as well as its extent. Although, there is verly little information available concerning the financial resources allocated by individual countries to this area, there is certainly a diversity of institutional arrangements.

In terms of sheer size of *ex situ* germplasm collections, the Netherlands does not figure among the global top players. This is not meant to imply that a larger collection is necessarily better or more valuable. It is nonetheless interesting to observe that a country that accounts for one of the largest shares of exports of seeds and planting material (the result of genetic improvement programmes), itself has a rather modest *ex situ* germplasm collection.

Actors involved in management of genetic resources and trends

A wide range of actors involvedin the conservation and use of agricultural genetic resources in the Netherlands can be identified. These include breeding companies, research and education organisations, NGOs, and other government and public sector organisations, all which interact and exchange information and/or genetic resources with CGN.

A number of trends affecting the use of plant genetic resources can be identified, based on published sources and also interviews of a select number of stakeholders:

- Continued concentration among commercial plant breeding companies;
- Developments in biotechnology (including the fields of genomics and proteomics) implying further decreases in costs of evaluating (and hence using) plant genetic resources;
- Ongoing broadening of scope of scientific attention and policy issues beyond primary concern in 1990s with agricultural plant breeding (tree and shrub species, other botanical species).

Interactions between animal breeding companies and CGN are fairly limited (in comparison to the plant sector) and consist of the provision to CGN of semen for conservation, and also the exchange of information. On the other hand, CGN has fairly intensive interactions with NGOs for whom CGN is a knowledge centre that provides information about rare and/or local livestock breeds.

Trends identified in the animal genetic resource sector include:

- Expansion in the *ex situ* collections of the Netherlands during the past five years, as planned under the WOT-GB workplan for the period 2004-2008;
- Continued globalisation and concentration of commercial animal breeding sector;
- Developments in biotechnology including genomic selection, cryopreservation of female embryos and enhanced use of DNA information; and

- Changes in market demand, including some increased use of some specific rare breeds in landscape and environmental conservation.

Implications for the WOT-GB

International Agreements
The policy support activities under the WOT-GB have likely made a significant contribution to the international institutional architecture for genetic resources. This has been most apparent for crop species falling under the IT-PGRFA. It appears that livestock species are unlikely to require the same amount of international policy attention. But a relevant question for the next WOT-GB is whether more resources should be allocated to other crop species.

Plant Genetic Resources
The availability of public collections of germplasm, by providing a source of 'genetic liquidity', may play a role in supporting vigorous competition in the breeding sector. At the same time though, the role of genebanks does seem to be shifting more towards one of long-term conservation. There seems to be an increasingly apparent distinction between germplasm that is conserved for its cultural-heritage value, and that which is valuable for current breeding efforts. This may mean that appropriate indicators for assessing the role of public genebanks should be reassessed.

Animal Genetic Resources
The growth in CGN's collections under the first WOT-GB implies the need for setting priorities in ongoing (proposed) expansion. In addition, technological developments imply the need for decisions on the extent to which female embryo preservation should also take place. The nature of the relationship between CGN *ex situ* collections and those of commercial breeders may also require review, given the pace of technological development.

One clear theme that emerges from the analysis of developments over the last five years, is a continuation of the broadening of actors and priority issues in the management and use of genetic resources. Thus a key challenge for LNV is establishing priorities among a limited budget for the WOT-GB, relative to possible claims. There is no simple calculus (such as cost-benefit analysis) for how to assign priorities for conservation efforts across species, breeds and varieties.

It may therefore be advisable to devote resources to improvements in the governance structure, concerning agricultural genetic resources. As mentioned above, this could also include more explicit attention to the nature of a coordinating role that could be included in the WOT-GB for the range of initiatives taking place. Almost all actors seem convinced that the importance of improved management of these resources for future challenges is under-appreciated, despite some of the recent broadening of interest and stakeholders noted above.

Indeed, there is a pro-active rationale to continued, and perhaps even strengthened government sponsorship of the management of genetic resources. Such a rationale is based on the benefits of maintaining instruments at government's disposal to be able to respond to current and future challenges in agricultural and food production. Such challenges are being posed already along a range of issues, including climate change, the need to reduce chemical use in crop production, renewed food security concerns and associated limits to expanding (or even maintaining) food and feed production, increased consumption globally of meat products, the potential risks of current levels of antibiotic use in intensive livestock production, to name but a few. It appears that the demands of society for adjustment in both crop and livestock systems only continue to grow, while the technological possibilities continue to be pushed.

Samenvatting

Institutionele analyse van het beheer van genetische bronnen voor de landbouw (WOT-GB)

Genetische bronnen zijn één van de belangrijkste bouwstenen van landbouwsystemen. De voortdurende ontwikkeling van een duurzame bio-economie is afhankelijk van innovaties die gebruikmaken van en gebouwd zijn op de genetische code van het leven. Dit houdt in dat verstandig moet worden omgegaan met het behoud en beheer van de wereldwijde voorraad van deze genetische bronnen.

Het gebruik van genetische bronnen in de landbouw is nog altijd volop in ontwikkeling. Er kunnen twee drijfveren worden vastgesteld: globalisering en technologie. Er ontstaan steeds meer wereldwijde marktaandelen voor nieuwe plantensoorten en vooral voor nieuwe dierenrassen. Nieuwe mogelijkheden op zowel technisch als economisch vlak volgen elkaar in hoog tempo op dankzij de ontwikkelingen op het gebied van genomica en proteomica. Dergelijke economische en technologische ontwikkelingen hebben gevolgen voor de manier waarop het behoud en gebruik van genetische bronnen wordt georganiseerd.

In Nederland is er een speciaal programma van wettelijke onderzoekstaken (WOT-GB) voor het behoud van genetische bronnen. In 2004 werd een eerste overeenkomst van kracht tussen het ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV) en de Stichting DLO van de Wageningen Universiteit en Researchcentrum (WUR). Deze overeenkomst wordt herzien voor een tweede periode van vijf jaar. De taken die in deze overeenkomst zijn vastgelegd, worden uitgevoerd door het Centrum voor Genetische Bronnen Nederland (CGN) van DLO.

In dit rapport worden de ontwikkelingen geanalyseerd in de institutionele omgeving van de WOT-GB en wordt geprobeerd een antwoord te vinden op de volgende vragen:

1. Wat is er sinds 2002 veranderd in de institutionele omgeving die verband houdt met het beleid *Bronnen van ons bestaan* en welke ontwikkelingen kunnen we in de komende vijf jaar verwachten?
2. Wat zijn de implicaties van deze veranderingen voor de activiteiten die worden opgenomen in een volgende overeenkomst over wettelijke taken, gezien de algemene rol van de overheid?

Openbaar beleid en het reguleren van genetische bronnen voor de landbouw

Dat het voor de overheid rendabel is, betrokken te zijn bij het beheer van genetische bronnen heeft te maken met het feit dat de voordelen die deze bronnen opleveren in grote mate publieke goederen zijn. Ondanks de vaak vrijwillige inspanningen van boeren, bedrijven en niet-gouvernementele organisaties kan niet worden verwacht dat deze essentiële bronnen hierdoor in voldoende mate worden behouden en gebruikt.

Genetische bronnen zijn echter niet altijd in dezelfde mate een publiek goed. Er zijn wat dat betreft duidelijke verschillen tussen landbouw, veeteelt en bosbouw, wat ertoe heeft geleid dat er verschillende institutionele structuren zijn om het gebruik te regelen. Genetische bronnen voor de bosbouw en de landbouw bieden gebruikers of telers minder mogelijkheden winstgevende exclusieve rechten te ontwikkelen, die hebben geleid tot het creëren van verschillende systemen voor intellectuele eigendomsrechten (IPR). De institutionele structuren omvatten diverse internationale overeenkomsten.

Internationale overeenkomsten

De internationale uitwisseling en het gebruik van genetische bronnen voor de landbouw worden direct en indirect beïnvloed door een groot aantal internationale overeenkomsten op het gebied van handel, intellectuele eigendomsrechten en biodiversiteit. De WOT-GB staat gedeeltelijk voor de implementatie van de toezeggingen van Nederland krachtens het Verdrag inzake de Biologische Diversiteit en het meer recentelijk gesloten Internationaal Verdrag inzake Plantaardige Genetische Hulpbronnen voor Voeding en Landbouw (IT-PGRFA). De voortdurende onzekerheid op veel gebieden, onder andere over de details voor het implementeren van enkele van deze overeenkomsten, is een belangrijk kenmerk van de institutionele omgeving.

De implicaties van al deze onderhandelingen en overeenkomsten voor stakeholders in Nederland zijn een logische grondreden voor de relatief grote inzet en deelname van de Nederlandse regering in internationale discussies. Het CGN biedt het ministerie van LNV onder de noemer WOT-GB veel beleidsondersteuning voor deze doelen, wat de WOT-overeenkomst een gemengd karakter geeft. De reden hiervoor is het feit dat er maar weinig mensen zijn die beschikken over de technische ervaring op het gebied van genetische bronnen. Dit kan echter voor problemen zorgen bij de toewijzing van financiële middelen voor het verschaffen van dergelijke kennis en voor het leveren van publieke goederen door middel van het behoud en beheer van genetische bronnen.

De situatie in een aantal andere landen

Voor beleidsdoeleinden is het belangrijk om te weten hoe er in Nederland overheidssteun wordt verleend voor het behoud en gebruik van bronnen voor de landbouw en wat de omvang is van die steun in vergelijking met andere landen. Hoewel er zeer weinig informatie beschikbaar is over de financiële bronnen die de verschillende landen beschikbaar stellen voor dit gebied, is het zeker dat er enkele institutionele regelingen zijn.

Wat betreft de totale omvang van de verzamelingen plantaardige genetische bronnen *ex situ* kan Nederland niet tippen aan de grote spelers op dit gebied. Dat wil overigens niet zeggen dat een grotere verzameling altijd beter of waardevoller is. Toch is het interessant te constateren dat één land dat een van de grootste spelers is op het gebied van de export van zaden en uitgangsmateriaal (het resultaat van programma's voor genetische verbetering) zelf een tamelijk bescheiden verzameling plantaardige genetische bronnen *ex situ* heeft.

Betrokken actoren bij het beheer van genetische bronnen en trends

Er kan een groot aantal actoren worden geïdentificeerd dat betrokken is bij het behoud en gebruik van genetische bronnen voor de landbouw in Nederland. Dit zijn onder andere fokbedrijven, onderzoeks- en onderwijsorganisaties, NGO's en andere overheids- en semioverheidsorganisaties, die allemaal contact onderhouden en informatie en/of genetische bronnen uitwisselen met het CGN.

Op basis van gepubliceerde bronnen en interviews met een aantal stakeholders kunnen er enkele trends worden vastgesteld die te maken hebben met het gebruik van plantaardige genetische bronnen:

- blijvende concentratie van commerciële plantenkwekers;
- ontwikkelingen in de biotechnologie (onder andere op het gebied van genomica en proteomica) die ertoe zullen leiden dat de kosten voor de evaluatie (en het gebruik) van plantaardige genetische bronnen nog verder zullen dalen;
- voortdurende verbreding ten opzichte van de jaren '90 van de wetenschappelijke aandacht en het beleid op het gebied van plantveredeling (bomen en struiken, andere botanische soorten);

De wisselwerking tussen veehouderijen en het CGN is zeer beperkt (in vergelijking met de tuinbouwsector) en bestaat uit het leveren van zaad aan het CGN ten behoeve van het behoud van genetische bronnen en het uitwisselen van informatie. Met NGO's heeft het CGN echter tamelijk intensieve contacten. Voor NGO's is het CGN namelijk een kenniscentrum dat informatie verstrekt over zeldzame en/of lokale veerassen.

Vastgestelde trends op het gebied van dierlijke genetische bronnen zijn:

- uitbreiding van de Nederlandse verzamelingen *ex situ* in de afgelopen vijf jaar, zoals gepland in het werkplan WOT-GB voor de periode 2004-2008;
- blijvende globalisering en concentratie van de commerciële veeteeltsector;
- ontwikkelingen in de biotechnologie waaronder genoomselectie, cryobewaring van vrouwelijke embryo's en verbeterd gebruik van DNA-gegevens; en
- wijzigingen in de marktvraag, waaronder een lichte stijging in het gebruik van een aantal specifieke zeldzame soorten voor het behoud van landschappen en het milieu.

Implicaties voor de WOT-GB

Internationale overeenkomsten
De beleidsondersteunende activiteiten krachtens de WOT-GB vormden waarschijnlijk een belangrijk onderdeel van de internationale institutionele architectuur voor genetische bronnen. Dit viel vooral op voor gewassoorten die onder het IT-PGRFA vallen. Het blijkt dat er voor veerassen vaak minder internationaal beleid nodig is. Voor de volgende WOT-GB is het echter relevant de vraag te stellen of er meer bronnen moeten worden bestemd voor andere gewassoorten.

Plantaardige genetische bronnen
De beschikbaarheid van openbare verzamelingen plantaardige genetische bronnen door voor een bron van 'genetische liquiditeit' te zorgen, kan bijdragen aan een stevige concurrentiestrijd in de teeltsector. Tegelijkertijd lijkt de functie van genenbanken echter niet meer te verschuiven in de richting van langetermijnbehoud. Er lijkt een steeds duidelijker onderscheid te worden gemaakt tussen plantaardige genetische bronnen dat is behouden vanwege de culturele waarde en plantaardige genetische bronnen dat waardevol is voor de huidige teelttoepassingen. Dit betekent dat de indicatoren voor het beoordelen van de functie van openbare genenbanken misschien opnieuw moeten worden bekeken.

Dierlijke genetische bronnen
Uit het toenemen van de verzamelingen van het CGN krachtens de eerste WOT-GB blijkt dat er behoefte is aan het stellen van prioriteiten voor de voortdurende (voorgestelde) uitbreiding. Daarnaast is er door de technologische ontwikkelingen behoefte aan beslissingen over de mate waarin vrouwelijke embryo's ook

nog moeten worden bewaard. De aard van de relatie tussen verzamelingen *ex situ* van het CGN en die van commerciële telers moet misschien ook opnieuw worden bekeken, gezien de snelheid van de technologische ontwikkelingen.

Eén thema dat uit de analyse van de ontwikkelingen van de afgelopen vijf jaar duidelijk naar voren komt, is een voortzetting van de verbreding van actoren en prioriteitskwesties bij het beheer en gebruik van genetische bronnen. Een belangrijke uitdaging voor het ministerie van LNV is dus het stellen van prioriteiten met betrekking tot mogelijke claims binnen een beperkt budget voor de WOT-GB. Er bestaat geen simpele berekening (zoals een kosten-batenanalyse) voor het stellen van prioriteiten in de activiteiten voor het behoud van soorten, rassen en variëteiten.

Het is daarom aan te raden middelen in te zetten om de bestuursstructuur voor genetische bronnen voor de landbouw te verbeteren. Zoals eerder gezegd kan dit ook in de vorm van meer aandacht voor een coördinerende rol die kan worden opgenomen in de WOT-GB voor de initiatieven die plaatsvinden. Bijna alle actoren veronderstellen dat men onvoldoende overtuigd is van het belang van een verbeterd beheer van deze bronnen voor toekomstige uitdagingen, ondanks het eerder genoemde recent toegenomen aantal belangstellenden en stakeholders.

Er is inderdaad een proactief argument om de financiële steun van de overheid voor het beheer van genetische bronnen onveranderd te laten of misschien zelfs te verhogen. Dit argument is gebaseerd op het feit dat het voordelig is de middelen in handen van de overheid te houden om te kunnen reageren op huidige en toekomstige uitdagingen op het gebied van landbouw en voedselproductie. Dergelijke uitdagingen doen zich al voor binnen een aantal kwesties, waaronder klimaatverandering, de noodzaak minder chemicaliën te gebruiken in de landbouw, de nieuwe problemen op het gebied van voedselveiligheid en de bijbehorende beperkingen met betrekking tot het verhogen (of zelfs gelijk houden) van de voedsel- en veevoerproductie, de wereldwijd verhoogde consumptie van vleesproducten, en het mogelijke risico van de huidige hoeveelheden antibiotica die worden gebruik in de intensieve veeteelt, om er maar een paar te noemen. Het lijkt erop dat de vraag van de maatschappij naar aanpassingen in de landbouw en veeteelt alleen maar blijft toenemen, zolang de technologische mogelijkheden steeds groter blijven worden.

Abbreviations

ABS	Access and benefit sharing
AnGR	Animal genetic resources
BEKO	Advisory and Co-ordinating Committee for Agricultural and Horticultural Crops (Germany)
BLE	Federal Agency for Agriculture and Food (Germany)
BRG	Bureau des Ressources Génétiques (France)
BvB	Bronnen van ons bestaan (= Sources of Existence)
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CGN	Centre for Genetic Resources, the Netherlands
CGRFA	Crop genetic resources for food and agriculture
CIRAD	Centre for International Cooperation in Agronomic Research for Development (France)
CNRS	National Centre for Scientific Research (France)
COP	Council of Parties
DAD-IS	FAO's Domestic Animal Diversity Information System
DFID	UK Department for International Development
DGIS	Directorate-General for Development Co-operation
DLO	Dienst Landbouwkundig Onderzoek
ECPGR	European Co-operative Programme for Plant Genetic Resources
ENSCONET	European Native Seed Conservation Network
EPO	European Patent Office
ERFP	European Regional Focal Point for Animal Genetic Resources
EUFORGEN	European Forest Genetic Resources Network
FAO	United Nations Food and Agriculture Organisation
GEVES	Group for the Study and Monitoring of Varieties and Seeds (France)
GM	Genetic modification
GRFA	Genetic resources for food and agriculture
GSPC	Global Strategy for Plant Conservation
IFREMER	French Research Institute for Exploitation of the Sea
INRA	National Institute for Agronomic Research (France)
IPK	Leibniz Institute of Plant Genetics and Crop Plant Research (Germany)
IPR	Intellectual Property Right
IRD	Institute of Research for Development (France)
ISF	International Seed Federation

IT-PGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
JKI	Federal Research Centre for Cultivated Plants - Julius Kuehn Institute (Germany)
LNV	Ministry of Agriculture, Nature Management and Food Quality
MTA	Material transfer agreement
NAGP	National Animal Germplasm Program (US)
NGRP	National Genetic Resources Program (US)
NVBT	Nederlandse Vereniging van Botanische Tuinen
PBR	Plant breeders' rights
PGR	Plant genetic resources
PTO	US Patent and Trademark Office
SGL	Stichting Genenbank Landbouwhuisdieren
SMTA	Standard Material Transfer Agreement
SNP	Stichting Nationale Plantencollectie
SoE	Sources of Existence (= Bronnen van ons Bestaan)
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
UNCED	United Nations Conference on Environment and Development
UPOV	Convention for the Protection of New Varieties of Plants
USDA	United States Department of Agriculture
WIPO	World Intellectual Property Organisation
WOT	Wettelijke onderzoekstaken
WOT-GB	Wettelijke onderzoekstaken - Genetische bronnen
WTO	World Trade Organisition
WUR	Wageningen University and Research Centre

1 Introduction

Genetic resources are one of the basic building blocks of agricultural systems. All crop and livestock production effectively involves the nurturing of seeds, seedlings or young animals through maturity. The farmer's success depends upon the quality of the initial planting material or growing stock. The success of agriculture in meeting society's needs for food and other raw materials, both in quantity and quality, has built on the achievements of farmers and scientists in unlocking the secrets and potential of genetic resources.

Ongoing development of a sustainable bioeconomy will depend on innovations that make use of, and indeed build on, the genetic code of life. This implies judiciously conserving and wisely managing the world's stock of agricultural genetic resources Most countries have long recognised this importance of these tasks, developing their own national frameworks and institutions, often centred around storage facilities known as 'genebanks'. Given the interdependence between countries in the use of genetic resources, international agreements have been negotiated to regulate the exchange of such resources by public or private actors.

The use of genetic resources in agriculture continues to evolve quickly. Two driving forces can be identified: globalisation and technology. New plant varieties and especially animal breeds are increasingly developing global market shares. The developments in genomics and proteomics are rapidly revealing new possibilities, in both technical and economic terms.

Such economic and technological developments have consequences for how the conservation and use of genetic resources is organised. Governments have historically played a strong, if not leading, role in this. Private sector companies and non-governmental organisations are also increasingly present.

The conservation of genetic resources in the Netherlands is addressed by a special programme of statutory research tasks (WOT-GB[1]). This programme is manifested in a contractual agreement between the Netherlands Ministry of Agriculture, Nature Management and Food Quality (LNV) and the Agricultural Research Service (Stichting DLO) of the Wageningen University and Research Centre (Wageningen UR). The first contract came into force in 2004 and is up for renegotiation for a second five-year period. The tasks agreed upon in this

[1] The Dutch term is Wettelijke Onderzoekstaken voor behoud en gebruik van Genetische Bronnen.

contract are undertaken by the Centre for Genetic Resources, the Netherlands (CGN) of DLO.

Given the dynamic situation described above, this report analyses the developments in the institutional environment of the WOT-GB and attempts to answer the following questions:

1. What has changed in the institutional environment associated with the government policy document *Sources of Existence* since 2002 and what developments can be expected in the coming five years?
2. What are the implications of these changes for the choice of activities to be included in a subsequent statutory tasks agreement, given the general role of the government?

The report is structured as follows. Given the historically prominent role played by public sector organisations in the conservation and use of agricultural genetic resources, section 2 reviews basic arguments behind government support in this area. In general, agricultural genetic resources have many public goods characteristics. Despite the efforts of farmers, companies, and non-governmental organisations, often acting on a voluntary basis, it cannot be expected that this will lead to sufficient conservation and use of these critical resources.

Section 3 then describes recent developments in international agreements and frameworks that provide the most general institutional environment for the management of genetic resources. This is important because the WOT-GB represents in part the implementation of the Netherlands' commitments under the Convention on Biological Diversity and the more recently concluded International Treaty on Plant Genetic Resources for Food and Agriculture. As will be explained, the international exchange and use of agricultural genetic resources is actually influenced directly or indirectly by a wide range of international agreements spanning the domains of trade, intellectual property rights and biodiversity. Ongoing uncertainty in many areas, including in the details of implementing some of these agreements, is a major characteristic of the institutional environment.

For comparative purposes, section 4 summarises the institutional organisation of these resources in selected other countries, These situations vary considerably reflecting different historical circumstances, as well as the distinctive traits of agriculture in different countries. It is interesting to observe that the Netherlands, while being a visible player internationally in the conservation and use of agricultural genetic resources, does not seem to be devoting relatively more resources than others to this area.

Section 5 then discusses plant genetic resources in detail, followed by a treatment of animal genetic resources in section 6. Each section proceeds in two steps. First, the various actors are described, together with any types of interactions they have with the CGN as implementer of the WOT-GB. The second step is then to describe the trends affecting these actors and the interactions between them. These trends are primarily related to developments in technology affecting the conservation and use of genetic resources, the evolution of market structure and globalisation, and developments in international agreements and ongoing negotiations.

The coverage of stakeholders is far from complete or exhaustive. The ABS Focal Point website for the Netherlands lists 190 collection holders and a total of 826 collections, for the plant, animal (including also fish) and microbial domains.[1] Not all of these consist of genetic resources that can be classified as relevant for food and agriculture, nor as falling under the WOT-GB (which, for example excludes microbial collections). The discussion here concentrates on the 'most visible' genetic resources for food and agriculture (at the risk of maintaining the bias of most treatments of this subject matter) and concedes that much more investigation and documentation could be undertaken.

The information presented is drawn from documents and websites, which are both referenced as much as possible. This is complemented by information obtained from interviews with a number of key stakeholders involved in the management of plant and animal genetic resources. Questions were posed to these stakeholders on their perceptions of ongoing and expected developments, and the implications for their own activities, including their relationship with CGN. More information on the questions posed and the full list of interviewees is provided in the Appendix.[2]

Both sections 5 and 6 identify a number of implications for the WOT-GB posed by the ongoing developments. These are also summarised and compared in the concluding section 7. A major theme throughout this report is the broadening of both actors and policy issues, emphasised at the end in section 7. The broadening concerns in part a growing range of policy objectives related to genetic resources (and agrobiodiversity in general) from the narrower

---

[1] documents.plant.wur.nl/cgn/pgr/ABSFocalPoint/all_collections.asp

[2] In some cases, these specific sources are identified in the text or in footnotes, but this is not always possible. The interviews were conducted in general on the understanding that interviewees would not be quoted directly, in order to encourage open and frank discussion on issues that could be viewed as sensitive.

focus on supporting breeding and research on productivity, to enhancing the role of multifunctional agriculture and also to include internationally agreed obligations. Even in terms of conservation, policy addresses *in situ* conservation as well as the historical concentration on *ex situ* conservation.

The broadening of issues and actors poses challenges for the WOT-GB and for government policy in general. It is difficult, and perhaps impossible, to objectively prioritise among the growing demands on government support in this field. Even an increase in available resources may not match all legitimate claims. The report argues that it may be worthwhile to consider means and governance mechanisms that can adapt to this situation.

2 Public policies, programmes and regulation of agricultural genetic resources

Genetic resources are a vital component of agricultural systems and the importance of conserving these resources, developed over thousands of years, for future use is clear. Genetic resources are necessary for maintaining the ability of agricultural systems to respond to changing and evolving circumstances.

Despite the importance of the task, modern societies appear however to face a challenge in ensuring this conservation. At least this is the impression conveyed by experts involved in this endeavour. Concerns are repeatedly made about the sustainability, both physical and financial, of the world's *ex situ* genebanks (see for example, Anon., 2005; Qualset and Shands, 2005). This raises questions concerning how the management of these resources can best be organised.

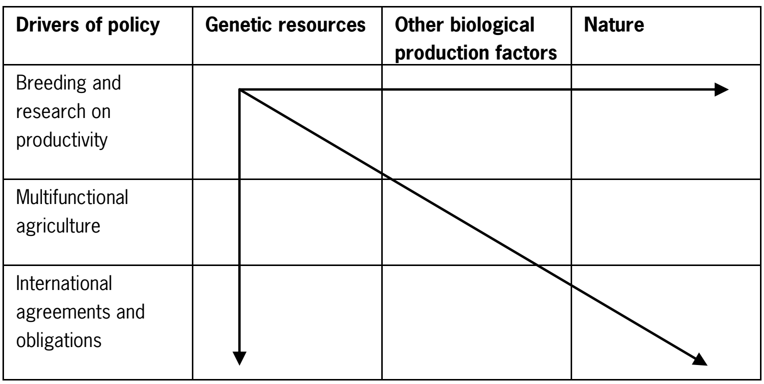
This report is concerned primarily with agricultural genetic resources, and specifically for the crop, livestock and forestry sectors.[1] It is useful to situate these resources within the broader realm of biological diversity of importance to agriculture, often termed agrobiodiversity. This is represented in figure 2.1, which shows levels of agrobiodiversity on the horizontal axis and policy domains on the vertical axis. Genetic resources of cultivated and domesticated species are often viewed as the most basic level of agrobiodiversity. This is complemented by functional species diversity that are found in agricultural production systems (e.g. soil microorganisms). A third level consists of the other, more diverse species found (e.g. hedgerows) that do not necessarily play a direct role in production but nevertheless form part of the overall biological diversity, and also includes the interface between agriculture and nature management.

The traditional focus of policy concerning genetic resources was on their use for breeding and research, which corresponds to the upper left corner of figure 2.1. With the broadening of policy and research efforts to the environmental sustainability of agriculture and international dimensions of genetic resource management, agrobiodiversity policy expanded downwards in the figure, primarily during the 1990s. In the last ten years, policy has also grown more to

[1] And not for example, with fish or microorganisms.

the right, particularly as policy objectives have expanded from conservation alone to promoting sustainable use of agrobiodiversity. This type of broadening is apparent in the principal policy document of the Government of the Netherlands concerning genetic resources of domesticated species (here termed GRFA = genetic resources for food and agriculture), *Sources of Existence* (Ministry of Agriculture, Nature Management and Food Quality. 2002). As pointed out by Bijman and Eaton (2003), this broadening of domain and objectives has not yet been fully realised in terms of specific targets, indicators and criteria. Much of the focus of public programmes, such as the WOT-GB, remains concentrated on genetic resources.

Figure 2.1 **Levels of agrobiodiversity and broadening of agrobiodiversity policy**



Source: Bijman and Eaton (2003).

There are two main strategies for conservation: *ex situ* and *in situ*. Although sometimes portrayed as substitutes, they are actually seen as complements by agrobiodiversity experts (Engels and Wood, 1999). *In situ* conservation in centres of origin (or where a species was domesticated) is viewed as essential for ensuring the ongoing maintenance and co-evolution of agricultural species. But historically *ex situ* conservation appeared as a reaction to changes in agricultural systems in such areas leading to a disappearance (extinction) or erosion of landraces and breeds. *Ex situ* conservation efforts grew considerably in the middle part of the 20th century. *In situ* conservation has on the other hand been less successful as a project of public policy; in other words, there are as yet few instances in the world where it can be confidently claimed that the success of *in situ* conservation activities can be attributed to outside support, whether from governments or other actors.

This section reviews the general rationale behind public support for the conservation and management of genetic resources. From an economic perspective, genetic resources have economic value. They are valuable in two ways. First, and almost trivially, they are a necessary physical component of agricultural production. This refers to the specific seed planted or the animals mated. But second, these resources are used to adapt this production to new environmental and biological circumstances (e.g. climate change or evolution of pests such as phytothphora). Thus more importantly, these resources form the basis for maintaining and possibly enhancing future agricultural production.

This economic value, which is perceived in the future, depends on the type and extent of diversity available within the pool of genetic resources. It is therefore difficult to consider the value of specific genetic resources (such as an individual accession) in complete isolation from the rest of the available resources. This value depends on the contribution that the specific resource makes to diversity of the entire group. This diversity can be measured in various ways, for example using the Shannon index commonly used for species diversity.

The case for public involvement is first discussed at a general level and then some observations are made concerning the three particular types of agricultural genetic resources under consideration (crop, animal, forestry).

The economic case for public involvement in the management of genetic resources is based on the argument that the benefits provided by genetic resources are to a large extent public goods (see, for example, Day Rubenstein et al., 2005). Economics distinguishes between public goods and private goods. For the latter, reasonably clear and efficient property rights systems are feasible meaning that individuals and organisations (such as firms) are expected to manage the resources responsibly.[1] On the other hand for public goods, it is typically not feasible to define efficient property rights, primarily due to two reasons. First, it may be very difficult (i.e. expensive) to exclude others from enjoying the benefits from one's management of a resource. Second, the fact that some people benefit from the resource is not necessarily at the expense of benefits for other people (non-rivalry).

[1] In this case, public involvement may still be conceivable, for example from a concern for who benefits and how much (equity or distribution concerns). Indeed there are plenty of examples of such intervention and regulation, such as in the labour market.

The benefits obtained from the diversity of agricultural genetic resources available are of both a private and public good nature. First, in terms of private goods, the breeding of a new variety with enhanced productivity attributes leads to benefits for the farmers cultivating it, most simply in terms of a higher net income (due to increased production and revenues, or lower costs). Many farmers are thus willing to pay for such benefits, as increased costs for seed are more than compensated by the benefits. A breeding company can capture part of this extra value provided it can exclude, at reasonable cost, others from this value. Ensuring this exclusion can however be quite costly given the fact that genetic resources are in essence, self-reproducing. Among crop genetic resources, hybridisation offered the first strategy to achieve this exclusion. In Europe and other industrialised countries, this was complemented by legal systems for protecting 'intellectual' property (or genetic property), particularly plant breeders' rights (PBRs), patents, trade secrets, and trademarks.

Second, agricultural genetic resources have a public good nature as well. The clearest example of these concerns the future effects of decisions with respect to the conservation and use of specific resources. If a farmer chooses to maintain specific rare varieties or breeds, there is a possibility for benefits to others through future use of these in improvement programmes. Given that some other farmers may have the same options open to them, it is difficult (i.e. costly) to devise ways of excluding other people in the future from these benefits. At a broader level, the ongoing evolution of agricultural pests and diseases for crops and livestock is strongly influenced by the diversity of species and also varieties and breeds in the agricultural landscape. This diversity is largely the uncoordinated result of the decisions of all farmers as well as other actors. Benefits from greater diversity also have a public good aspect in that they benefit effectively everyone (increased resilience in food production) and means to charge directly for these benefits seem inconceivable (costly exclusion).

It is often observed for public goods that they pose a challenge to society in terms of ensuring that they are provided in sufficient quantity. The 'market' for such goods may not develop as spontaneously as for private goods in demand. Thus, public goods lead to a coordination problem in the sense that the actions of various people and organisations need to be adjusted to one another in order to ensure that the public good is sufficiently provided. Government intervention and regulation is not necessarily the only answer. In some cases, people may develop private arrangements to ensure that the good is provided. Part of the political debate around the proper role of government versus individual initiative in society can be seen as revolving around different expectations concerning whether such arrangements will materialise, as well as how they will allocate costs and benefits.[1]

The discussion has so far treated the rationale for public involvement in the management of genetic resources in fairly general terms. A relevant question is whether GRFA are different from other areas where governments intervene in one form or another? Do special arguments apply to determining the government's role? In this regard, it is possible to examine the issue of policy for GRFA through the lens of the Public Interest Calculus, a framework developed to analyse the government's role in market regulation from an economic perspective (see Appendix 1). Such an exercise leads to a conclusion that there is a role for government to play in ensuring adequate investment in the conservation of GRFA. Furthermore, it is unlikely that the government can avoid some form of 'direct intervention' and coordination of activities. The framework then makes a distinction between rationales for input and output financing with a presumption that the latter is more efficient. In the case of GRFA, it seems evident that steering on outputs is partially but not completely possible. Applying the Public Interest Calculus framework thus leads to the conclusion that a direct public role is desirable. The analysis is very general though and does not offer any guidance in terms of which activities of conservation and use or which sectors (crop, animal or forestry) deserve more or less attention.

Looking at the public and private good nature of GRFA provides insights into the longer term developments in institutions for the governance of these resources. The most important long-term trend in GRFA are the various public and private initiatives to increase the private good nature of these resources i.e. their privatisation. This trend can be traced back to at least the beginning of the 19th century and the rise of large-scale commercialisation in agriculture, based partly on professional, scientific breeding.

The 1992 Convention on Biological Diversity (CBD) can also be viewed as an attempt to create exclusive rights in genetic resources. In this case, these rights are first recognised as residing with sovereign states. This is intended to provide the basis for contracting between these providing countries and users, such as researchers and biotechnology companies. The difficulties in ensuring exclusive rights to GRFA led to the conclusion of the International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA) which is discussed in more detail below (Bijman and Eaton, 2003; Eaton et al., 2004). The main dif-

[1] Additionally, this debate also concerns different assessments of how effective and efficient government intervention will be, particularly as to whether the intended consequences will be realised (the presentation of this argument by Coase (1960) is often cited, as are writings of Hayek).

ference between GRFA and genetic resources occurring primarily in the wild is that the former type have often travelled much further due to the longstanding management by people. This makes establishing an origin and providers much more difficult, as well as restricting use of such resources that have already been reached other hands.

3 Developments in international agreements and associated frameworks

This section reviews main developments in international agreements and other associated institutional frameworks that have taken place in the past five years. There are a variety of different international agreements and frameworks relevant for the management of genetic resources. An understanding of the main trends cannot avoid a certain amount of detail and specific terminology.

3.1 Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) is the principal international agreement concerning the conservation and use of biological diversity. The CBD was adopted in 1992 during the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, and entered into force at the end of 1993. There were 191 parties to the treaty as of May 2008 when the ninth Conference of the Parties (COP 9) was held in Bonn, Germany.

The main focus of the CBD is on the conservation and sustainable use of wild biodiversity, but the ongoing discussions at the CBD do also concern genetic resources for food and agriculture. The CBD recognises national sovereignty over biological resources, and hence the legitimacy of national governments in regulating the exchange, including international exchange, of genetic resources. This exchange is to be governed by the Bonn Guidelines for Access and Benefit-Sharing (ABS) which prescribe that access is to be based on prior-informed consent and mutually-agreed terms, which should include agreements and mechanisms for an equitable sharing of benefits derived from the resources. The ongoing negotiation of implementation mechanisms for the Convention has concentrated to a large degree on what kind of institutional structure is necessary to implement the Bonn Guidelines. Very simply, countries of the South (roughly characterised as 'providers'[1]) favour the creation of legally-binding measures at an international level, to increase the possibilities for en-

[1] Though many countries of the South do not contain significant biodiversity hotspots, or centres of diversity, and thus might also be seen as more 'users' than 'providers'.

forcement. For their part, countries of the North (roughly characterised as 'users') have generally argued for implementation through national legislation and regulation, primarily within the providing countries.

The Bonn Guidelines were adopted at COP 6 in the Hague in 2002 and in the same year, the World Summit on Sustainable Development (WSSD) mandated that an international regime on ABS be concluded by 2010. Since that time, the Working Group on ABS of the CBD has conducted frequent negotiations on the form of this international regime. Until 2008, the opposing positions of most simply, North and South, have been described as 'entrenched'. At the COP 9, there was, in contrast, a commitment made by parties to the goal of having an international regime with legally binding components. The detailed 'roadmap' laid out for negotiations through to COP 10 (in 2010) indicates an increased commitment internationally to developing the international regime. This could become a reality by 2010 and thereafter, which would probably be a major step towards reducing the uncertainty concerning the rules applicable to international exchange of genetic resources. If it is not possible to reach an agreement, the issue may simmer for quite some time, not only contributing to increased uncertainty for those involved in the exchange of resources, but possibly also spilling over to hardened positions in other fora, such as the WTO and its related agreements.

For plant genetic resources for food and agriculture, the Conference of the Parties to the CBD has recognised the validity and applicability of the International Treaty on Plant Genetic Resources for Food and Agriculture. This Treaty was negotiated, at the request of the COP, to be a revision of an earlier International Undertaking (1983) that had been negotiated prior to the CBD (see Eaton et al., 2004). The International Treaty establishes an international regime for facilitated access and benefit-sharing for genetic resources of a specific list of (currently) 64 species comprising the principal food crops of the world. Developments around the Treaty are discussed in the next section.

There are ongoing negotiations on a wide range of issues under the CBD of importance to the conservation and use of biodiversity, which cannot all be described here. For instance, definitions need to be agreed up for a number of standard terms such as 'genetic resources' which are necessary for implementing agreements. For genetic resources, a definition may need to set criteria for the amount (is carrying one seed over a border an international exchange of genetic resources?), possibly including the intended or actual use to which the biological specimen/individual is put.

Another important issue under negotiation concerns appropriate indicators for assessing the state of the biological diversity. For the diversity of plant and animal genetic resources, these indicators need to be able to take account of the diversity within a species (within and among varieties, breeds and races) as well as between species (Windig et al., 2006). Inevitably choices and compromises will have to be made. At this point, the lack of agreed indicators arguably contributes to uncertainty surrounding what the specific goals of policy at the national level should be with respect to conservation of genetic diversity.

In general, countries are moving along in making agreements concerning the conservation and use of biodiversity, including agricultural biodiversity. Over a longer period, this can be seen as scratching away at the high level of uncertainty facing stakeholders who are (possibly) engaged in the international sharing and exchange of biological material. This uncertainty increased drastically in the early 1990s with the entry onto the scene of the CBD. For various stakeholders who previously were characterised as 'users' in the North, this uncertainty has meant a considerable deterioration in their ability to access resources. The situation expected by some, of a flourishing and high-valued market in biological resources, has also not materialised, due to the uncertainty and associated risks and potential costs. Negotiations continue on ways to design institutional arrangements that recognise the rights and principles of the CBD and that also ease transaction costs and create conditions for exchange and use of biological resources. The next section discusses the International Treaty in more detail, which can be seen as an attempt to develop such arrangements.

3.2 International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA)

The International Treaty entered into force as of 29 June 2004 after being ratified by 40 countries.[1] Currently 120 countries are parties to the Treaty.[2] The principal accomplishment of the Treaty is the establishment of the Multilateral System (MS) for facilitated access and benefit-sharing. The Multilateral System covers 64 of the major food crops which together account for approximately 80% of human food consumption.

[1] www.planttreaty.org, see also Stoll (2004) for a concise and accessible summary.
[2] As of November 2008.

The Multilateral System is based on a standard contract governing the exchange of germplasm. This contract, the Standard Material Transfer Agreement (SMTA), was adopted in June 2006 by the Governing Body of the Treaty, after extensive negotiations. The SMTA sets standard terms for access and benefit-sharing. In essence, access to germplasm is unrestricted for utilisation and conservation in research, breeding and training. If a commercial product is derived from the germplasm, then the SMTA includes a standard formula for a financial payment to be made to a central fund, under the jurisdiction of the Governing Body.[1] Payment is not strictly required though if the product is still available, without legal restriction, for use in further research (and breeding). In this case, voluntary payments may be encouraged.

The terms of this monetary benefit-sharing clause in the SMTA highlights and recognises one of the principal difference between the use of plant breeder's rights (PBR) versus patents for the protection of newly-developed varieties of agricultural plants. The breeder's exemption under plant breeder's rights (also known as plant variety protection) ensures that a protected variety is available without any necessary permission of the breeder holding a PBR to be used in further research and (commercial) breeding. In contrast, such uses of a plant or plant variety protected by a patent would require the permission of the holder of the patent. The patenting of plant varieties is possible in the United States where this has become a standard form of intellectual property right protection for many new varieties of crops since the 1980s. In Europe and most other countries, plant varieties are only eligible for PBR protection.[2] Thus, if a plant breeder develops a new crop variety using germplasm obtained from the Multilateral System and then acquires a PBR, there is no requirement for monetary benefit-sharing. If the variety is protected by a patent, then payment is compulsory. Monetary payments could be made to the Global Crop Diversity Trust, es-

[1] The SMTA stipulates that one of two formulas are to be applied: (i) 1.1% of revenues from the derived product, typically a crop variety, minus 30%; or (ii) 0.5% of gross revenues of all varieties of crop.

[2] The situation becomes more complicated though in the case of new plant varieties embodying an invention, in particular a genetic transformation 'event', such as in the case of genetically-modified crop varieties. The event is, in principle, eligible for patent protection which could imply that the plant variety also falls under the broader patent protection, as the event is contained physically in the plant. In order to try and preserve the breeder’s exemption, various EU countries have drafted legislation meant to achieve this, with certain requirements on any breeder making use of such an exemption. There has not yet been any experience with this overlapping protection in the EU to determine whether such a 'solution' is practical.

tablished in 2004, which has been recognised by the Governing Body of the Treaty as an 'essential element' of its funding strategy (described below).

The SMTA represents a considerable milestone in the development of an international regime to regulate the exchange of germplasm. There are a number of issues that still need to be resolved for this regime to become fully functional, including possible mechanisms for tracking the flows of germplasm, the management of the envisaged financial mechanism, and the issue of Farmers' Rights.

With respect to the first point on tracking international flows, many countries of the South, but also from the North, have expressed concern about the need for mechanisms to counteract the possibility of non-compliance with the terms of the SMTA. In particular, this relates to patent (or even PBR) applicants who might wish to avoid making the compulsory payments into the fund. Being a contract, the SMTA relies on parties to the contract monitoring each other to ensure that the terms are respected. Given the potential scenario of these parties being on the one hand, a genebank in a developing country with few resources, and on the other, a large multinational company well experienced in litigation, the concern is thus that some form of institutional oversight is necessary. An element of such arrangements includes a proposal to alter legislation and/or procedures for applying for patent and/or PBR protection to require applicants to disclose the source of genetic material used (see the discussion concerning 'disclosure of source/origin' under TRIPS below). A small number of European countries (including Norway, Switzerland) endorse this proposal while others would prefer not to amend IPR systems, arguing in part that they might not be so practical.[1]

With respect to Farmers' Rights, there remains, at least according to some stakeholders, ambiguity in the SMTA concerning the potential implications of this clause. Specifically, it is not clear whether this implies an exemption to the protection offered under PBR, that normally prevents farmers from saving seed of a protected variety for subsequent (local) exchange and sale.

Further uncertainties arise because of the slow process of implementation of the Treaty. Only a handful of countries (including the Netherlands, Scandinavian countries, Germany and France) have taken the necessary steps (including either legislative or in terms of regulations and procedures) to implement the use of the SMTA. This applies to the institutional rules governing the request for ma-

[1] One issue concerns for example how the 'source' of genetic material is helpful when it has been passed through a number of hands (legitimately) after the initial provider. It has also been questioned whether this will provide much of a tool for preventing applicants intent on making a false disclosure from doing so (Eaton and Visser, 2007).

terial that falls under the Multilateral System, as well as procedures for legally declaring germplasm to be part of the System (see also Fowler, 2003; 2005 for a discussion of some of these issues).

In summary then, during the last five years the Treaty has come into force, and is only most recently starting to provide a regime for facilitated access to germplasm of the crops falling under the Annex I list of this agreement. Various stakeholders express optimism about the future developments. It appears quite possible though that progress on the issues above will be such that a 'fully-functioning' system might only become discernible after another four to five years. At this point, there are no strong trends towards further expanding the list of species included in the Multilateral System. This implies that exchange of genetic resources for many crops of agricultural importance, particularly though not exclusively those cultivated for non-food purposes, will fall under the (direct[1]) regulation of the CBD. This also implies for many other species whose genetic resources can be classified as part of agrobiodiversity, such as insects, bacteria and fungi, not to mention livestock species which are discussed below.

3.3 Global Crop Diversity Trust

The Global Crop Diversity Trust[2], an independent international organisation, was established in 2004 as a partnership between the FAO and Bioversity International (formerly the International Plant Genetic Resources Institute - IPGRI) on behalf of the international research centres of the Consultative Group on International Agricultural Research (CGIAR), most of which have some of the largest and most important *ex situ* collections. The Trust works to ensure the conservation and availability of crop diversity for food security worldwide. The Trust also entered into a Relationship Agreement with the Governing Body of the International Treaty (above) which recognises the Trust as an 'essential element' of the Treaty's strategy for funding *ex situ* conservation.

Since its inception, the Trust has been working to establish an endowment fund that would be used to fund *ex situ* conservation through existing institutions, particularly genebanks located in the South.[3] Donations have been se-

[1] The International Treaty is recognised under the CBD as being applicable for the species listed under Annex I which do also fall under the scope of the latter agreement.

[2] www.croptrust.org

[3] Part of the rationale and background calculations for such an endowment fund are provided by Koo et al. (2003, 2004).

cured from a number of governments, including some developing countries, and also a number of private sector companies[1] and foundations (major seed companies or their foundations). The rationale behind the this strategy is that genebanks almost everywhere fulfil a long-term function but that their funding mechanisms are of a short-term nature, with even 3-5 year grant providing 'very little meaningful security'.[2]

The Global Crop Diversity Trust is one of the partners in the establishment and operation of the Svalbard Global Seed Vault on Norway's arctic island of Spitsbergen. The Vault is a secure seed bank, whose construction was funded by the Government of Norway, and is managed under an agreement involving that government, the Nordic Gene Bank and the Global Crop Diversity Trust. The Vault is (being) stocked with duplicate accessions of genebanks around the world as a secure safety net in the event of catastrophic loss of those original collections (for example due to war, natural disasters, etc.) The Trust funds the operation and management of the Seed Vault, as well as paying for costs of transport of accessions to be stored from developing countries.

3.4 World Trade Organisation (WTO)

The Doha Round of negotiations on trade negotiations has repeatedly reached a stalemate. This is due in large part to the 'new' group of BRIC countries (Brazil, Russia, India, China) gaining political power in international negotiations, as a result of their increased share and importance in the global economy. The issues of importance concern market access support to agriculture.

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is one of the agreements such as the TBT and SPS agreements, that are also an integral part of the agreement establishing the World Trade Organisation (WTO). The TRIPS agreement establishes compulsory minimum requirements for the nature and scope of IPR systems for all WTO members. Of particular importance to the agricultural sector is the requirement under Article 27(3)b of the TRIPS agreement which requires member countries to implement some form of intellectual property protection for plants and microbiological organisms, in particular either patents, or some kind of plant variety protection, or a combination of both. Plant variety protection is not specified as requiring

[1] Including the International Seed Federation (ISF), which is the international organisation representing national and international seed industry associations.

[2] www.croptrust.org/main/role.php

adoption or membership of the International Union for the Protection of New Varieties of Plants (UPOV), but may be of a '*sui generis*' or 'in-kind' nature. Least-developed countries have been given an extension through 2013 for implementing this Article.

The issue of possible revisions to Article 27(3)b has been an issue on the agenda of the TRIPS Council for almost 10 years. And the issue has also been included in the agenda of the Doha Round, although geographical indications and access to medicines have received more attention during the negotiations in recent years. Discussions within the TRIPS Council specifically on Article 27(3)b have slowed considerably, and could possibly be described as deadlocked between two groups. On the one hand certain countries of the North would like to push for stronger enforcement of implementation of the Article as well as discussions of even stronger requirements. This could include for example, a requirement that UPOV membership be seen as the only 'effective' system for protection of plant varieties.[1] On the other hand, most countries of the South perceive the review of Article 27(3)b as actually providing the opportunity to discuss whether the scope of the requirements should be reduced.

The issue of a mandatory disclosure of source/origin of genetic resources in patent applications has been discussed in the TRIPS Council, as a possible amendment to the TRIPS Agreement. India has been one of the most vocal proponents of such an amendment which has the support of 80 countries (as of October 2008[2]). The issue is typically portrayed as being essential to achieving consistency between the CBD and the WTO, and thus touches at the heart of international differences between North and South. Some European countries are in favour; others may have expressed sympathy but also reservations concerning the practical implementation of such a requirement. A few countries of the North are simply opposed. One complication concerns the possible need to amend the Patent Co-operation Treaty if such a disclosure were to become a requirement in the legal sense of other requirements for protection (such as demonstration of inventiveness). Possible solutions include not making the disclosure an official requirement for granting of patent protection, but de facto making it a necessary step in the application or granting process. Such a procedure has recently been implemented by Switzerland.

[1] There is as yet no agreed interpretation among parties to the TRIPS Agreement as to what constitutes an 'effective' *sui generis* system for the protection of plant varieties.
[2] see www.ip-watch.org/weblog/index.php?p=1294

Looking ahead, it does not seem likely that the obligations under the TRIPS Agreement would be extended, unless both Brazil and India change their current positions and see that as in their interest. These two countries have quite considerable influence in the negotiations (which has grown in recent years) and have been strong opponents of TRIPS compliance. (China, one of the other emergent economic powers in negotiations, has been less resistant to complying with TRIPS obligations, for example, having become a signatory of UPOV's 1991 Act.)

3.5 Intellectual Property Right Systems

The situation concerning the WTO TRIPS agreement was described above as one in which WTO members, particularly developing countries, have been busy establishing various IPR systems including patents, plant variety protection, trademarks, copyrights and geographical indications, in order to comply with their obligations under TRIPS.

During the last five years, there have been increasing signs that these IPR systems are coming under stress, partly as victims of their own success. The number of applications for IPRs has grown explosively, particularly for patents and trademarks. And countries that are establishing plant variety protection systems are also sometimes confronted by a surge of applications. For patent offices in the US (Patent and Trademark Office - PTO) and the EU (European Patent Office - EPO), a major source in the increase of applications is the growth in innovation in fast-growing economies such as China and India. One consequence is that the agencies that grant protection are having difficulty keeping up with the demand, meaning that applications are either delayed or the thoroughness of the examination is reduced.

A number of academic studies in the past five years have identified and analysed some of these problems (for example, Jaffe and Lerner, 2004; Bessen and Meurer, 2008). These studies have tended to concentrate on the US patent system, but many of the general issues are similar in the European system as well. The EPO published an important study in 2008 entitled 'Scenarios for the Future: How might IP regimes evolve by 2025? What global legitimacy might such regimes have?' (European Patent Office, 2008). This study outlines four different scenarios for the future development of the patent system, with a global perspective, and recognises the various shortcomings and deficiencies in the current system. It sketches scenarios in which for example, patents are eliminated in various technological fields as a whole.

As the IP community searches for reforms and improvements in the coming years, it might well be conceivable that the current approaches to IP protection for plants, plant varieties, and living matter in general could be revised. Indeed, there have already been some changes in recent years. In the United States, new guidelines were issued by the PTO in 2003 concerning the patenting of plant biotechnological inventions in plants. These were intended to raise the threshold necessary for an invention to qualify for a patent, sometimes termed the inventive step, as well as the scope of the applicable protection. In part, these stricter guidelines were a response to a concern that patents covering plants had become too broad, allowing for example a patent referring to a specific type of plant to imply a claim of coverage over many variations of the plant that were not necessarily associated with the patented invention. The EPO, for its part, issued stricter guidelines concerning the required usefulness of modified genetic constructs to be demonstrated in patent applications.

Currently, legislation to reform the patent system has been formulated and is under consideration by the US Congress. These reforms are reasonably modest. It is possible that the US and the EU may encounter more difficulties in the coming years in terms of coordinating reforms and harmonising their patent systems. While the EPO has itself initiated what seems to be a long-term strategic process representing many interest groups, the US patent legislation seems to be heavily influenced by lobbying of major technology companies. In addition, any legislation has to be conceived with some foresight concerning eventual interpretations by the Supreme Court, in terms of accordance with the US Constitution.

The US and the EU already pursue quite different paths with respect to the protection of plant varieties as referred to above. The EU does not permit patenting of plant varieties, whereas this has been possible in the US for at least two decades, and has become quite common for hybrid varieties of major grains and oilseeds. The US plant variety protection system (UPOV 1991) is thus relatively less used than in the EU.

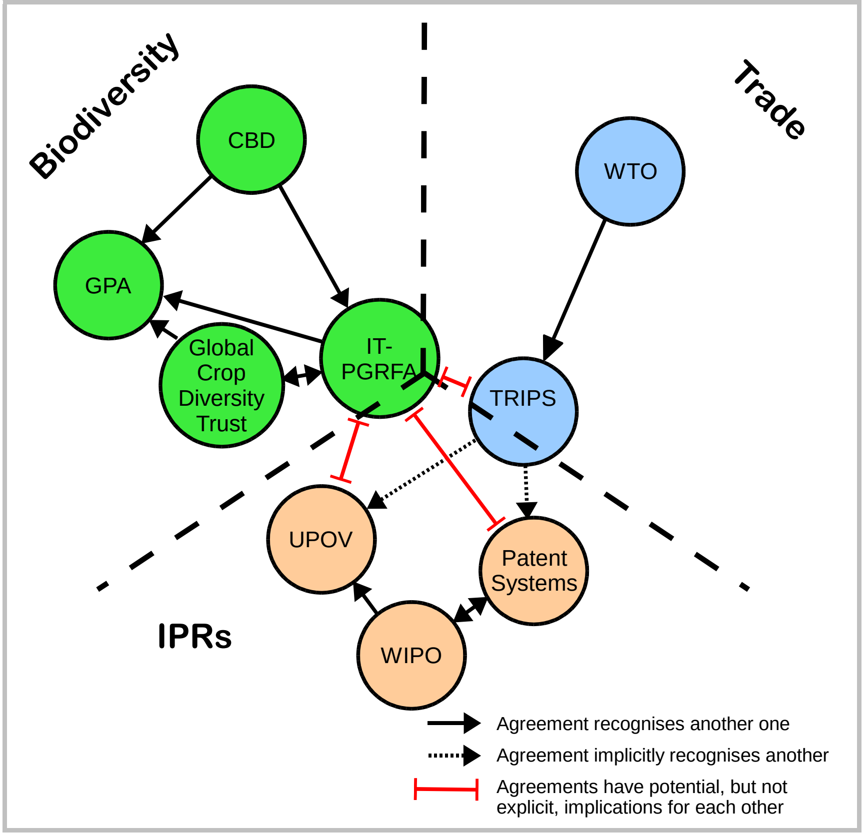
Indeed, during the last five years, a major debate has been initiated among international seed companies, with a clear division between primarily US companies (for example, Monsanto, Pioneer) and European companies. Within the International Seed Federation, which comprises national and regional seed sector associations, the large US companies have sought to gain support for a policy position that would limit the breeder's exemption under plant variety protection. This would effectively increase the scope of protection towards that offered by patents. For the most part, European companies have reacted negatively, some arguing that the European plant variety protection system actually works more efficiently than the patent system. Many also indicate (often informally) that the higher costs of patent protection, as well as a more patent-like protection in plant variety protection, would provide a further stimulus to the ongoing acquisition activity of the largest seed multinationals. Given the links between such policies and other international discussions such as the implementation of the IT, these proposals do not seem to be likely to move much further in the next five years. It is possible that this provides a further trans-Atlantic fault line with repercussions for the EU's plant breeding sector.

3.6 Relationship between international agreements

The various agreements have a complex relationship with each other, that continues to be the subject of international discussions. The relationships are represented in Figure 3.2, which allocates the agreements to three different domains: biodiversity, trade and IPRs. In the biodiversity domain, the CBD is the principal international agreement concerning genetic resources. The CBD recognises both the International Treaty and the GPA in the area of plant genetic resources for food and agriculture. In addition, the Global Crop Diversity Trust, while technically not an international agreement, has been established as a mechanism for implementing both the GPA and the International Treaty.

The International Treaty lies primarily in the domain of biodiversity but does straddle both the trade and IPRs domains. This is because the Treaty regulates, under specific terms, the trade, including international trade, in plant genetic resources (falling under Annex 1 and the Multilateral System). In this respect, the International Treaty has potential implications for the TRIPS agreement, which forms part of the WTO, the principal agreement regulating international trade. TRIPS clearly straddles both the trade and IPR domains, as its name clearly indicates, by setting minimum requirements for IPR protection to be made available by all WTO members. The provisions of the SMTA of the International Treaty specify various formulas for financial contributions to an international fund, depending effectively on whether PVP or patent protection is acquired on subsequently improved genetic material. TRIPS allows member countries to choose between offering either or both forms of protection to agricultural plant varieties. Thus, this option in the TRIPS Agreement partly enables the choice available in the SMTA, which is represented in Figure 2 by the red lines.

Figure 3.2 **International frameworks and agreements related to PGR**



The International Treaty also straddles the domain of IPRs, given these provisions in the SMTA that specifically reflect the scope of any intellectual property rights claimed on subsequently improved genetic material. Thus, the International Treaty also has an implicit relationship with both UPOV and various national and internationally harmonised patent systems. UPOV, originally a separate international agreement, has administratively been brought under the World Intellectual Property Organisation (WIPO), which is the principal international organisation responsible for coordinating IPR policies and systems among countries.[1] WIPO provides a forum for international discussions concerning the ongo-

[1] WIPO can be characterised more as an organisation than as an agreement, which sets it apart from the CBD and the WTO. Other international IPR agreements, such as the Patent Co-operation Treaty

ing evolution and harmonisation of patent systems, and thus these form part of the realm of WIPO. Both UPOV and patent systems are implicitly recognised by the TRIPS Agreement, though there is not a formal relationship between this agreement and the former entities, or WIPO for that matter.

3.7 FAO State of the World Report on Animal Genetic Resources

The agreements and frameworks discussed above apply primarily to PGR. Concerning AnGR, there are relatively fewer frameworks applicable. Indeed, policies and regulations concerning the conservation and use of AnGR have been primarily formulated at the national level (Hiemstra et al., 2006).

At the international level, the first Report on the State of the World's Animal Genetic Resources was completed in 2007, coordinated by the FAO's Commission on Genetic Resources for Food and Agriculture. This report was generated on the basis of a country-level process with national reports, including for example that of the Netherlands (2002). CGN staff were also involved in assisting some developing countries in the preparation of their reports, which were the first of their kind and meant to be corollary to the national reports on the state of PGR, first prepared in the mid-1990s. The State of the World's Animal Genetic Resources was finalised at the First International Technical Conference on Animal Genetic Resources in 2007 which also endorsed the FAO's Global Strategy on AnGR. The national reports and the Global Strategy create national priorities for conservation. In addition, the FAO's Domestic Animal Diversity Information System (DAD-IS) is the key communication and information tool for implementing the Global Strategy, providing countries with a clearing-house for both information and data (Hiemstra et al., 2006).

For biological and physiological reasons, patterns of conservation and exchange of genetic resources for livestock have developed quite differently as contrasted to plant genetic resources. *Ex situ* collections have not developed to anywhere near the same extent as for plants. Livestock genetic diversity is much more embodied in the living animals and *ex situ* collections are much expensive than for most plant species, even with the advent of technological

---

which facilitates the application of patent protection in more than one country, are not represented in figure 3.2 for simplicity sake (and nor is the FAO included for similar reasons). Nevertheless, WIPO currently provides the principal forum for international discussions concerning international harmonisation of IPR systems, primarily in the context of a Substantive Patent Law Treaty.

means for conserving sperm and embryos. For similar reasons, populations used for improved breeding purposes have remained more exclusively in the hands of breeders' associations and later private companies. The involvement of public research organisations and resources has been more limited. And the degree of market concentration among private sector breeding companies is much higher than among seed companies.

Animal genetic resources have not therefore been subject of the same extent of international negotiations. But such resources do fall under the definition of agricultural biodiversity in the CBD. There have recently been some movements by certain countries to devise a treaty to regulate international exchange of animal genetic resources for food and agriculture. This issue is on the official agenda of the FAO's Commission on Genetic Resources for Food and Agriculture (CGRFA).

In 2006, researchers with CGN collaborated with other international experts on AnGR in a study commissioned by the FAO and financed by the Department for International Development (DFID) of the UK Government into policy and regulatory options concerning the international exchange of AnGR (Hiemstra et al., 2006). This study was based on a stakeholder consultation process. The report highlights that the international exchange of AnGR has followed different patterns than for PGR. Whereas PGR have been exchanged between a wide range of countries for the purposes of further breeding, the exchange of AnGR has, in recent times, been more confined to the transfer of improved lines, more often from North to South. Thus, there has not been the same degree of political confrontation and discussion between countries of the North and the South concerning access and benefit-sharing issues. The principal difficulties in international transfer of AnGR reported by stakeholders concerns zoo-sanitary regulations.

Nonetheless, the study indicated that there might be some benefits from the development of voluntary standard material transfer agreements (along the lines of the SMTA under the International Treaty, though not necessarily with the same provisions) to support 'responsible' exchange and transparency. Some stakeholders also noted an increasing tension between the growing use and relevance of patents in animal breeding, and the normal property rights of livestock owners. This tension could be further complicated by the sovereign rights, recognised by the CBD. This has led to some initial discussion of the possibility of livestock keepers' rights, as a parallel to farmers' rights in the context of PGR and as recognised in the International Treaty. Such rights would aim to support the continuation of traditional means of livestock conservation and management, viewed as important for AnGR conservation, where these practices might be affected by the granting and enforcement of patents.

International discussions on such issues have only just begun. It appears as though many countries are giving priority to the further development of a working system for exchange of PGR, before devoting more attention to international regulations concerning exchange of AnGR. In general, there is a certain amount of uncertainty concerning future scenarios for AnGR.

3.8 Summary and implications for the Netherlands and the WOT-GB

The situation concerning the various international agreements is complex and still evolving.[1] In the past five years, there have been incremental improvements in uncertainty concerning legal rules governing international exchange of crop genetic resources. Collectively, these add up to significant steps towards the (re-)establishment of exchanges among actors located in different countries. These flows have not yet resumed though, and various issues (as described above) still need to be resolved, even for the Annex I crop species, and subsequently concretely implemented.

A number of issues concerning the specific terms of exchange under the SMTA, or the modalities of their implementation, are still being resolved. This implies a situation of ongoing uncertainty facing various stakeholders involved in genetic resource conservation and management. Given the relative international prominence of the Netherlands in both crop and livestock improvement, this uncertainty is important to a range of public and private sector organisations. In particular, plant breeding companies face ongoing uncertainty, and effectively difficulty, in accessing genetic resources from many other countries. CGN also faces a similar situation.

The implications of these agreements for stakeholders in the Netherlands provides a logical rationale for the relatively high degree of engagement and participation by the Government of the Netherlands in international discussions. Both public and private sector organisations have a strong interest in the resolution of various international differences and the reduction of uncertainty around the international exchange of resources. (This uncertainty translates into higher risks and transaction costs for these organisations).

This participation includes the active involvement of the Netherlands' official representatives in the various negotiations. It is also reflected in a part of the

[1] More details can be found in Eaton et al. (2004).

WOT-GB agreement under which CGN provides extensive support to these representatives, and even includes the participation of CGN staff in the Netherlands' delegation. Another example includes the temporary secondment of CGN expert staff to the Commission on Genetic Resources for Food and Agriculture (CGRFA) at the FAO in 2006.

It is important to highlight that the implications described above for the Netherlands apply particularly to crop genetic resources. Similar frameworks for either animal or tree genetic resources have not been developed, and as mentioned above, the issues particularly for animal genetic resources are somewhat different. The dependence of private sector breeders on international exchange and access of genetic resources for breeding purposes is much less. There is however potential that negotiations of frameworks for the international transfer of AnGR will become an issue of increasing importance to various stakeholders in the Netherlands in the next 5-10 years.

There has indeed been a continued divide in the relatively high investment of human (negotiating) resources invested by governments and other stakeholders in developing the framework for the Annex I species, and the corresponding efforts made for all other species falling under the CBD. Similarly, some stakeholders in the private sector see a lopsided focus of activist NGO attention to the activities of commercial plant breeding companies while other stakeholders, including researchers with publically-financed organisations receive much less scrutiny, which they reportedly exploit. The situation thus appears to remain fragile in the sense that even the gains won with respect to the implementation of the International Treaty might be at risk from a political backlash resulting from discovery of, and increased attention to, activities that do not respect the Bonn Guidelines on ABS.

Concerning ABS, it is quite possible that progress on discussions within the CBD may not progress much further in the coming years, despite recent commitments, simply due to the constellation of political interests involved. For many crop species and other plant genetic resources, this could further inhibit a number of activities to promote improved use and conservation.

Table 1 summarises the principal changes in international agreements in the last five years and likely directions of future developments that have been described in this section. These are categorised partly by the specific agreement and partly by issue area. The table also provides some indication of possible implications for the WOT-GB.

Under CBD and the IT, the differences between Annex 1 crop species and genetic resources of other species are noted in the table. For Annex 1 species, the liquidity crisis that has settled in during the past years, particularly for commercial users, may start to ease, although there are likely to be considerable delays in effective implementation in various countries.[1] On the other hand, prospects for further agreement on ABS regulations and their implementation for other species seem rather bleak. It seems fairly convincing that policy support activities under the WOT-GB have made a signficant contribution to the development of the mulitlateral system under the IT. A relevant question for the WOT-GB is whether more of this policy support should, or should not, be devoted to the CBD process. Arguments might be made for both options, based on perceived importance or on expectations of success. Indeed it may be possible to have some more explicit criteria for assessing the division of resources in the WOT-GB workplan.

It is relevant to recognise that the policy support activities under the WOT-GB do not fall under the typical rationale for government in genetic resource management outlined above in Section 0. These activities consist essentially of the provision of expertise services to LNV, as opposed to the provision of public goods. This expertise is very useful for the Ministry to fulfill its own responsibilities, on behalf of the Netherlands citizens, in international negotiations. Whether a government ministry maintains what it considers to be sufficient expertise in-house or whether it contracts such expertise from outside the organisation is another question, into which this analysis does not delve. It is though relevant for such an assessment to recall that technical expertise in the area of genetic resources is concentrated among a limited number of individuals. But nonetheless, the inclusion of policy support activities under the WOT-GB effectively gives this WOT agreement a mixed character. It concerns not only management of genetic resources, but also the provision of specialised expertise for government policy advisors. It could thus be argued that a contract in which financial resources must be allocated between these two types of goods and services is presenting a difficult decision-making process. How should the conservation of genetic resources be weighed up against the out-sourcing of expertise to inform the government's position in international negotiations? Without questioning the clear value-added of this expertise, it does seem relevant to ask why it should effectively be financially fungible with support to genetic resource management.

In terms of international coordination of *ex situ* collections, much has transpired in the last five years, with various initiatives at European level under the

[1] Wright (1998) can be credited with developing the concept that one of the tasks of publically-financed genebanks was to ensure sufficient liquidity, or in other words, availability and circulation of germplasm.

auspices of the ECPGR (which is described below in Section 0) and the newly created Global Seed Diversity Trust and Svalbard Global Seed Vault. A relevant implication for the WOT-GB is what the advantages and disadvantages might be of including more specific goals with respect to the international coordination of *ex situ* collections.

Within the domains of IPRs and associated discussions, for example, on farmers' rights, there continue to be tensions at an international level, although their nature and the balance of power has changed somewhat in the last few years. Within the commercial plant breeding sector, there is friction between the largest US-based multinationals and their European competitiors on the desired scope of protection on plant varieities. In inter-governmental circles, the rising political powers of the South, including India and Brazil, have stalemated the discussions in TRIPS and elsewhere on placing further IPR obligations on these countries, and also intensified discussions for some kind of farmers' rights or related elements. One implication this might raise, with respect to policy support activities under WOT-GB, is the question as to how best to maintain a clear and separate institutional identity for CGN in this regard. Staff of CGN sometimes represent the Government of the Netherlands in international negotiations, and the Centre is probably perceived by many stakeholders as being a public agency. This it is not, and staff of CGN are also involved in research activities on policy issues concerning property rights to genetic resources, financed by other means, where the consistency with official policy of the Government of the Netherlands may be less obvious to other stakeholders. Such issues might, at least in theory, be alleviated by separating policy support activities from genetic resource management functions, as discussed above. In practice though, as noted above, specialised expertise is concentrated among such a limited number of individuals. Other options might be specific conditions concerning efforts made by CGN to communicate to others more explicitly when it is acting on behalf on the government, and when not.

Table 3.1	Summary of relevant changes in international agreements	
Agreement or issue area	**Developments in international agreements (since 2002 and expected to 2013)**	**Implications for WOT-GB**
CBD - Access and Benefit Sharing	- International exchange, under agreed terms, of genetic resources has become close to impossible - Slow progress in achieving workable framework *Future*: Target of 2010 agreed but considerable likelihood will not be achieved; implementation likely to also be slow	A relevant question is whether policy support should devote more attention to frameworks for non-Annex 1 species
IT-PGRFA - Multilateral System for major food crop species (Annex 1)	- Liquidity crisis in international exchange of crop genetic resources - Standard MTA has been agreed but implementation is slow *Future*: Facilitated access under multilateral system should become operational but may still involve delays and large uncertainty in many countries	Policy support activities have most likely made a signficant contribution to international developments
International coordination on conservation of CGR	- Global Crop Diversity Trust and Seed Vault established with additional financing *Future*: Possibly further efforts to rationalise collections through networks, most likely European	A relevant question is what the advantages and disadvantages are to including more specific goals with respect to international coordination of *ex situ* collections
AnGR	- There has been some preliminary discussion of international agreements *Future*: Not likely to be much formal discussion of exchange of AnGR since not commercially as relevant	This area arguably requires less attention in terms of policy support

Table 3.1	Summary of relevant changes in international agreements	
Agreement or issue area	**Developments in international agreements (since 2002 and expected to 2013)**	**Implications for WOT-GB**
IPRs	- Tensions have emerged between largest US-based plant breeding companies and others (incl. European) on possible further strengthening of UPOV-PBR - International IPR negotiations on genetic resources have reached a stalemate between North and South *Future*: No clear direction for future developments	Tensions imply the possible need for conditions and mechanisms to ensure clear institutional identity of CGN (whether WOT or not) in activities

4 Situation in other countries

This section provides a glimpse at how the conservation and management of genetic resources for food and agriculture is managed in some other countries. It is, of course, interesting to see what features are common between countries, as well as those that are different.

The discussion is divided into specifically national level information and then international initiatives. In Europe, various networks of national organisations appear to play an increasingly important role in coordination and rationalisation of activities and collections in the various countries, while management of these genetic resources remains a national responsibility within the EU.

There is very little information available concerning financial resources allocated by individual countries. Some figures are included here but this has not been the subject of systematic study, which would need to be quite detailed in order to develop comparable data across countries.

4.1 Germany

Information on agricultural genetic resources are available through one focal point website in Germany.[1] The organisation of programmes and activities is divided according to the types of resources (crop and plants, animals, forest). With respect to *crop* genetic resources, the German Federal Ministry of Agriculture adopted the National Programme for Genetic Resources of Agricultural and Horticultural Crops in 2002. There are a large number of organisations, both governmental and others, involved in the management of genetic resources in Germany, in part due to its federal structure. The federal ministry therefore established an Advisory and Co-ordinating Committee for Agricultural and Horticultural Crops (BEKO), consisting of 18 representatives of the Federal and Laender governments, as well as research institutions, breeding organisations and non-governmental organisations. Under the BEKO, two working groups have been established, one on *in situ* and on-farm aspects of conservation, and the other for national support of the work of the European Co-operative Programme for Plant Genetic Resources (ECPGR; see IPGRI, 2005).

[1] www.genres.de

In recent years, the *ex situ* collections of PGR held by three governmental organisations have been administratively merged under the Federal Research Centre for Cultivated Plants - Julius Kuehn Institute (JKI). Within this, the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK) manages collections at three locations. The IPK collections comprises approximately 148,000 accessions from 3,032 plant species, making it one of the largest and most important in the world. This includes a potato collection of almost 6,000 accessions, and a collection of oil and forage plants totalling more than 13,000 accessions. In addition, the JKI manages collections for fruits and grapevines at two locations. In addition considerable *ex situ* collections are also maintained by 95 botanical gardens.

Core financing of the IPK collections (about 110,000 accessions of the 148,000) is currently about €5.3m. per year which is comparable to the Netherlands financing of Euro €1.2m. for core collections (25,000 accessions) under the WOT-GB.[1]

With respect to *animal* (livestock) genetic resources, the various Laender ministries of agriculture in Germany adopted a 'National Programme for Conservation and Sustainable Use of Animal Genetic Resources in Germany' in 2003. This programme includes, among other initiatives, the establishment of an *ex situ* cryobank for endangered indigenous farm animal breeds. The other elements of this programme include the monitoring of the status of these breeds, and the development of sustainable breeding programmes for breeders (thus to be incorporated in herdbook systems). Germany has 63 indigenous animal breeds (21 sheep breeds, 19 cattle breeds, 14 horse breeds, 5 pig breeds and 4 goat breeds) of which 52 are classified as endangered. The initial goal of the cryo-preservation programme is to store at least hundred sperm samples from at least 25 sires (if possible not related to each other) per endangered breed. Germany, which has 188 indigenous woody plant species (77 tree and 111 woody shrub species), also has a national programme for *forest* genetic resources which includes measures for conservation and sustainable use. The national programme involves even more federal and state-level coordination, as the conservation of forest genetic resources is primarily undertaken through *in situ* conservation on parcels of land that are often under Laender jurisdiction. The Federal and State Working-Group on Forest Genetic Resources and Forest Seed Law has thus defined the national programme and the conservation meas-

[1] Based on figures provided by Bert Visser, CGN, quoting budget figures provided by the IPK director via email.

ures deemed necessary. The national programme is essentially laid out in the document 'Concept for the Conservation and Sustainable Utilisation of Forest Genetic Resources in the Federal Republic for Germany'.[1] This group is comprised of representatives of the Laender forest institutions, as well as the ministry of agriculture (BMELV), the forest genetics institute of the Heinrich von Thuenen-Institut, and the Information and Coordination Centre for Biological Diversity (IBV) of the Federal Agency for Agriculture and Food (BLE). The members of the Federal and State Working-Group on Forest Genetic Resources and Forest Seed Law coordinate their implementation of the resulting projects on the basis of a four-year action plan. Such projects concentrate in general on

- the identification and evaluation of forest resources;
- *in situ* measures (natural regeneration, conservation of forest stands and individual trees, sowing and planting in the forest);
- *ex situ* measures (evacuation, seed orchards, gene banks);
- conservation within forest management (regeneration, silvicultural treatment, forest harvesting).

4.2 France

In France, genetic resources for food and agriculture are managed by a wide variety of actors. But since 1983, a central organisation the Bureau des Ressources Génétiques (BRG; Office for Genetic Resources) has been mandated to coordinate the activities of these various organisations and to develop a national approach to the management of genetic resources.[2] The BRG is a scientific body with representation of six ministries, the National Institute for Agronomic Research (INRA), the National Museum for Natural History (MNHN), the National Centre for Scientific Research (CNRS), the Institute of Research for Development (IRD), the Centre for International Cooperation in Agronomic Research for Development (CIRAD), the Group for the Study and Monitoring of Varieties and Seeds (GEVES), the French Research Institute for Exploitation of the Sea (IFREMER). In 1993, this agency was strengthened to status of inter-ministerial organisation (Mitteau, 2005).

In 1998, France adopted a National Charter for the Management of Genetic Resources (BRG, 1998). The Charter, endorsed by all the above-mentioned organisations, defines the national strategy for conserving animal, plant and also

[1] www.genres.de/fgrdeu/concept
[2] www.brg.prd.fr

microbial genetic resources, and also promotes programmes designed to use genetic resources as well as preserve biodiversity.

The French approach is a decentralised one, ostensibly because of the view that large, centralised genebanks are too remote from users (Mitteau, 2005). This might, on the other hand, be an indication of the reluctance of the multitude of collection managers to relinquish sovereignty, as the French approach to governance is often characterised by a centralised approach. The stakeholders involved include public or private bodies for plant breeding, research, training, collection or the management of nature reserves, as well as associations, regional genebanks, territorial authorities, and others. In addition to coordinating the conservation activities of all these stakeholders, the BRG, as an inter-ministerial organisation, is also the principal vehicle for French participation in relevant international negotiations and fora, such as the International Treaty.
For plant genetic resources of temperate species (which includes forest species), a number of stakeholders co-operate together to preserve and enhance a National Collection of genetic resources for a species, or a species-group. About thirty of these networks have been established so far, each corresponding to a species, or a species-group.

With respect to animal (livestock) genetic resources, a cryobank was created in 1999 with status as Groupement d'Intérêt Scientifique.[1] Since then, more than 3000 donors have contributed sperm and embryo samples for 10 different livestock species. This cryobank is administratively related to the Institut d'Elevage, the principal national livestock research organisation. The cryobank preserves samples of breeds that are threatened (Type I), sparsely distributed (Type II), as well as widely distributed (Type III).

The wide variety of stakeholders involved in the conservation and management of genetic resources in France, together with the coordinated network approach, may explain why summary figures on the financial resources of the government devoted to this theme are not easily available.

4.3 Scandinavian countries

Scandinavian countries (comprising Denmark, Finland, Iceland, Norway, Sweden) have combined their *ex situ* efforts in the form of the Nordic Genetic Resource

[1] www.cryobanque.org

Centre (previously the Nordic Genebank.)[1] This combined genebank began as a pooling of plant *ex situ* germplasm collections. It now contains about 30,000 accessions (somewhat more but comparable to the size of CGN's crop genetic resource collection). Wheat, oat and barley are the main crop species included in the collection, with approximately 10,000 barley accessions. This regional organisation, accountable to the Nordic Council of Ministers, now also covers both animal and forest genetic resources. Animal genetic resources have been included in this coordinated mechanism since 1984. It is not clear though whether any *ex situ* conservation facilities have been developed.

As mentioned above, the Nordic Genetic Resource Centre is also the implementing agency responsible for the operation of the Svalbard Global Seed Vault.

4.4 USA

In 1990, the US Congress authorised the creation of the National Genetic Resources Program (NGRP) under the Agricultural Research Service of the Department of Agriculture (USDA). The NGRP is intended to provide a 'continuous flow of genes from source to end use'[2] and covers crops, livestock and forest genetic resources.

The American system is comparable in some ways to that of France, in that it is comprised of a decentralised network of stakeholders involved in the management and conservation of genetic resources. With respect to crop genetic resources, the US established the National Plant Germplasm System which includes government organisations at Federal and State level, as well as private organisations (both profit and non-profit) and research organisations, such as universities and specialised institutes. Funding comes from Federal, State and commercial sources. The base collection of the system is the long-term, *ex situ* National Seed Storage Facility at Fort Collins, Colorado. Next to this, four regional plant introduction stations maintain working collections of seeds for regular distribution. Germplasm of species that need to be maintained as living collections, as opposed to seed, are stored at the National Clonal Germplasm Repositories. According the USDA's Genetic Resource Information Network (GRIN), the database of the NGRP, the collections cover more than 13,000 different crop species, with more than 510,000 accessions. Informal indications are that the US devotes about €3.0-3.5m. on an annual basis to the storage of

[1] www.nordgen.org
[2] www.ars-grin.gov

the basic collection, which includes 380,000 seed accessions (and thus more than 10 times the size of CGN's collection).

The National Animal Germplasm Program (NAGP) covers beef cattle, dairy cattle, bison, chicken, elk, goat, pig and sheep, as well as some aquatic species. The farm livestock species account for more than 90% of the 520,00 accession held. This cryo-preserved collection has been built up over the past six years, since 2002.

The NPGS does include woody landscape species, but it is not clear if it covers all indigenous forest genetic resources.

4.5 Summary

The situation varies in other countries. International initiatives such as the Global Plans of Action and the European networks have contributed to a number of common elements emerging in the various national systems. Nonetheless, these retain their own strong national characteristics, which may be bound to the relatively small number of experts involved in conservation and management of genetic resources for food and agriculture.

It is perhaps interesting to note that, in terms of sheer size of *ex situ* germplasm collections, the Netherlands does not figure among the global top players. The various collections of the 10 or 11 research centres of the CGIAR total more than 500,000 accessions. The US collections count more than 460,000 accessions, and 14 other major national collections, including those of China, Canada, Japan, South Korea, India, Brazil, Germany, Italy, Ethiopia, Hungary, Poland, the Philippines, Brazil and Russia, each far outweigh the size of CGN's collection (see Qualset and Shands, 2005; based on figures compiled by the FAO in the 1990s). This is not meant to imply that larger is necessarily better; some of these collections may contain more duplication than is the case at CGN which has made considerable efforts to rationalise its collection. Furthermore, some of these collections, perhaps out of lack of resources, may not comply with regeneration protocols as strict as those of CGN, meaning that some accessions may no longer be useful. Finally, the diversity of the material in a collection is only partly related to the size of the collection. Ideally, a comparison of collections (for the same crop species) would be conducted using a combination of such criteria. But it is nonetheless interesting to observe that a country that accounts for one of the largest shares of exports of seeds and planting material (the result of genetic improvement programmes), itself has a rather modest *ex situ* germplasm collection. Aside from the remarks made above, the reliance of commercial plant breeders on public germplasm collections is known to vary from company to company, and particularly by crop species. These issues will be revisited below in the perspectives of Dutch stakeholders on the importance for them of the CGN collections.

An important issue concerning the system of national and international *ex situ* genebanks concerns to what extent it actually is a system. There undoubtedly exists duplication of collections in different places, and perhaps also duplication of efforts to evaluate and characterise material. Duplication is not necessarily a bad thing, as it provides additional insurance in the case of loss, for example due to a natural or human-caused disaster at the site of one genebank. Indeed, this is the rationale behind placing duplicates of most major genebanks in the Svalbard Global Seed Vault, Norway. Nonetheless, genebank managers themselves have long recognised the need to coordinate their activities as best possible, particularly given the limited financial resources available relative to established priorities for conservation, both *ex situ* and *in situ*, including recognised gaps in existing collections.

The principal attempts at coordinating the important genebank collections involve European countries. Separate networks have long existed for each of the three sectors considered here:

- European Crop Programme for Plant Genetic Resources (ECPGR);
- European Forest Genetic Resources Programme (EUFORGEN);
- European Regional Focal Point for Animal Genetic Resources (ERFP).

ECPGR

The ECPGR, which was formerly known as the European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR), was established in 1980.[1] It is a collaborative programme involving most European countries (not necessarily EU members) that aims to facilitate the long-term conservation of crop genetic resources on a cooperative basis, and to increase their use. The programme is funded by participating countries.[2] A Secretariat is based at Bioversity International (formerly IPGRI) in Rome, and the work programme is agreed upon by a Steering Committee. Each member country is represented primarily by a national coordinator; Bert Visser fulfils this role on behalf of the Netherlands.

[1] www.ecpgr.cgiar.org

[2] Annual contributions based on the United Nations scale of assessment.

Bioversity International has estimated that there are approximately 500 crop genebanks and other institutes in Europe maintaining somewhere on the order of 2 million accessions (Maggioni, 2002), and accounting for roughly two-thirds of global collections. The ECPGR provides the principal vehicle by which information on the contents of these collections can be integrated (the AEGIS database) and efforts can be undertaken to coordinate their individual efforts at conservation and characterisation.

The ECPGR is entering Phase VIII which covers the period 2009-2013, for which the Steering Committee has agreed upon the following four priorities:

- Task sharing (in integrated database systems) and capacity building;
- Characterisation and evaluation;
- *In situ* and on-farm conservation and management;
- Documentation and information.

Much of the ECPGR's work programme is formulated and implemented by various networks (based on crop groupings, such as cereals, forages, or thematic topics, such as *in situ* conservation, documentation and information), and working groups for specific crop species (currently numbering 18) within the respective networks. The ECPGR has provided a mechanisms for its member countries to coordinate on the creation of core collections for certain crop species. One example is *allium*, for which CGN is now recognised as holding an international core collection.

EUFORGEN

Similar to ECPGR, EUFORGEN is a 'collaborative mechanism among European countries to promote conservation and sustainable use of forest genetic resources'.[1] There are currently 34 member countries and an additional 11 collaborating countries. EUFORGEN was established in 1994 and is currently nearing the end of its third phase (2005-2009), which has concentrated on promoting appropriate use of forest genetic resources as an integral part of sustainable forest management. It is also financed by contributions from its member countries, and a Secretariat is located at Bioversity International. The programme is also approved and overseen by a Steering Committee.

EUFORGEN operates through a number of networks by which scientists involved in forest genetic resources can exchange information and also develop strategies and methods for better management of forest genetic resources.

[1] www.bioversityinternational.org/networks/euforgen/index.asp

Currently there is one thematic network, on forest management, and three species-oriented networks, on conifers, scattered broadleaves, and stand-forming broadleaves.

EUFORGEN has produced long-term conservation strategies for nine genera or groups of species, as well as technical guidelines for conservation and use. Other scientific outputs include distribution maps for various tree species, and databases. The network also develops public awareness material.

In general, EUFORGEN supports national programmes; there appears to be less coordination on the formulation of these programmes than is the case with ECPGR, which probably reflects the much lower levels of investment in *ex situ* conservation in the case of forest genetic resources.

ERFP

The ERFP is described as 'the European implementation of Global Strategy of the Food and Agriculture Organisation of the United Nations (FAO) for the management of farm animal genetic resources (FAnGR)'.[1] The Global Strategy follows a country-based planning and implementation approach, but includes regional focal points in addition to those at the national level. The ERFP is primarily a platform for communication between national coordinators (Sipke-Joost Hiemstra fulfils this role for the Netherlands). Its aims are thus to assist these coordinators in developing and implementing their national strategies. It also seeks to develop regional projects and programmes, as well as regional databases on AnGR.

The national coordinators meet annually under the auspices of the ERFP, which also has a Steering Committee. The ERFP was established in 2000 and has a small Secretariat provided by France.

Examples of early ERFP projects include the development of guidelines for cryopreservation of AnGR, a study on optimising the implementation of databases on AnGR, a scoping study on cryoconservation of heritage sheep breeds. The ERFP activities are also relatively limited in comparison to those of the ECPGR for crop genetic resources. Again, as with forest genetic resources, the extent of national investments and programmes in the conservation of AnGR is much less than for PGR. And the network was created 20 years after the ECPGR crop network.

[1] www.rfp-europe.org

5 Actors and trends in plant genetic resources

This section discusses actors in the Netherlands involved in the management of plant genetic resources, including both conservation and use. Section 0 describes the various actors in crop genetic resources, as well as their interactions with CGN. The actors are divided into groups comprising breeding companies, research and education organisations, and non-governmental organisations (NGOs). The discussion concerning crop breeding companies is organised according to major crop species or species groupings. Section 0 describes the actors involved in forest genetic resources, as these are also plant genetic resources. Section 0 then summarises some of the important trends affecting these actors, as well as their interactions with CGN.

The information presented on actors and their interactions is based on the analysis of documents, including websites and downloadable documents. In a number of cases, this descriptive material is supplemented by information obtained from interviews conducted with a number of key stakeholders. Such interview information, where primarily descriptive, is not generally attributed to specific interviews. In some cases, particularly in the discussion of trends in section 0, reference is made to specific interviews.[1]

5.1 Crop genetic resources: actors and their interactions with CGN

The various actors with whom CGN interacts and shares genetic resources and information include breeding companies, research and education organisations, and NGOs. The nature of their interactions are summarised in Table 5.1 and described below. In general, the exchange and flow of genetic resources can be classified into two types:

- Genetic resources of current and recognised potential future value for crop improvement programmes; and
- Genetic resources of cultural and historical value.

[1] Such references should be treated as confidential information.

Table 5.1	**Actors that have interactions with CGN concerning crop genetic resources (PGR)**		
Main types of interactions	**Organisations**		
	research and education organisations	**breeding companies**	**NGOs**
Exchange of genetic resources	Request from CGN Donate to CGN	Request from CGN Donate to CGN	Provide newly discovered material to CGN Receive accessions from CGN for regeneration and return part to collection
Research collaboration or results	Evaluate GR in CGN collections	Return results of evaluation of accessions to CGN	Request CGN to evaluate *in situ* GR
Information exchange			Exchange of knowledge on state of *in situ* activities
Support for policy		Collaboration in international agreements	
Public awareness, education	CGN assists in training courses	Collaborate on raising awareness of benefits of IT and SMTA	NGOs would like to see more use of their knowledge in education, and receive more support for raising public awareness

An important difference between these two groups is their geographical origin. The first group concerns plant germplasm that, for the most part, originates outside of the Netherlands and indeed Europe. The second group consists of landraces of species that have been cultivated and maintained in the Netherlands over an historical period. Although they may not have originated in the Netherlands, and may perhaps be found in adjacent countries, they are considered to be of cultural value.

The flow and exchange of the first group is represented in a simplistic manner in Figure 5.1. The figure distinguishes between actors in other countries and those in the Netherlands. The former include farmers and genebanks: many landraces in centres of origin of major crop species have been collected and stored in national or international (CGIAR) genebanks, and in some cases this germplasm comes directly to CGN through collection missions. In other circumstances, CGN will have received samples from the other genebanks, who also provide such resources upon request to universities and public research institutes in the Netherlands (such as Wageningen Plant Breeding). Both CGN and research institutes may evaluate and characterise germplasm for any useful traits for breeding. Samples of such germplasm with desirable characteristics may then be distributed to a breeding company that has requested it (or possibly participated, even financially, in a preceding collection mission). Universities and public research institutes can also undertake preliminary breeding, termed pre-breeding, to develop lines that contain these desirable characteristics but are also better suited for crossing with existing improved lines.

The plant breeding companies cross germplasm received from CGN or researchers with their existing improved lines. The diagram also shows that these companies may obtain samples from foreign genebanks directly, and the discussion earlier on has concentrated on the evolving institutional framework for all such transactions. So from this point downwards in the diagram, the flows of germplasm consist essentially of improved varieties, as opposed to the upper part of the diagram, where these flows consist of samples of landraces and possibly also wild relatives. Breeding companies may also undertake seed production and marketing activities themselves; otherwise they negotiate a licensing deal with seed companies. The commercial varieties are then marketed to farmers, including farmers in both the Netherlands and other countries. Foreign commercial farmers are not typically the same group of farmers in centres of origin at the top of the chain, but do cover a wide range of countries, given the global market share of many Netherlands-based plant breeding companies.

Figure 5.1 **Flow of plant genetic resources among actors for crop improvement**

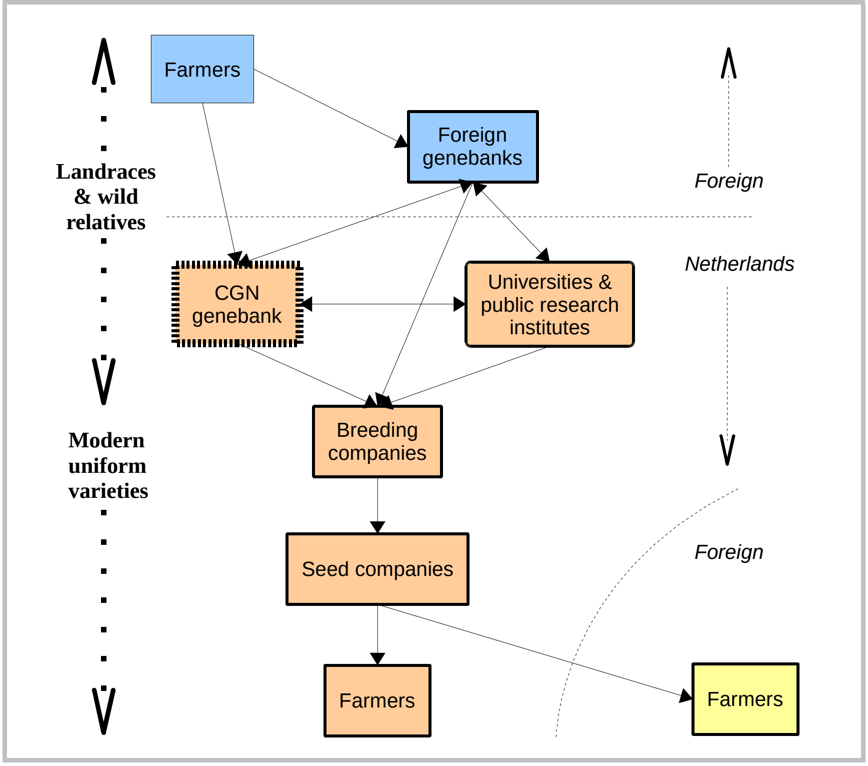


Table 5.2 provides an overview of the PGR accessions held by CGN, according to crop species, including the change between 1996 and 2008. The number of distributed samples over the 12-year period 1997-2008 is provided in the last column. Many of these accessions are distributed to plant breeding companies, as well as research institutes, as shown in Figure 5.1. Some of these crops species are referred to specifically below.

Table 5.2	**CGN crop germplasm collections**					
Crop	**No. of accessions in 1996**	**No. of accessions in 2008**	**No. of characterisation and evaluation data in**	**No. of characterisation and evaluation data in**	**No. of distributed samples over the period**	**No. of distributed samples over the period**
Wheat	5,246	5,551	27,413	43,166	1,917	6,973
Barley	3,414	3,458	39,686	46,300	651	3,762
Flax		952	2,863	14,354		363
Peas	986	1,001	12,572	15,699	867	940
Oats	536	536			247	314
Lettuce	2,118	2,571	53,737	91,168	6,752	18,716
Cruciferae	1,560	1,780	16,547	24,649	3,882	8,089
Maize	488	488	5,076	5,076	73	167
Lolium	134	394			156	34
Faba beans	607	728	8,533	8,831	118	146
Clover	137	263			7	566
Spinach	381	387	13,391	14,446	3,859	3,994
Allium	242	384	5,229	10,204	137	2,575
Timothy	34	105			3	10
Cocksfoot	28	42			2	20
Lupin	69	69	109	109	10	15
Tomato	1,025	1,275	40,147	44,905	61	2,068
Pepper	343	978	23,719	43,719	75	3,556
Eggplant	293	488	10,301	18,344	1	559
Cucumber		922	1,088	12,467		1,855
Potato	787	1,311	6,703	7,042	222	4,862
Poa		78				59
Fescue		73				
Agrostis		11				
Melon		2				4
Lily		46				
Apple		175				
Total	*18,428*	*24,068*	*267,114*	*400,479*	*19,040*	*59,647*

Source: CGN.

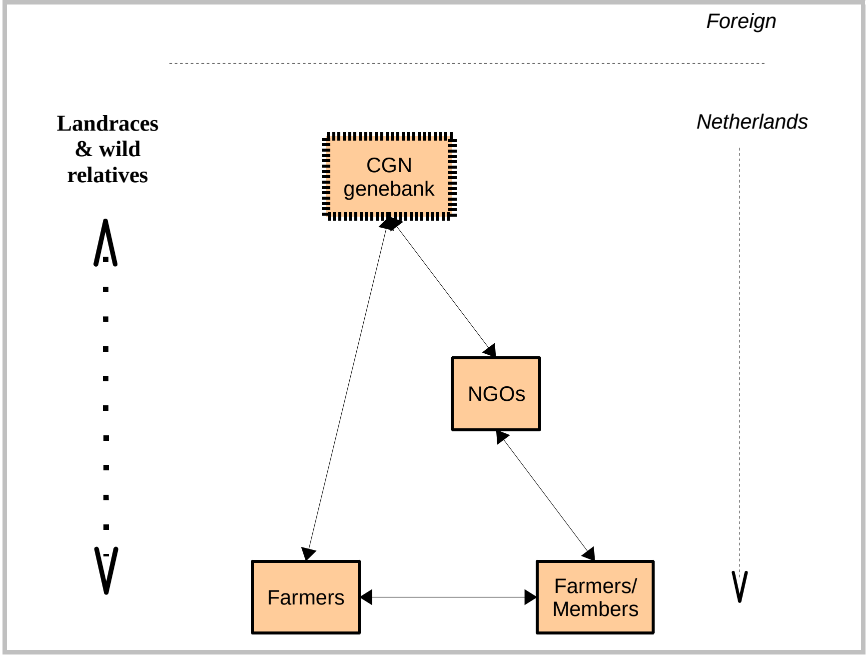
Figure 5.1 represents the flow of crop genetic resources in a fairly simplistic manner. There are numerous variations on this picture observed for different crops, some of which are mentioned below. There are also trends observable in the organisation of this genetic value chain, and these will be discussed further after the general description of actors. Such trends can relate, for example, not only to the quantity and nature of the flows of resources among actors, but also to changes in the activities of various actors.

While Table 5.2 details the number of accessions distributed over the past 12 years, annual figures are given in Table A2.1 (appended to document on p. 113). This shows the breakdown per type of actor, corresponding in general to those in Figure 5.1, although for all types of crop accessions grouped together. During the past 12 years, about 55% of the distributed accession were requested by the private sector, and about 40% by the research institutes and universities. Various other types of actors account for the remaining 5%, including foreign genebanks, individuals (e.g. farmers), NGOs, and botanical gardens. While there has been considerable fluctuation in the number of accessions distributed each year, there is no clear increasing or decreasing trend, including for the two largest groups of recipients, the private sector and research institutes and universities.[1]

The flow and exchange of crop genetic resources of cultural and historical value, the second group described above, is represented in Figure 5.2. This diagram is much simpler than Figure 5.1, although the multitude of farmers and members of NGOs participating is considerable. A major difference though is that these flows concern primarily landraces and wild relatives of crop species that are cultivated in the Netherlands. There is relatively little interaction with actors in other countries (although some requests from NGOs or genebanks in neighbouring European countries could be included). These resources concern essentially *in situ* conservation by individual farmers, who may undertake such conservation as a hobby activity and possibly serve for local niche markets. Some of these farmers are members of associations or NGOs that work to coordinate and publicise such efforts. These organisations also act as an intermediary between their member farmers and CGN. Genetic resources can flow between farmers, between farmers and their organisations, and also to CGN.

[1] A study of the distribution of US publically-held germplasm predicts an increase in the demand of germplasm by developing country breeders and research organisations (Day Rubenstein and Smale, 2004), but this has not yet manifested itself in the distribution of accessions by CGN.

Figure 5.2 **Flow of crop genetic resources of cultural and historical value among CGN and other actors**



Farmers may provide samples of landraces or lines to CGN for *ex situ* conservation. CGN may provide samples of conserved varieties to farmers upon request, or as part of a coordinated effort to regenerate accessions in the *ex situ* collection. In the latter case, farmers would then return a portion of the reproduced seed to CGN for *ex situ* storage.

The discussion now describes the various specific categories of actors, in turn, including the general types of interaction with CGN.

5.1.1 Plant breeding companies

Plant breeding companies can be categorised by type of crop. All plant breeding companies maintain their own collections of germplasm for use in breeding. Thus they both conserve and use genetic resources. The composition of their collections is a well-guarded secret, given that such information effectively indicates current and potential breeding research strategies to competitors. Indeed these genetic resources form, together with the expertise and reputation, the principal strategic resources and source of value of these companies. Companies themselves do indicate though that their collections are working collections, meaning that they do not generally maintain samples of germplasm that they do not expect to use in the near future. They therefore see little overlap with public collections, such as those of CGN.

Plant breeding and seed production companies in the Netherlands account for a considerable share of the international seed market. In 2004, this was estimated to be about one-quarter (by value), with the Netherlands as world leader, followed closely by France and the USA.[1]

Although it many companies indicate that they make little use of CGN germplasm, they are the largest group of requestors, as seen in Table A2.1. Even if the companies do not use such germplasm, their general view is that it is a public responsibility to conserve it for potential future use. Many would not contribute their own resources to this purpose, or in other words, maintain their own long-term collections. But they nonetheless expect that some of the material in CGN collections will be of longer-term use in breeding, or that it should be conserved as part of cultural heritage.[2] This does not necessarily mean that all accessions in public collections should be conserved, from the private sector perspective; there could be room for rationalisation of collections that still meets the overall conservation goals.

The discussion below concentrates on the various plant breeding companies and their interaction with CGN in terms of transfer of genetic resources. There is also another form of interaction between CGN and these companies, through their industry association Plantum.[3] CGN and Plantum are both involved intensively in various international negotiations, as described above, concerning the exchange and management of genetic resources. Both organisations provide experts as members of Dutch delegation, or simply in their own right. This leads to considerable information exchange between CGN and Plantum concerning negotiating positions of the Netherlands, and thus also includes the Government of the Netherlands, in particular LNV. These are discussed somewhat further below under interactions with government and public sector organisations.

---

[1] Definitive figures are not regularly compiled. These estimates are reported by Plantum (www.plantum.nl/pdf/groen_en.pdf) based on figures from the International Seed Federation (ISF) and LEI. A considerable amount of international trade is intra-European, and exports from and among European countries as a whole, account for roughly three-quarters of world seed exports (Eaton, 2008).

[2] These points were expressed by Orlando de Ponti, currently president of the International Seed Federation in an interview.

[3] www.plantum.nl

Potatoes

Potatoes are a special and interesting case in the plant breeding sector because of the relatively high cost of seed production (compared to grain or vegetable crops) and because of the ease with which a given variety can be reproduced given that potatoes are vegetatively propagated.[1] The development of new potato varieties still involves therefore considerable role played by the public sector research organisations, in the case of the Netherlands, Wageningen UR. Potato breeding companies make use of material containing improved traits, including those obtained by use of genetic modification, developed by Wageningen Plant Breeding. The breeding companies cross these with existing elite varieties. Companies then employ specialised contract farmers to sow the various crossings and to select the best performers. As explained by Bijman and Eaton (2003), these arrangements are becoming less common with the use of molecular markers and genetic modification to more accurately introduce desired traits. A major example is the research project on cisgene breeding[2] for phytophthora resistance (Duurzame Resistentie tegen Phytophthora - DuRPh), approved by the Dutch Ministry of Agriculture, Nature Management and Food Quality in 2006.

The potato germplasm (*solanum*) collection of CGN is among the most important in the world, and classified as a basic collection. The collection has grown from 787 accessions in 1996 to over 1300 in mid-2008, reflecting CGN's decision to concentrate on vegetable and potato collections.[3] CGN has distributed on average more than 400 potato accessions per year over the period 1997-2008 (see Table 5.2).

The relative bulk of seed potatoes means that breeding companies also contract a relatively large number of farmers to produce the growing stock. The resulting crop of seed potatoes is returned to the company for marketing to farmers in either the consumption potato or starch potato market segments.

---

[1] Thus it is relatively costly for a potato seed company to produce seed potatoes and relatively easy for others to reproduce the variety, even without authorisation of the seed company when this holds a plant breeder's right. In other words, the production costs are high and so are the costs of enforcing exclusive rights.

[2] Cisgene genetic modification involves the insertion of genes from the same species, including possibly wild relatives, and is thus distinguished from transgene genetic modification, in which genes are inserted from other species (as has been the case with genetically modified crops containing a gene from the Bt bacterium). Plant breeders expect that cisgene varieties will be more widely accepted by the food industry and consumers than transgenic varieties have been, and the regulatory requirements may also be less onerous.

[3] Rationalisaton of the collection has also been explored (see, for example, Van Treuren et al., 2004).

Thus, seed potato production accounted for 35,882 ha in 2007, which was almost 20% of total area under potato cultivation, including also consumption potatoes (99,944 ha) and starch potatoes (47,980).[1] A large portion of the seed potato crop is exported, indicating the important position of Dutch potato breeding companies in the international market. The Netherlands is the largest exporter of seed potatoes in the world. Of the 894,000 tons of seed potatoes produced in 2006, 70% were exported (LEI and CBS, 2008), approximately 600,000 tons on average. The two largest seed potato companies in the Netherlands, Agrico and HZPC, together account for approximately 80% of the Dutch market. Both are farmer-owned, reflecting the relative importance in this value chain of the farmers who undertake the seed production.

Grasses and Forages

Grasses are particularly important for the dairy sector in the Netherlands. The country is one of the centres of origin for grass and has made international commitments to ensure the conservation of indigenous varieties within the framework of the CBD and as stated in the genetic resources policy document *Sources of Existence*.[2] In 2002, there were still five grass seeding companies active in the Netherlands, although most of them had been acquired by foreign-based multinationals. This trend has continued, with Cebeco being acquired that year by DLF-Jenks, a Danish-based company, to form DLF International Seeds, now based in the US. Advanta was sold by AstraZeneca to Syngenta in 2004[3], and Zelder Zaden was also purchased. Joordens' Zaden, still a subsidiary of the French farmer-owned R.A.G.T. Group is still present in the Netherlands, and Barenbrug remains as the sole privately-owned, Netherlands-based company specialising in grass and forages.

While information on the use of CGN germplasm by these companies is not available, different perspectives on the usefulness of landraces and traditional varieties for grass breeders were voiced already in 2002. Some breeders view the conservation of such varieties as being very valuable for future breeding possibilities, while others expect that it will be sufficiently effective and more efficient to seek traits among improved varieties, including those from other countries.[4] CGN has for its part chosen to not concentrate further on developing its grass and forage collection.

---

[1] All figures concerning agricultural production in the Netherlands are taken from LEI and CBS (2008).

[2] *Bronnen van ons Bestaan* (LNV, 2002).

[3] And some Advanta brands were acquired by Limagrain in 2005.

[4] See Bijman and Eaton (2003) for a summary of views expressed in an article in the magazine *Veeteelt* (volume. 19, no. 15/16, August, pp. 26-27).

Grains

Grain crops cultivated in the Netherlands include wheat, barley, oats, rye, spelt, buckwheat and maize. Of these, maize is the most significant in terms of area, as it has grown in importance as a feed crop for livestock holders. According to the database of the Netherlands ABS Focal Point, there are currently four companies in the Netherlands holding collections of maize germplasm for breeding purposes. A considerable portion of maize seed sown is from international companies with breeding programmes based in other countries, although precise figures have not been gathered. Maize is one crop for which varieties genetically-modified for insect resistance, herbicide tolerance or both, have gained considerable market share in North and South America. A more limited varieties have been approved for cultivation in the EU (and hence the Netherlands). There is interest among farmers (as voiced through their associations such as LTO) in increased access to and use of such GM varieties. CGN has a relatively limited collection of maize (see Table 5.2) and distribution and use of these accessions also seems low, although that should not necessarily be taken as indicative of their value. Nonetheless, exchanges between CGN and plant breeding companies for maize seems to be of secondary importance.

Table 5.2 indicates that CGN has relatively large collections of wheat and barley germplasm. Although these have remained effectively stable over the last decade, distribution of accessions appears to have increased considerably. On the other hand, the ABS Focal Point shows no commercial breeding companies in the Netherlands with working collections for wheat, suggesting that varieties grown in the Netherlands are provided by international seed companies.

Other field crops

Other field crops include sugarbeets, fodder beets, various legumes, and flax. In Europe, and thus the Netherlands, there are now really only two companies active in sugarbeet breeding, KWS and Syngenta, since the acquisition by the latter in 2004 of Advanta. CGN transferred its sugarbeet collection to the German genebank some time ago[1], and thus there are no longer any significant interactions or exchange between CGN European sugarbeet breeders. As reported already by Bijman and Eaton (2003), there are only a limited number of plant breeding companies active in the Netherlands for the other field crops mentioned.

[1] Prior to the entry in force of the first WOT-GB agreement.

Vegetables

The Netherlands is the original home to many of the leading vegetable breeding companies in the world. While many have grown to become true multinational companies and merged with or acquired by companies based in other countries, a number are still Dutch-based or at least have considerable operations in the country. According to the ABS Focal Point (with data supplied by Plantum), there are up to 11 companies involved in the breeding of vegetable seeds and that maintain active collections of germplasm, depending on the crop species.[1] The largest vegetable breeding and seed companies in the Netherlands include Seminis (formed from a merger of Royal Sluis and Bruinsma, and now a subsidiary of Monsanto), Syngenta (seed business was formerly part of Novartis, and vegetable seed business was acquisitions of Zaadunie and Sluis and Groot), Nunhems (a Dutch-based subsidiary of Bayer CropScience) and Nickerson-Zwaan (a subsidiary of Limagrain). Privately-owned Dutch vegetable seed companies include RijkZwaan, Bejo Zaden and Enza Zaden. A fourth prominent company, De Ruiter Seeds, particularly successful in recent years in tomato breeding, was acquired by Monsanto in 2008, which apparently wanted to strengthen its position in vegetable seed for protected cultivation, alongside the strengths of Seminis in open-field vegetable seeds.[2] The export of vegetable seeds takes a major share of agricultural exports from the Netherlands, and the Dutch-based multinationals are responsible for considerable amounts of investments in their operations in countries of both North and South.

As mentioned above, CGN has decided to concentrate on expanding and improving its existing important vegetable collections (in addition to the potato collection), a move that can be justified in part by the strong Dutch presence in commercial vegetable breeding. As seen in Table 5.2, CGN has large collections of lettuce, brassica/cruciferae (including cabbage family, mustard family and crops such as cabbage, cauliflower, kale, broccoli), spinach, allium (onion, garlic, leek), tomato, pepper, and cucumber germplasm. The lettuce, cabbage and onion collections have the international status as basic collections.

Fruit crops

The breeding of new varieties of fruit trees and shrubs involves longer time periods than for other crops. This may explain why there are generally fewer

---

[1] The ABS Focal Point lists the number of commercial plant breeding companies with germplasm collections, per type of species, but does not include the names of the companies. There is considerable overlap as many companies are active in breeding varieties of more than one crop.

[2] www.deruiterseeds.com/News?path=%2FNews%2FCorporate_Site_en%2FMonsanto+Company+completes+acquisition+of+De+Ruiter+Seeds

commercial companies investing in this enterprise, which has generally been undertaken by research institutes, universities and growers' associations, not only in the Netherlands but worldwide.

A recent Netherlands exception to this pattern is Inova Fruit, a private company formed in 2001 with fruit growers marketing cooperatives as its shareholders. Inova Fruit develops and markets new apple and pear varieties, and has introduced three new apple varieties (Wellant, Rubens and Junami).[1] CGN does not have significant fruit germplasm collections and thus, there is little interaction with Inova Fruit. But the new apple varieties have been developed in collaboration with, among others, Plant Research International of Wageningen UR.

Ornamental crops

Alongside vegetables and potatoes, the Netherlands is also the home or origin of many of the major commercial companies involved in the breeding of new varieties of ornamental plants (flowers and potted plants). The ABS Focal Point lists up to a maximum of 12 commercial breeding companies as holding working collections for each of 20 ornamental crop species. CGN does not have any major collections of these species and thus there is almost no interaction or exchange with these breeding companies, which obtain germplasm from other sources, such as botanical gardens and their own collection activities.

5.1.2 Research and education organisations

Figure 5.1 shows interactions between CGN and research institutes and universities in terms of flows of genetic resources. As a genebank, one of CGN's principal activities is the provision, upon request, of genetic resources to organisations in both the public and private sector that use germplasm in breeding programmes. As mentioned above, research institutes and universities account for 40% on average of the accessions distributed by CGN, second only to commercial plant breeding companies.

Wageningen UR is, for obvious reasons, the most important organisation engaged in applied research and education with which CGN interacts. CGN is a part of Wageningen UR, which is also the principal publically-funded research organisation in the Netherlands in the area of crop genetic improvement. The principal group within Wageningen UR active in this area is Wageningen Plant Breeding, a partnership between the Plant Breeding Department of Wageningen

[1] See www.inovafruit.nl

University and the Biodiversity and Plant Breeding Business Unit of Plant Research International. The interactions between Wageningen Plant Breeding and CGN are of three types:

- Wageningen Plant Breeding requests germplasm from CGN for use in research projects;
- Wageningen Plant Breeding donates/hands over germplasm collections to CGN for it to maintain;
- Collaboration on research projects.

The first two types are reflected in the two-way arrow between CGN and research institutes in Figure 3. The handing over of germplasm collections to CGN, as occurred in 2007 with the allium collection of Wageningen Plant Breeding, is though the type of transfer that takes place at certain discrete points in time (in other words, not regularly). An example of germplasm requests of CGN is the project in which Wageningen Plant Breeding, in collaboration with the Centre for Biosystem Genomics (CBSG), is screening wild relatives of potatoes held in CGN collection for genes that might be related to *phytophthora* resistance. In this case, specific accessions were proposed by CGN. One researcher of Wageningen Plant Breeding indicated that they have a general preference for working with genetic material from CGN collections, given the relative ease of access.

There have recently been more collaborative research projects involving both Wageningen Plant Breeding and CGN. The DuRPh project on *phytophthora* resistance, mentioned above, is almost a collaborative project in terms of the nature of the interaction with CGN. CBSG screened the accessions provided by CGN and the resulting information was then returned to CGN for inclusion in its database, thus making it available to others. CBSG is a public-private partnership between Wageningen UR and various plant breeding companies.[1] Thus, CBSG may delay returning the evaluation information to CGN's database for a period of 6-9 months in order to provide CBSG's financing companies some lead time in its exploitation. CBSG indicates that the collections held by CGN can be very important sources of genetic resources, particularly in searching for resistance to pest and disease.

Another example of a collaborative project is BIOEXPLOIT[2], an EC-funded integrated project under the DG Research's 6th Framework Programme. This project, involving more than 43 research organisations and plant breeding

[1] www.cbsg.nl

[2] www.bioexploit.net

companies from 15 (primarily European) countries, efficient and rational breeding strategies for wheat and potato using genomics and post-genomics tools to exploit natural host plant resistance. CGN leads a work-package on database integration.

Another form of interaction between CGN and WUR concerns education. CGN collaborates with Wageningen International on annual short courses on the genebank management and genetic resource policies, for mid-career professionals coming primarily from countries of the South.[1] CGN provides expert staff to organise and lead these training activities.

CGN has interactions, in terms of request for genetic material, from other research institutes and universities, particularly from other countries. Detailed information on these interactions has not been obtained for the current report.

5.1.3 Non-governmental organisations (associations, clubs, foundations)

There are a wide variety of NGO's (including, for the present purposes, associations, clubs, foundations) active in managing plant genetic resources. In most cases, such organisations provide a framework for presenting and possibly coordinating the activities of individual farmers, members and volunteers. Most of these organisations concentrate on traditional varieties and species of cultural and historical value, as depicted in Figure 5.2. A number of these were described by Bijman and Eaton (2003), although essentially in an illustrative, as opposed to exhaustive manner. The major organisations are summarised here, but a comprehensive overview is still lacking.

One of the most prominent organisations is 'De Oerakker', headquartered in Bakkeveen.[2] This organisation maintains less well-known varieties and species of agricultural (including horticultural) crops, that are no longer grown for commercial purposes. Established in 1995, De Oerakker maintains a collection originally started by in the 1960s. De Nieuwe Akker, formed in the 1976s along the lines of the Stichting Zeldzame Huisdierrassen (SZH) was absorbed into De Oerakker in 2008.[3]

Under the auspices of De Oerakker, and the initiative of Obe Bootsma, The Netwerk Eeuwige Moes was established in 2007 as a network of intiatives, including NGOs, that are active in the conservation of crop genetic resources in the

[1] These activities and interaction do not form part of the WOT-GB, although could be interpreted as contributing to global objectives of Dutch policy.
[2] www.deoerakker.nl
[3] www.denieuweakker.com

Netherlands. The objective of this network is the conservation of old/traditional crops, with the original Oerakker collection as basis or starting point. Members of Eeuwige Moes work on *in situ* conservation of these resources in order to maintain genetic variation, conserve the cultural values, and to promote their culinary use. Members of the Network (as of end 2008) include:[1]

- Tuinen van Weldadigheid, Drenthe (www.detuinenvanweldadigheid.nl);
- It Griene Nest, Friesland (www.itgrienenest.nl);
- De Bolster V.O.F., Gelderland (www.debolster.eu);
- Hof van Twello, Gelderland (www.hofvantwello.nl);
- Historische tuin Lent (www.historischetuinlent.nl);
- Kasteel Doorwerth Moestuin, Gelderland;
- Nationaal Park Veluwezoom, Gelderland (part of Vereniging Natuurmonumenten);
- De Ommuurde Tuin, Gelderland (www.ommuurdetuin.nl);
- Openluchtmuseum, Gelderland (www.openluchtmusuem.nl);
- De Oude Moestuin, Gelderland (www.oudemoestuin.nl);
- De Historische Groentenhof, Limburg (www.vergeteneten.nl);
- Kasteeltuin Oud-Valkenburg Sjloensheim, Limburg (www.kasteeltuinoudvalkenburg.nl);
- Landgoed De Hoevens en Stichting Korensla, Noord-Brabant
- Buitenplaats Gooilust, Noord-Holland (part of Vereniging Natuurmonumenten);
- Heemtuinvereniging De Heimanshof, Meerboerenvereniging, Noord-Holland;
- Historische Tuin Aalsmeer, Noord-Holland (www.htaalsmeer.org);
- Stichting De Nieuwe Akker, Noord-Holland;
- Stichting Rijksmuseum Muiderslot, Noord-Holland (www.muiderslot.nl);
- Jaap Vlaming, te Den Burg, Noord-Holland;
- Stichting Twickel, OverIJssel (www.twickel.nl);
- Bd Tuinderij De Aardvlo, Utrecht (www.aardvlo.nl);
- BijenAkker, Utrecht;
- Eemlook, Utrecht (www.knoflooksite.nl);
- Kasteel Amerongen, Utrecht;
- Landgoed Eyckenstein, Utrecht (www.landgoedgroenten.nl);
- Landhuis Groeneveld, Utrecht (property of LNV);
- Ridderhofstad Hindersteyn, Utrecht (www.hindersteyn.nl);
- Stichting Vrienden Landgoed Vollenhoven, Utrecht;
- Vreeken's Zaden, Zuid-Holland (www.vreeken.nl);

[1] www.deoerakker.nl/deelnemers.htm

- Westlands Museum, Zuid-Holland (www.westlandsmuseum.nl);
- CGN.

Netwerk Eeuwige Moes is thus an attempt to coordinate the activities of these various organisations, including attempts to raise public awareness, build partnerships and obtain financial support. A major concern voiced is that various species and varieties are threatened with loss, as their continued existence is dependent on a limited number of committed farmers, some but certainly not all of whom could be classified as hobby farmers. Knowledge about traits and uses (such as culinary ones) of these resources lies with these individuals, who are often of, or approaching retirement age. Eeuwige Moes aims to develop initiatives to conserve both the resources and the knowledge, together forming the cultural and historical value, including means for transferring this to others, such as young farmers, which could involve more attention in education and training institutions to traditional crops and varieties. There is frustration on the part of some of the members over difficulties in applying for government financial support because of the small size of the initiatives and proposals. The network is thus also an attempt to bundle such initiatives and avoid such restrictions.

Eeuwige Moes is coordinating the compilation and revision of the Orange of threatened and endangered varieties of vegetable crops. Orange lists for beans and for peas have been formulated in 2008 and there are plans to conduct the exercise for lettuce and cabbage in 2009.[1]

CGN is also a member of the Netwerk Eeuwige Moes. It supports the network and its members, with its *in situ* conservation project. Specifically CGN will conserve in its *ex situ* facilities accessions donated by members of the network. CGN will also redistribute seed for regeneration by network members and refreezing. Thus CGN has a two-way exchange of genetic resources with certain network members (referring to Figure 5.2), that is different in nature than its exchanges with professional breeders. In this case though, CGN is also fulfilling a type of 'bank' function (for storage), but the 'liquidity' function is currently less pronounced. CGN has also conducted some limited molecular marker analysis to evaluate the variation among certain traditional races. The initiator of Eeuwige Moes, O. Bootsma, indicates that the support of CGN is extremely limited relative to the objectives of the Network.

[1] See www.deoerakker.nl/oranjelijst.htm; this was complemented with information from the minutes of the meetings of Netwerk Eeuwige Moes.

In terms of grass species, for which the Netherlands is the home for the development of a number of indigenous varieties, *in situ* conservation on 'old grasslands'[1] was undertaken almost ten years ago by about 50 farm enterprises (van Soest and Bas, 2000), for various motives such as personal interest in agricultural heritage, or role of such varieties in organic farm production systems (Janssens et al., 2002). It is not clear to what extent such *in situ* locations are still operative, as there does not appear to be a systematic and regular effort to collect data on this activity. While there might be a risk that some of these *in situ* conservation sites have disappeared, an analysis by CGN of diversity in the genepool for three principal species found essentially no difference in the diversity between traditional (in situ) grasslands, commercial cultivars and nature reserves (Van Treuren and Visser, 2005). This suggests that specific policy measures to support this form of *in situ* conservation are not required.

5.1.4 Government and public organisations

The principal form of interaction between CGN and governmental organisations concerns expertise contributed to ongoing international negotiations and discussions, as discussed above on various occasions. This type of interaction is not represented in Figure 5.1. Staff of CGN have an understanding of the provisions, particularly those related to ABS, being negotiated under the International Treaty, CBD and other fora, that is more comprehensive than LNV staff. Policy support takes place in the form of advice on specific positions, but also includes participating in delegations of the Netherlands. This policy support is included in general terms as one of the activities under the WOT-GB.

CGN also has interactions with the Directorate-General for Development Cooperation (DGIS), primarily on either specific collaborative projects involving partners in the South, or on issues concerning the Consultative Group on International Agricultural Research (CGIAR). CGN staff lead collaborative projects involving research centres of the CGIAR, though these do not fall under the WOT-GB, and also represent Wageningen UR at CGIAR meetings.

[1] In Dutch, *oude graslanden*.

5.2 Other plant genetic resources: actors and their interactions with CGN

The preceding discussion has concentrated on crop genetic resources and attention now turns to actors involved in the management of other plant genetic resources, that may be relevant for food and agriculture.

5.2.1 Botanical Gardens

Botanical gardens are another important category of stakeholders active in the management of plant genetic resources, particularly *ex situ* conservation. In the Netherlands, 16 botanical gardens are united under the Dutch Botanical Gardens Collection Foundation (Stichting Nationale Plantencollectie - SNP) as caretaker of the National Plant Collection (Nationale Plantencollectie).[1] This foundation provides a mechanism, in existence since 1988, by which the botanical gardens can coordinate their conservation efforts in terms of a national collection, as opposed to only separate collections. The collection is meant to conserve specimens of plants that are of extraordinary scientific, cultural-historical or social value. Plant species included in the collection include ornamentals, and tree and shrub species (thus relevant for forest genetic resources, as discussed below), as well as some agricultural crop species, such as tea and spices.[2]

In addition to this National Plant Collection, 19 botanical gardens in the Netherlands are represented by a national association, de Nederlandse Vereniging van Botanische Tuinen (NVBT).[3] 11 of these member gardens collaborate on a Red List project with a four components, including[4]

- *Ex situ* conservation of 50% of the Red List species held by members and 75% of the critically-threatened species (small numbers of individual plants);
- Adoption of Red List species at population level, approximately 2 species per member;
- Sampling at population level of all Red List species and duplicate storage in two *ex situ* collections (Utrecht and Delft);

---

[1] www.nationale-plantencollectie.nl/index.htm
[2] Strictly speaking, a number of these species can be considered as crop species, and thus falling under the realm of the preceding section. Given the wide range of species that botanical gardens conserve, they are included here.
[3] botu07.bio.uu.nl/nvbt/links.htm
[4] Personal communication from B. Wollenberg, Curator, Botanic Garden, Delft, and Head, BGCI-Netherlands.

- Raising public awareness of project and Red List species, particularly by targeting their 3-4 million annual visitors.

The two *ex situ* collections to be created will be brought under the European Native Seed Conservation Network (ENSCONET) in order to ensure their compliance with established procedures and methods. The NVBT has permission from LNV to endorse mandates, approve activity plans and monitor their implementation by the individual botanical gardens.

There does not appear to be many species in common between the botanical gardens and the collections of CGN, which explains why there is little interaction between them. The botanical gardens, for their part, would very much like to see collaboration with CGN, at the very least on this project, and specifically with respect to the third point. The botanical gardens are generally not included as partners in international plant conservation strategies, such as the Global Strategy for Plant Conservation (GSPC), which focuses on stakeholders involved in the agricultural plant breeding sector. For example, the project mentioned above is an initiative of the botanical gardens 'on their own'.

5.2.2 Actors involved in the management of forest genetic resources

In contrast to the situation concerning crop genetic resources, the actors involved in forest genetic resources, comprising trees and shrubs (and excluding commercial fruit tree species[1]), are all primarily undertaking conservation activities; there are few genetic improvement programmes, nor are there large commercial tree breeding companies located in the Netherlands. There are however a number of companies involved in the reproduction and sale of seed and planting material.

Research in the late 1990s estimated that only 5% of the tree and shrub species in the nature areas originates from the Netherlands (Engels, 2006). In 2001, government policy was formulated on the conservation of autochtone and semi-autochtone tree and shrub populations.[2] This led to the initiation of an *ex*

---

[1] On the other hand, wild varieties of fruit trees are included under forest genetic resources, including wild apple trees in the case of thet Netherlands genebank.

[2] Autochtone populations of trees and shrubs are defined (by the EC) as those that are descended from populations that have established themselves naturally (in the Netherlands in this case) since the last ice age. As explained by Engels (2003), it is difficult to establish the autochtone status of a population in the Netherlands with full certainty, given the extent of human interference in essentially all areas of the country. Nonetheless a number of criteria are used by which a population can be declared as autochtone.

situ genebank which now includes approximately 3,500 accessions of 50 different species.[1] The fragmented network of more than 400 *in situ* locations of such species is not considered to be a sustainable conservation strategy. For this reason, the genebank was established over 36 different sites, or parcels of land, of Staatsbosbeheer in Flevoland (Roggebotzand), comprising 28 ha in total.[2] Forest genetic resources were added to the WOT-GB in 2005 (roughly halfway during the first contract period) and the genebank was officially opened in 2006.

Staatsbosbeheer

Staatsbosbeheer (State Forest Service) manages approximately 250,000 ha of protected nature areas in the Netherlands.[3] In managing these areas for sustainability, the organisation concentrates on natural areas that provide a variety of functions, including conservation of natural, cultural and historical resources, as well potential for human use, such as recreation. Staatsbosbeheer is thus the principal manager of forest resources, as well as natural areas, in the Netherlands.

Until 1998, Staatsbosbeheer was a part of LNV, but it is now an independent public agency under the jurisdiction of LNV. The agency commits itself to a workplan and targets with LNV on an annual basis and functions under the oversight of an oversight council (*Raad van Toezicht*).

Staatsbosbeheer works to conserve and maintain as wide a variety of natural ecosystems in the Netherlands as possible. These protected areas include both conservation and regeneration, with an attempt to support natural evolutionary processes. Staatsbosbeheer is implementing a plan to create an ecological network of protected areas (Ecologische HoofdStructuur) that attempts to limit the problems of fragmentation among the multitude of parcels.

The specific organisational arrangements by which Staatsbosbeheer has been involved in the conservation of forest genetic resources has changed in recent years. The product group Zaad en Plantsoen (Seed and Public Gardens) of Staatsbosbeheer was responsible in the early part of the current decade for procuring planting material, particularly for use in public projects and the own sites of Staatsbosbeheer. In 2000, Zaad en Plantsoen formed a partnership with an NGO, Bronnen Bomen, 'Bronnen - voor nieuwe natuur'. This enterprise

---

[1] www.genenbankbomenenstruiken.nl

[2] This description also makes use of a number of articles in the professional periodical, *Boomkwekerij* (Engels, 2003, 2006, 2008).

[3] www.staatsbosbeheer.nl

worked on the establishment of national genebank for forest genetic resources, and also to supply high quality planting material for government and public agencies (for example, at provincial or municipal level). This partnership also began formulating a policy document for LNV on the conservation of the Netherlands forest genetic resources. Before this was completed, a reorganisation at Staatsbosbeheer led to the ending of the partnership with Bronnen Bomen in 2004. Bronnen Bomen now procures and delivers autochtone planting material to its client organisations. The Zaad en Plantsoen product group is now termed Staatsbosbeheer Bronnen. This group arranges for the purchasing of all planting material required by Staatsbosbeheer itself as well as the Dienst Landelijk Gebied (DLG) of LNV.[1] In addition, Staatsbosbeheer Bronnen manages the national genebank, the parcels of land on which the Netherlands genebank of tree and shrub species is located at Roggebotzand in Flevoland.

CGN

The genebank is managed as a partnership between Staatsbosbeheer, CGN, Maes (an ecological consultancy), and Bronnen Onderzoek en Advies. The activities of CGN with respect to the genebank for forest genetic resources are:

- Providing policy support to the Dutch government and representing the Netherlands in the European collaborative network for conservation and utilisation of forest genetic resources in Europe (EUFORGEN);
- Developing conservation strategies for endemic tree and shrub species;
- Performing molecular genetic research to support *in situ* and *ex situ* conservation of forest genetic resources;
- Functioning as an information source for the Genebank of trees and shrubs of the Staatsbosbeheer.[2]

Thus, in contrast to the situation with crop genetic resources (and also with animals, as will be seen below), CGN does not actually manage the genebank for forest genetic resources. Instead, CGN works to develop conservation strategies and undertakes research to support the operation of the genebank by Staatsbosbeheer.

Both Staatsbosbeheer and other managers of nature areas have indicated that they would like to see CGN have more resources in order to perform the research on genetic variability of *in situ* populations, as a means to improve

[1] The activities in procurement has led to accusations from the commerical sector (members of the Nederlandse Bond van Boomkwekers - NBvB) of unfair competition (see Engels, 2006).

[2] www.cgn.wur.nl/UK/CGN+Forest+Genetic+Resources/Activities

conservation strategies. In other words, their perceptions are that these activities are relatively limited in the current WOT-GB. In addition, many of these nature areas are managed as ecosystems comprising a group of interacting species, and thus the limitation of CGN's analysis and contribution to specific species of trees and shrubs is also viewed as suboptimal.[1]

Other actors
Other managers of forest genetic resources include private forest and nature enterprises, many of which are landowners. These enterprises, and the unions of employees (particularly CNV) are represented in the Bosschap,[2] an industrial board which provides a forum for collective wage bargaining and other forms of self-regulation. Private forest owners are also represented in various regional Bosgroepen, which are united nationally in the Unie van Bosgroepen.[3] Many of these owners can be considered as managers of *in situ* forest genetic resources.

Aside from commercially-oriented forest owners, there are also other private and public (or semi-public) owners of forest and nature areas. An exhaustive list is not offered here but some of the principal owners include

- the provincial Landschappen,[4] which are private nature conservation organisations at provincial level, based on individual donations and volunteer work;
- Natuurmonumenten,[5] a national association for nature conservation, with about 880,000 members. The organisation owns and manages 345 nature areas, together totalling 100,000 ha;
- The Hoge Veluwe National Park,[6] a non-governmental organisation that owns and manages the oldest and largest national park, covering 5,000 ha.

[1] These perspectives were voiced at a meeting of stakeholders involved in forest genetic resources, organised by CGN, 13 December 2007, to discuss their vision concerning a new WOT-GB (minutes of meeting provided by CGN). Bosschap and Natuurmonementen (discussed below) were the principal other managers, aside from Staatsbosbeheer, of nature areas invited to the meeting; neither could attend but Bosschap provided comments on the minutes.
[2] www.bosschap.nl
[3] www.bosgroepen.nl
[4] www.landschappen.nl
[5] www.natuurmonumenten.nl
[6] www.hogeveluwe.nl

5.3 Plant genetic resources: developments, trends and implications

This section assesses more specific trends in the conservation and use of plant genetic resources. The analysis is based primarily on information provided by individuals from various organisations involved in conservation and use of the resources.[1] The implications of these developments for consideration of the second WOT-GB are also discussed. These developments and implications are summarised in Table 5.3 (which is similar in structure to Table 3.1).

The discussion above in section 0 provided considerable detail on developments concerning international agreements affecting plant genetic resources. From the perspective of many commercial plant breeding companies, there is still a kind of 'liquidity crisis' in the availability and flows of crop germplasm (and their wild relatives), particularly from certain countries of the South.[2] This situation has given commercial companies an incentive to build up their own crop germplasm collections, and has also affected research options open to publically-financed research organisations such as Wageningen Plant Breeding.[3]

Developments in commercial plant breeding: ongoing concentration
The last five years has seen continued concentration among commercial plant breeding companies, involved in various crop species. The largest companies have continued their acquisition of smaller, privately-owned businesses, particularly in vegetable breeding. Thus, in the past five years a number of Dutch-based companies have been acquired by, or merged with, new foreign owners.

Part of the rationale behind concentration appears to be the acquisition of genetic resource collections, aside from breeding expertise and brand names. The continued developments in biotechnology mean that there are ongoing economies of both scale and scope in plant breeding.[4] But it may also be that the liquidity crisis in crop germplasm makes the building-up of company's own working collections even more attractive.

---

[1] See the introduction to section 5 and the appendix.
[2] This interpretation was confirmed by A. van den Hurk, Plantum, and O. de Ponti, International Seed Federation (ISF).
[3] Interview B. Vosman, Wageningen Plant Breeding.
[4] Economies of *scale* here refers to lower average costs for breeding new varieties of a crop species, the bigger the breeding programme is, in terms of breeding goals, number of varieties, market segments, etc. Economies of *scope* refers to lower average costs for breeding when a programme works on more than one crop species. Such savings may result from the ability to apply the same technology and expertise, for example in marker-assisted selection or genetic modification, to more than one breeding programme.

Another factor possibly behind the drive by companies to expand their own working germplasm collections is the strategic motivation to enhance secrecy concerning their R&D programmes. It is more difficult for competitors to deduce the research directions being pursued in breeding programmes, if these rely less on requests of material from public genebanks.[1]

Some stakeholders are concerned that the concentration will ease the pressure of competition among larger companies. This may not necessarily manifest itself in terms of prices for seed, but perhaps in lower R&D investments. Relatedly, such stakeholders, who can include breeders with SME breeding companies, view sharper competition among more players as increasing the likelihood that the breeding sector will pursue a wider range of breeding strategies, and thus a faster rate of innovation. These arguments are connected to discussions concerning further changes to IPR regimes, particularly between US and European seed companies, as discussed in Section 0. This issue may have recently receded from debate, but could likely surface again in the course of the next five years.

One implication of this development for the WOT-GB is that *ex situ* collections, such as those of CGN, may provide a source of liquidity in plant genetic resources that is more important for smaller companies. In such a case, maintaining these collections, and equally importantly further evaluating and characterising their contents, would help support competition in the sector. This hypothesis has not however been systematically assessed in the current study and its validation would require gauging the perspectives of a broader range of companies. To the extent that it is true, which is more likely for certain crop species, this would imply an additional rationale for public support of *ex situ* activities.

It is not clear at this point whether this ongoing concentration has implications for the breeding programmes, in terms of directions or strategies chosen.

[1] Although such genebanks, including CGN, agree to maintain such information confidential, it can become more widely known given informal exchanges and networking, given the relatively small group of individuals involved in commercial and public research organisations.

Table 5.3	**Developments in plant genetic resources and implications for WOT-GB**	
Issue	**Developments (since 2002 and expected to 2013)**	**Implications for WOT-GB**
Commercial plant breeding sector	Continued concentration (acquisitions) Future: acquisition may be decline; cross-licensing may increase	Availability of public *ex situ* may provide some genetic liquidity that is more relied upon by smaller companies, and thus supports competition
	Building of own in-house working collections, diminished use of public *ex situ* collections as (transaction) cost of access have increased Future: use of public collections depends on implementation of SMTA and also ABS	Importance of CGN collections may be shifting more towards long-term conservation, including for cultural-heritage values; appropriate indicators for assessing genebanks role may need to be revised
Technology	Declining costs of evaluation Future: value of genetic resources should increase but also increased research attention to other species in agricultural production	It should be possible to do more with less in terms of evaluating own collection
Scope of PGR policy issues	Range of PGR and actors has broadened beyond primary concern in 1990s with agricultural plant breeding (tree and shrub species, other botanical species)	Demands and expectations on WOT-GB will continue to grow, given historical allocation of resources
In situ conservation	Principal NGOs in Netherlands have created a coordinating association and are frustrated at lack of public support or initiative	A relevant question is how to assess what allocation between *ex situ* and *in situ* should be in WOT-GB.

Longer-term use of ex situ *collections by commercial companies*

It is difficult to forecast what the implications of reduced government support to the WOT-GB would be for commercial plant breeding companies. As indicated above, many of these companies do not rely regularly on requesting material from CGN, although any such use would only be negatively affected if CGN decreased regeneration activities or actually abandoned certain collections. On the other hand, representatives of the private sector generally express the view that maintaining such collections should be a public responsibility. These collections support not only the breeding sector, but conserve cultural and heritage values as well. And the support for commercial breeding may not materialise in some cases until many years in the future. Thus the immediate implications might be hard to see but more long-term in nature.

In general, this suggests that appropriate indicators for assessing genebanks role may need to be re-adjusted. Judging the value of genebanks based on the numbers of accessions distributed may be less relevant than the diversity of material maintained for long-term conservation purposes.

Technological developments: costs decreasing

Ongoing developments in biotechnology (including the fields of genomics and proteomics) continue to lead to a drop in costs of evaluating (and hence using) plant genetic resources. This trend is likely to continue and also will lead to further opportunities to exploit existing collections of germplasm, including wild relatives. In general, the decrease in research costs implies an increase in the value of these germplasm collections, and could imply an increase in demand (ignoring for the sake of argument the constraints placed by developments in international agreements). At the same time, research such as genome sequencing is becoming so routine that it has become less the exclusive territory of advanced research institutes and universities in countries such as the Netherlands, and more an activity in which emerging economies with strong R&D resources, such as China and India, can profitably engage. This means that organisations such as Wageningen Plant Breeding are shifting their focus further up the chain to more fundamental research on cell functioning, including also other species involved in plant production such as insects and soil microorganisms.

The fact that it is becoming progressively less expensive to characterise and evaluate accessions of plant germplasm and their relatives may also have a longer-term effect on breeding strategies in both public and private breeding organisations. Since the 1980s, the main US companies, such as Monsanto, have invested heavily in a breeding strategy based on genetic modification involving the insertion into a plant of genes isolated in other species (transgenic technology). The resulting genetically-modified varieties have not done nearly as well in the European market due to stronger political pressure voiced by opponents, affecting both the regulatory framework (see Backus et al., 2008) and also the weighing of risks by the food processing and distribution sector (Bijman and Kalaitzandonakes, 2003). The reduced costs of sequencing and marker-assisted selection may well be changing the basic economics of plant breeding, offering improved opportunities for 'cisgene' and other breeding strategies that rely on traits found within the same species or its wild relatives. In any event, the Netherlands is home to world leaders in such research (for example, CBSG), and their position appears to rely in part on access to collections at CGN.[1]

For the WOT-GB, these technological developments means that it should gradually (certainly over a five-year horizon) be possible to do more characterisation and evaluation of genetic resources in the *ex situ* collection for the same budget. This would also apply to characterisation of resources conserved in situ. This does not immediately imply that such activities should be reduced in the WOT-GB; the perspective of many stakeholders is that such activities are under-financed. These implications also apply to *in natura* contributions of other stakeholders to the WOT-GB, particularly commercial breeding companies, that are in the form of information from evaluating germplasm.

Wider range of stakeholders and goals

As can be deduced from the discussion above, developments concerning crop genetic resources have occupied a large portion of the attention of stakeholders, including among the government. This seems understandable given the traditional strong representation of public and private organisations in the Netherlands in plant breeding. Another trend though concerns the ongoing broadening (see section 0) of scientific attention within research and discussions concerning agrobiodiversity.

It appears that public activities (including publically-financed activities such as those within the WOT-GB) have not kept pace with this broadening. This, at least, is the perspective voiced by stakeholders involved with 'less traditional' plant genetic resources or with *in situ* conservation, which tends to concentrate on plant genetic resources of more cultural or historical value. There is an increasing sense of frustration among those involved with other species (e.g. bo-

[1] Interview with W. Stiekema, Director, CBSG.

tanical gardens) with lack of attention and resources.[1] The scope of policy documents, such as *Sources of Existence*, seems to such stakeholders to be broader than the current focus of public resources. It seems almost certain that, at the same time, the Netherlands (and certainly other countries) continue to lose genetic material in the form of traditional varieties, although little can be said of the value of this loss, given the lack of information.

Similarly, there is little attention to other types of species (insects, soil microorganisms) that are becoming increasingly important in research for more sustainable crop production.

While interest in plant genetic resources continues to broaden in terms of species and agroecosystems, this remains confined to a relatively narrow circle occupied by specialists (breeders, researchers, etc.) and committed volunteers (for example, NGOs and their members). There is little awareness among the broader public or the media on which they rely, of the importance of plant (and animal) genetic resources for the ability of agricultural systems to respond to changes in the future. To some extent, this ignorance can be seen in the lack of 'follow-up' media attention to the official opening in June 2008 of the Svalbard Global Seed Vault.[2]

For the WOT-GB, this suggests that the demands and expectations of various stakeholders will only continue to grow in coming years. This implies yet further challenges for the allocation of resources between various activities in the WOT-GB. Given that *Sources of Existence* may well have to be revised in the coming years, there will also be other avenues for these stakeholders to voice their concerns about government policy on genetic resources and its implementation.

---

[1] This was expressed in personal communications by O. Bootsma (Stichting de Nieuwe Akker) and B. Wollenberg (Curator, Botanic Garden, Delft, and Head, BGCI-Netherlands; see also footnote 4).

[2] A similar point was voiced in the interview with A. Ardenne, Permanent Representative of the Netherlands to the UN and other organisations based in Rome.

6 Actors and trends in animal genetic resources

This section describes different stakeholders involved in use and management of animal genetic resources. A brief description of the sector including some prinicipal actors is presented.[1] This section furthermore outlines stakeholders' interactions with CGN and current trends in managing and use of animal genetic resources (AnGR).

6.1 Actors and their interactions with CGN

Over the past 50 years, livestock farming in the Netherlands has undergone major changes due to intensification, specialisation and the generation of economies of scale. This enabled the sector to establish a strong competitive position within the EU. The majority of Dutch animal products are intended for export. Specialisation and economies of scale have different patterns in different livestock sectors. The pig and poultry sectors have intensified production to the greatest extent; cattle breeding, to a lesser extent; and the sheep sector has hardly intensified at all (Hiemstra et al., 2002). The cattle, pig, poultry, sheep and goat farming sectors may be regarded as the main livestock sectors in the Netherlands.

The Pig sector
In the pig sector two breeds dominate: Great Yorkshire and Dutch Land Pigs (*Nederlandse landvarken*). The leading Dutch pig breeding company is Pigture Group Cooperative whose TOPIGS accounts for 60% of Dutch market share and about 8% of world market share. Pig farms can be divided into two types: sow herds (piglet production) and finishing farms (pork production). The two other principal pig breeding companies are Dumeco (30% market share) and De Hyper (10% market share).

[1] More details can be found in Bijman and Eaton (2003).

The Cattle sector
The cattle sector primarily provides meat and milk, with the latter mostly being produced on specialised dairy farms. For meat production, several foreign breeds are important such as Belgian White-Bleu, Limousine and Piemontese. The most important breed for the dairy sector is the Holstein Friesian. The leading diary breeding company in the Netherlands is Delta (Delta CR with a market share of 90%). Other leading companies are KI Kampen, KI Semen and Alta Genetics. These companies are all major players in the world market. Delta CR is also the leading company in the Netherlands for meat cattle breeding, however its international market share in this sector is more limited.

Poultry sector
The poultry sector consists of egg production and meat production. In layer breeding hens the important breeds are White Leghorne and Island Red. In the poultry meat sector important breeds are White Plymouth Rock and White Cornish. The poultry breeding sector is very concentrated internationally. One of the leading companies worldwide is Netherlands-based: Hendrix-Genetic (specialised in layer breeding hens with 70% market share worldwide and turkey breeding, which is about 45% market share). Others include the German Lohman/Hyline and US Hubbard/ISA.

Sheep and Goat sector
The important sheep breeds in The Netherlands are Texelaar and Swifter (for meat production) and Zeeuws Melkschaap and Fries Melkschaap (for milk production). There are 5000 farm enterprises specialised in sheep production, which produce three-quarters of lamb meat consumed domestically. There are no very big international players in this sector.
As with plant genetic resources, the actors involved in the management of AnGR can be grouped based on the type of the organisation:
- Commercial companies and industry associations;
- Non-profit associations, NGOs;
- Government and public sector organisations.

6.1.1 Government and public sector organisations

CGN
Under the WOT-GB, CGN conducts statutory research tasks associated with the genetic diversity and identity of species that are important for agriculture and

forestry. Its activities concentrate on *ex situ* conservation, support for *in situ* conservation, and promotion of the use of genetic propagation material in support of breeding and research, and as part of bio-cultural heritage. Policy support of the Dutch government and international organisations is also provided.

FAO

At the international level, FAO's work in the field of AnGR management takes a broad approach - addressing technical, policy and institutional issues, and taking account of interactions with other aspects of natural resource management, production system dynamics and general economic development.

6.1.2. Commercial companies and industry associations

Hendrix-Genetics

Hendrix genetics is specialised in layer breeding hens (70% market share worldwide), pig breeding (one of the biggest player in the world market), turkey breeding (about 45% market share worldwide) and poultry distribution.

Alta Genetics

Alta is one of the largest privately owned reproduction and genetic improvement companies worldwide in the dairy sector. It is active in over 80 different countries such as the United States, the Netherlands, Canada, United Kingdom, Germany, and Brazil.

IPG

The Institute for Pig Genetics (IPG) is an independent company that provides services to breeding and artificial insemination programmes. For example, TOPIGS is one of IPG's clients, for whom it supplies pig semen. IPG's mission is to supply independent scientific and administrative support for the improvement and support of existing breeding and AI (Artificial insemination) programmes as well as integrated production chains.

Product Board (Productschap Vee, Vlees en Eieren)

The product board is a Dutch public organisation (*publiekrechtelijk*) serving the companies that produce and process meat and eggs. With public status, the product board has the right to levy taxes and to set certain rules. At the same time it also represents interests of the sector and acts as an advisory body for the government. The represents the whole production chain, from breeders, slaughtering and processing companies, to wholesalers and retailers.

6.1.3 Non-profit associations, NGOs

'It Griene Nêst'
'It Griene Nêst' is a combination of a care farm (zorgboerderij) and a knowledge centre for rare or local Fries breeds of animals, plants and fruits. The organisation collects samples of Fries breeds, documents them, and provides lectures and information about them. In addition, the It Griene Nêst supports hobby farmers in the husbandry of rare breeds.

Stichting Zeldzame Huisdierrassen
Stichting Zeldzame Huisdierrassen maintains rare agricultural animal breeds and supports breeding companies. It provides advice to breeding companies, helps with marketing of the products, provides broad information about old breeds, and organises lectures about old rare breeds.

Geldersch Landschap
Geldersch Landschap has conserved and managed nature and cultural heritage for 80 years. It has about 42,500 supporters and 450 volunteers who help in conservation and use of natural-cultural heritage. The organisation supports hobby farmers in use of rare breeds.

Natuurmonumenten
Natuurmonumenten is an independent organisation, more than a century old.[1] It preserves nature, landscape and cultural-historical values by purchasing the estates and other parcels of land, conserving and protecting them. It has many volunteers, members and sponsors supporting its work.

6.2 CGN's Interactions with actors

Interactions between CGN and the various actors are summarised in Table 6.1, with each type of actor discussed in turn below.

[1] See also section 0.

Table 6.1	Interactions between CGN and actors in animal genetic resources			
Main types of interactions	**Actors**			
	FAO	**NGOs**	**Product Board**	**Breeding companies**
Exchange of genetic resources		Provide to CGN/ Request from CGN		Provide to CGN
Research e.g. collaboration	√	Conference symposia (intensive)		Conference symposia (not very intensive)
Support for policy	√	√	√	
Information exchange	√	Advice/guidance from and to CGN	√	√
Education, public awareness activities/support	√	Study days	Study days	

6.2.1 CGN's interactions with commercial organisations

Interactions between commercial organisations and CGN are fairly limited. Commercial organisations usually provide semen to be conserved by CGN. Information exchange is also relatively limited. Sometimes, companies participate in CGN symposia or conferences. Every now and then companies meet CGN to discuss issues concerning genetic resources. IPG, for instance, and CGN deliberate on issues about semen storage (e.g. what needs to be stored and what not; proper coding of the semen, so after 5 years it will be still clear what is available in genebanks).

Interviews with some companies about their interactions with CGN revealed some issues concerning research collaboration that are viewed as needing improvement. There is a perception that CGN makes very little use of knowledge available at commercial companies, resulting sometimes in a duplication (or repetition) of research efforts. One such example concerns new technologies for storing DNA, where knowledge is already available in other countries and private companies (e.g. in the USA). Another example mentioned concerns CGN's advice to 'Stichting Zeldzame Huisdierrassen' on breeding programmes, which might be more efficiently done by breeding organisations, rather than by CGN.

6.2.2 CGN's interactions with NGOs

CGN has fairly intensive interactions with NGOs for whom CGN is a knowledge centre that provides information about rare and /or local breeds. The interactions involve exchange of genetic resources in both directions (i.e. CGN provides NGOs with rare breeds which are available in the genebanks, and also receives semen from these organisations), CGN provides advice/guidance on husbandry of rare breeds, organises study days and participates in study days organised by NGOs, and carries out research. NGOs participate in symposia, conferences together with CGN.

One of these NGOs mentioned the potential to improve communications with CGN. In particular, it was suggested in an interview that CGN could do more on brand recognition and provide more information to organisations involved in the *in situ* conservation of genetic resources (e.g. to provide more information about breeds threatened with extinction which NGOs can use in their conservation efforts.

6.2.3 CGN's interactions with FAO

FAO has many different types of interactions with CGN including research collaboration, policy interaction/support for policy, information exchange, educational programs, side events at international meetings, public awareness activities/support. These interactions have international nature and are centred on the activities which are co-funded by FAO or fully funded by Dutch government. FAO considers these activities to be extremely useful for its work.

6.3 Animal genetic resources: developments, trends and implications

A number of developments in the management of AnGR can be identified, including most obviously, the expansion in the *ex situ* collections of the Netherlands during the past five years. In addition, interviewees mentioned three trends relevant for AnGR: technological developments, globalisation/concentration and changes in market demand. These trends are discussed below, together with possible implications for the WOT-GB (see Table 6).

Table 6.2	Developments in animal genetic resources and implications for WOT-GB	
Issue	**Developments (since 2002 and expected to 2013)**	**Implications for WOT-GB**
Ex situ conservation	Considerable expansion of CGN collections, including addition of poultry	What are priorities for further expansion various levels: - species - breed - number of male sperm donors - number of conserved doses
Technology	- Genomic selection - Decreased costs and improvements in embryo conservation	Should the WOT-GB devote more resources to conservation of female embryos?
Commercial animal breeding sector	Ongoing concentration	A relevant question concerns the nature of the relationship between the *ex situ* collections of CGN and those of the major breeders
Market demand	Increased demand for niche market for products of rare and local breeds	Are there relevant activities in the WOT-GB which would support the development of this sector?

Ex situ collections

The *ex situ* collections of CGN have expanded considerably in the past five years, as planned under WOT-GB workplan for the period 2004-2008 which included specific targets.[1]

- The existing collections of cattle, covering 8 breeds, have expanded in terms of male donor animals for the Holstein Friesian and Meuse Rhine Yssel breeds, and also the number of sperm samples in the case of the Holstein Friesian, which has more than doubled to around 76,000.

[1] This overview of the expansion of the ex situ collection is based primarily on the current status, as available at www.cgn.wur.nl/UK/CGN+Animal+Genetic+Resources/Gene+bank+collections, and the status of the collections in 2002, as detailed in the Netherlands National Report on Animal Genetic Resources (Anon, 2002).

- An additional breed, the Black Blazed Sheep, was added to the collection of five sheep breeds, most of which were increased in terms of number of donor rams as well as sperm samples.
- A collection of of two goat breeds, the Dutch Landgoat and the Saanen goat, was initiated in 2005, with more than 10,000 doses conserved (respectively 1,600 and 8,400).
- The Stichting Genenbank Landbouwhuisdieren - SGL (Dutch Gene Bank Foundation) transferred their collections of three horse breeds, Gelderland horse, the Groningen horse and the Dutch Draught horse, to CGN. And in 2006, the CGN collection was further expanded with the addition of the Dutch Harness horse.
- The poultry collection has been established during this period, with 6 initial breeds in 2003 and a further 5 in 2005, now comprising 11 breeds and 5,000 samples.
- The pig collection of 16 commercial breeding lines, which is maintained by CGN on behalf of SGL (and thus falls outside of the WOT-GB), has been expanded from 9,000 to 15,000 samples.

Stakeholders have indicated that the ongoing maintenance and expansion of these collections should be seen as a priority for the WOT-GB. There are even suggestions that additional species should be added such as ducks, geese, dogs, rabbits, and doves, while also maintaining a balance with support for *in situ* efforts.[1] Thus, one clear implication of this recent expansion and perceived importance, is what the priorities should be in the second WOT-GB concerning the *ex situ* collection, particularly at the various levels:
- species;
- breed;
- number of male sperm donors;
- number of conserved doses.

Technological developments
Rapid technological developments in biotechnology provide new opportunities for management and use of AnGR. These developments have major impacts on the animal breeding sector and include:

[1] These have been voiced for example in a meeting of stakeholders in AnGR organised by CGN in December 2007 (source: meeting report).

- Genomic selection - Development of new quantitative tools linking genomics and quantitative genetics);
- Storing of female embryos - Cryo-preservation, a process where cells or whole tissues are preserved by cooling to low temperatures;
- Use of DNA information.

A large amount of research on *genomics selection* is being carried but implementation lags behind, with New Zealand, the Netherlands, and the USA being the only countries to have implemented this approach. The big advantage of genomic selection is a shortened generation interval. Using genomic selection in breeding programmes helps to easily identify the best population, which is necessary in the selection process, and it also helps to reduce inbreeding. There are disagreements between different stakeholders on this topic: some mentioned that genomic selection is very effective compared to traditional selection, while others do not agree. This helps explain why the approach has not been fully adopted and continues to be further developed. Nonetheless, stakeholders expect this trend to continue in the near future and to be implemented by the majority of leading companies in animal breeding sector. According to stakeholders, it is not easy to predict the impact of this technology on genetic diversity. A balanced assessment might suggest therefore that it will be neutral, or in any case, differentiated. In general, companies indicate that they devote considerable efforts to prevent inbreeding and thus to maintaining genetic diversity.

Until now genebanks have stored only semen from animals. A new development is the possibility to store *female embryos.* This development has received considerable attention lately and in the near future it is expected to be implemented. This technological development could contribute to the conservation and use of rare breeds, in particular by improving the possibilities and decreasing the time required for re-establishing populations (Gandini et al., 2006). A clear implication for the WOT-GB is the need to address whether and how this approach should be incorporated into the *ex situ* collections of CGN.
Currently *DNA information* is used for different purposes, such as tracing back quality problems of the products (i.e. snips for DNA fingerprints are used) but also for the storage of DNA from threatened breeds/strains. Thus, DNA information might be used to recover small disappearing breeds although it still is not clear if this is economically viable.

Globalisation/concentration

The trend mentioned most often as affecting all types of stakeholders is globalisation and concentration. This trend is continuing and tends to marginalise local breeds. The number of breeding companies worldwide is reducing. In breeding sector there are very few players (e.g. in poultry sector, 2 major breeding organisations) that operate globally and these organisations are responsible for 80-90 % of production globally. A very limited amount of breeds thus contribute to 90% of food production. This trend is most prominent in the poultry sector. Pig and dairy sectors are also moving in the same direction of having a small dominant number of global players.

Commercial breeding companies see this trend as part of the competitive process and the development of scale economies. The main goal of commercial breeding companies is to enhance their competitiveness in the market. Companies that will survive are those that can increase their scale while improving their breeding programmes, which involves maintaining genetic resources.

Companies indicate that they undertake sustainable breed management within their breeding programs. Commercial companies do have very efficient breeding programmes for their own breeds which are sold all over the world. However they do not maintain local breeds, as this is not economically viable. Only developed countries (mainly EU) provide support in their rural development policy for support to local breeds. Other countries, in particularly developing countries, do not provide this support.

Globalisation may be expected to result in a wider use of a limited number of breeds, standardisation of consumer products and further moves towards large-scale production. Furthermore, globalisation may adversely affect the competitiveness of smallholder livestock production systems in developing countries, and thus undermine the sustainable management of local breeds (Hiemstra, et al., 2006). NGOs are working to prevent the disappearance of various breeds and expect government or public support in these efforts.

For the WOT-GB, this implies a need to address the nature of the relationship between the *ex situ* collections of CGN and those of the major breeders. This is most relevant for cattle and poultry where the concentration is most rapid and where CGN maintains collections.[1] In general, the WOT-GB has concentrated on *ex situ* collections of rare breeds. Are there arrangements for poultry and cattle, similar to those for pigs whereby society has some assurance that collections of commercial material are being maintained for long-term conservation and will be available in the event of major events (e.g. calamities)?

[1] For pigs, CGN maintains a collection of 'backups' of existing commercial lines, on contract with SGL, but these fall outside of the WOT-GB.

Market demand for products

Another recent development is the increased use of some specific rare breeds in landscape and environmental conservation, a trend which may well continue over the next 5 years. A separate trend is the growth of the organic agriculture segment, which includes products from rare breeds. This improves the chances of survival for some rare breeds, especially for local breeds (e.g. provincial/regional level), as their meat and dairy products are increasingly demanded by a particular segment of consumers. This trend may well continue for the next 5 years (depending on overall economic circumstances). Here hobby breeders play an important role, as they choose primarily to breed rare/local breeds.

Geldersch Landschap provides an example of the development of markets for rare breeds. The strategy of Geldersch Landschap towards conserving rare breeds is to promote consumption of their meat. Currently, it is difficult to satisfy local market demand and there are consumers on a waiting list.

Several NGOs have also mentioned emphasised the increased market demand for products from rare and/or local breeds. One possible explanation is the economic growth, including in the Netherlands, through mid-2008, leading to consumers puttng more emphasis on issues such as organic food, bio-products, and sustainability issues in general, as compared to previous decades. This trend also reflects increasing interests in historical values and landscape. More and more products from rare/local breeds (e.g. dairy products, meat) are marketed as organic or regional products. The demand for such products has grown, but currently there are not many breeding companies serving this market. Many breeders are reluctant to start this business because of the substantial investments. And there is the possibility that the current interest in cultural-historical values is only one of temporary fashion and it may subside, for example as a result of changing economic circumstances.

For the WOT-GB, these market developments imply a re-examination of the role played by the public sector. The activities of various organisations to develop markets for products from rare and/or local breeds is arguably an example of how to improve the sustainable use of AnGR. Are there then relevant activities in the WOT-GB which would further support the further development of this sector, in particular the availability of breeding material?

GMOs

During the interviews, all stakeholders were asked about the importance of genetic modification (GM). It appeared that GM is generally not accepted and sensitive issue. Currently the major policy on the topic of GM is not linking cloning and GM to each other in animal breeding. In general GM is perceived to be more sensitive issue than cloning. The response of the breeding industries on the topic of GM and cloning is that, they do not want to have cloning, because they do not see any advantage of it and for GM they do not want to talk about is, because it is very sensitive topic.

Outside of Europe, major investments are taking place in cloning in the US and Australia, so apparently these investors expect to have markets for such products in future. However, according to respondents probably there is a need for at least 20 years in order to be able to see any practical use of GM in animal breeding.

Food security

There is insufficient awareness of the importance of genetic resources for food security. Genetic resources are the bases for food security. According to interviewees, the majority of consumers do not think about conservation of genetic resources as long as it is possible to obtain relatively affordable food in the supermarkets. Consumers do not see that there could be changes in the future which will require different genetics for which we should take care now. Developed countries are aware to a certain extend about this problem, that is why there are conservation programmes and rural policy to maintain local breeds, but these are only marginal activities. The major activities in agriculture are directed to increasing food safety problems, increasing production, animal welfare and legal issues and not so much towards genetic resources.

Climate Change

Climate change may have crucial impact on genetic resources. However there is not much known about the implications of climate change on genetic resources. There are only speculations and building of scenarios, but what really will happen is not known. There should be more research done in this area and more understanding is required about breeds and adaptation processes (i.e. how physiological mechanisms work, how far it is possible to stretch environmental envelope of specific breeds, what types of knowledge systems are behind) which we do not know enough.

7 Conclusions and implications

The analysis in this report has been broad and not very detailed relative to the complexity of the subject matter. The report began with a general review of the public good nature of genetic resources for food and agriculture. The potential future value of these resources, which are possibly far in the future and largely unpredictable, provides the rationale for public support for their conservation and use. In the absence of such support, the independent initiatives by various actors are unlikely to deliver a sufficient level of conservation.

There is also a pro-active rationale to continued, and perhaps even strengthened government sponsorship of the management of genetic resources. This is based on the possible benefits of maintaining instruments at government's disposal in order to respond to current and future challenges in agricultural and food production. Such challenges are being posed already along a range of issues, including climate change, the need to reduce chemical use in crop production, renewed food security concerns and associated limits to expanding (or even maintaining) food and feed production, increased consumption globally of meat products, the potential risks of current levels of antibiotic use in intensive livestock production, to name but a few.[1] It appears that the demands of society for adjustment in both crop and livestock systems only continue to grow, while the technological possibilities continue to be pushed.

In the case of *ex situ* collections of animal genetic resources, commercial breeding has become reliant on such a narrow population base, that little use is made of publically-conserved material. Private sector crop breeders are more numerous, and their breeding strategies are more dependent on access to each other's material, as well as use of other collections. Yet, their varied national backgrounds, and fierce competition make it unlikely that they would agree on mechanisms to support the continuation and improvement of long-term *ex situ* collections.

In contrast to the situation with *ex situ* collections, numerous private initiatives, many of which are voluntary in nature, attempt to address perceived priorities in *in situ* conservation of both plant and animal genetic resources. Public policy towards *in situ* conservation was effectively only initiated in 2002 with *Sources of Existence*. A number of individual volunteers and NGOs appear to

[1] Many such challenges are currently grouped under the policy priorities of 'transition to sustainable agriculture' in the Netherlands.

have expected that this would lead to more support, including financial support and coordination, than has materialised. Indeed, a number of stakeholders, involved with either plant or animal genetic resources, expressed what could only be termed as frustration with CGN and/or LNV (or, in essence, with the WOT-GB) for the limited opportunities this provides. To some extent, CGN does fulfill a sort of coordinating role, and it seems that this could receive more attention, particularly in the WOT-GB. This would involve defining more explicitly what this role involves, and thus indirectly what the recognised roles of various other actors are.

The distinction between *ex situ* and *in situ* conservation in the Netherlands generally coincides with two groups of genetic resources, whether of plant or animals. One group consists of traditional breeds and varieties that primarily have cultural and historical value. These have, for the most part, been the focus of *in situ* conservation efforts, and complemented in some cases by *ex situ* measures. The other group, much more extensive for plant genetic resources, consists of *ex situ* collections, with varying geographic (international) origin, that may have some potential future value to commercially-oriented breeding programmes. Forest genetic resources in the Netherlands fall primarily in the first category, as the main market for seed material is provided by managers, mostly from the public sector, of nature areas, and these species are not the focus of commercial improvement programmes.

There are clear differences in the public good nature of genetic resources between the three sectors. This has resulted in different institutional structures governing their use. Forest and crop genetic resources have less potential for users or breeders to develop profitable exclusive rights, which led to the creation of various IPR systems. Today, the political tensions created between this and other regimes for biodiversity and trade has led to the liquidity crisis in crop genetic resources. In contrast, the greater ease with which both owners and breeders can exercise exclusive property rights over animal genetic resources embodied in their livestock, means that IPR systems have been relatively unimportant. But a corollary appears to be the lack of public attention for conservation purposes until more recently. In general, the extent of genetic erosion in modern commercial livestock production systems seems even more acute than in crops.

These distinctions are also reflected in differences concerning the functions and roles of genebanks. For crop genetic resources, the CGN genebank fulfils two kinds of roles: a long-term conservation (savings) and also pool of germplasm for use in current breeding and research (liquidity). For animal genetic resources, the CGN genebank serves essentially only the first role, given that breeding companies generally use their own material. For forest genetic resources, the *ex situ* CGN-Staatsbosbeheer genebank is also primarily for long-term conservation.

The conservation and use of agricultural genetic resources is increasingly regulated by a variety of international agreements. Commitments to conserve biodiversity have been made by all signatory countries of the Convention on Biological Diversity (CBD), including the Netherlands. For crop genetic resources, there are now various agreements and initiatives originating in three different domains, biodiversity, trade and IPRs, that have implications for the exchange and use of these resources. One of the most important is the International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA) which seeks to facilitate international exchange. It remains to be seen whether the ongoing steps in its implementation will ease the liquidity crisis in crop germplasm. The future developments in Access and Benefit-Sharing (ABS) discussions for other crop, plant and animal species are even more uncertain. Various actors in the Netherlands are closely involved in these negotiations, given the considerable size of the plant breeding sector, both public and private, in the country. For animal genetic resources, such issues are only beginning to emerge, but less likely to lead to the same challenges for the livestock breeding sector, which is relatively much less dependent on accessing genetic resources from publically-managed genebank.

7.1 Overview of implications identified for the WOT-GB

The developments since 2002 and ongoing and expected future trends have been discussed in respective sections on international agreements (section 3), plant genetic resources (section 5), and animal genetic resources (section 6). A number of implications of these developments were identified and these are summarised here.[1] Many of these are posed in the form of questions to be addressed by LNV and other stakeholders involved in the WOT-GB, not least of which is CGN.

[1] With some minor modifications; these implications are listed in more detail in Table 3.1, Table 5.3 and Table 6.2.

International agreements

- Policy support activities under the WOT-GB have likely made a signficant contribution to developments within the framework of the International Treaty.
- Should policy support provided under the WOT-GB devote more attention to frameworks for non-Annex 1 plant species?
- It may be relevant to consider the advantages and disadvantages of including more specific goals with respect to international coordination of *ex situ* collections.
- Animal genetic resources arguably require less attention in terms of policy support than plant genetic resources.
- Tensions between discussions concerning genetic resources and (intellectual) property rights may imply the need for conditions and mechanisms to ensure clear institutional identity of CGN in its varied activities (whether WOT or not).

Plant genetic resources

- Availability of public *ex situ* collections may provide some genetic liquidity that is more relied upon by smaller companies, and thus supports competition.
- Importance of CGN *ex situ* collections may be shifting more towards long-term conservation, including for cultural-heritage values and thus appropriate indicators for assessing genebanks role may need to be revised.
- Given technological developments, it should be increasingly possible to do more with less in terms of evaluating and characterising collections.

Animal genetic resources

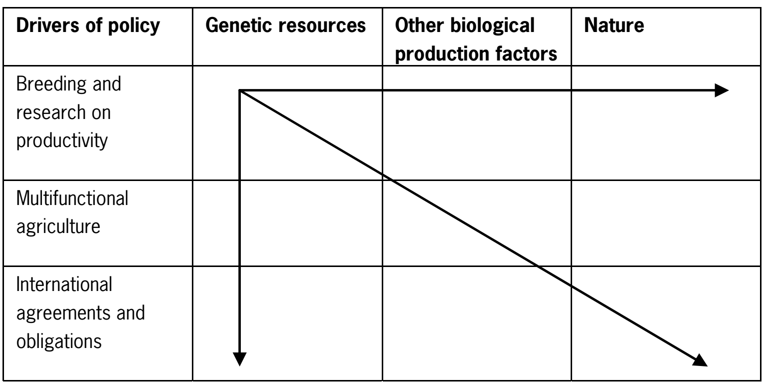
- What are priorities for further expansion of *ex situ* collection, specified according to various levels (species, breed, number of male sperm donors, number of conserved doses)?
- Should the WOT-GB devote more resources to conservation of female embryos?
- What is the nature of the relationship between the *ex situ* collections of CGN and those of the major breeders, particularly in poultry and cattle?
- Are there relevant activities in the WOT-GB which would support the development of the niche market developing in products derived from rare and/or local breeds?

Plant and *animal genetic resources*
For both plant and animal genetic resources, there were similar implications from developments in the ongoing broadening of issues and components of agrobiodiversity deemed to be of importance for genetic resource policy:

- Demands and expectations on WOT-GB will continue to grow, given historical allocation of resources;
- The growing demands implies a potential value in a more transparent process for defining activities and allocating resources in the WOT-GB, for example, between plant and animal genetic resources, between species, and between *ex situ* and *in situ* conservation.

One clear theme that emerges is a continued broadening of actors and priority issues in the management and use genetic resources (as seen again in Figure 7.1). In terms of supporting the commercial sector, researchers are increasing the scope of their attention to other species, including functional agrobiodiversity. With respect to cultural and historical values, the expectations of actors for public support have also increased since *Sources of Existence*, partly because of statements in that policy document.

Figure 7.1 **Levels of agrobiodiversity and broadening of agrobiodiversity policy**



Bijman and Eaton (2003), reproduced from Figure 2.1 above.

This expansion of actors and issues poses a significant challenge for government policy, including its implementation through the WOT-GB. There appear to be many claims for the provision of public goods in this area, many of which are only partly being met, if at all. Even the traditional core activities of CGN, *ex situ* crop genetic resources collection could hardly be seen as excessive from an international perspective. For example, the size of CGN's collection and its financing does not seem to be proportionate to the recognised place of the Netherlands as being among the world's leaders in crop improvement.[1] Although, as was emphasised above, it is relevant to look beyond the simple size of a collection and also consider its quality, uniqueness and importance to breeding (for example the core collection status of CGN's *allium* collection). Beyond this traditional core competence, there appear to be many possible ways in which the WOT-GB could further support *in situ* conservation efforts in the Netherlands. Various stakeholders have emphasised the opportunities in the areas of traditional varieties, breeds and their roles in agroecosystems and landscapes of cultural and historical value. While not specifically assessed in this report, it may well be the case that the Netherlands, through its WOT-GB is not yet fulfilling all its commitments under the CBD and the GPA, for example with respect to *in situ* conservation of certain livestock breeds.[2]

This raises the difficult issue of allocating resources between various activities in the WOT-GB. In particular, the relative attention and budget for different types of genetic resources, or for *in situ* versus *ex situ* tasks, will probably continue to be problematic. The activities in *ex situ* conservation, which have a longer historical basis, appear to have been supplemented during the first WOT-GB, with *in situ* activities. If additional financial resources cannot be secured for the WOT-GB, then this balance between *in situ* and *ex situ* will continue to reflect earlier historical priorities, and not necessarily a current assessment of priorities. Thus, the continued broadening of the policy focus to include more species and also *in situ* conservation will create further dilemmas for the process of allocating those resources across different activities.

A key challenge for LNV, therefore, is establishing priorities, relative to possible claims, for a limited WOT-GB budget. This report has not investigated the priority-setting mechanisms that have been used up until now, or that are being considered in the continuation of the WOT-GB. Such a process may inevitably lead to disappointments (as does any public budgetting exercise). There is no simple calculus (such as cost-benefit analysis) for how to assign priorities for

[1] Using other criteria, engagement in international initiatives and collaboration, CGN does however stand out in the role it fulfills as knowledge broker.

[2] Such an assessment would however be complicated by the various possible interpretations that can be given to some international commitments concerning in particular the translation of objectives such as conservation and sustainable use into specific targets, indicators and criteria.

conservation efforts across species, breeds and varieties; although there are a number of criteria that can be assessed and weighed up against each other. Thus there may be opportunities for more transparently systematic approaches to setting priorities and allocating financial resources within the WOT-GB.

Such difficulties in priority-setting implies that LNV must rely heavily on the professional opinions of a few experts, many of whom are directly involved in the implementation of the WOT-GB. This possibly presents additional challenges in terms of accountability (though again, this report has not examined the role of the Oversight Committee, 'Commissie van Toezicht'). In economic governance terms, this can be termed a 'principal-agent' type relationship between LNV (the principal) and CGN (the agent). But theory provides little guidance on how governance structures should be adapted or altered in this specific case; the issue here concerns as much the formulation of objectives and tasks (concerning genetic resource management), as the assessment of their achievement.[1]

Nonetheless, there are clearly signals from various actors of dissatisfaction with both the process of priority-setting and the outcomes. This may be rectified with a larger budget for the WOT-GB, thus expanding the scope and extent of activities. It may be advisable, in any event, to devote resources to improvements in the governance structure concerning agricultural genetic resources. This could also include more explicit attention to the role that the WOT-GB could fulfill in terms of coordinating the range of initiatives taking place. Almost all actors seem convinced that the importance of improved management of these resources for future challenges is under-appreciated, despite some of the recent broadening of interest and stakeholders noted above.

[1] The PIC framework (Teulings et al., 2003, and see section 0 and Appendix 1), for example, points out that in such a case, the government should contract with a single supplier of a public good and should choose if possible for specification of output targets (measures of goods and servides provided) in the contract, as opposed to only input targets (measures of human and financial resources consumed). But with the WOT-GB, the challenge is also how to specify what the scope and extent of the output targets should be.

8 Literature and online sources

National Report on Animal Genetic Resources, the Netherlands. A Strategic policy document. (Landenrapport Nederland over Dierlijke Genetische Bronnen. Een Strategisch beleidsdocument). Den Haag: Ministerie van Landbouw, Natuurbeheer en Voedselkwaliteit, 2002.

Anon. *Crop Diversity at Risk: The Case for Sustaining Crop Collections*. Wye, Ashford, UK: Department of Agricultural Sciences, Imperial College of Science, Technology and Medicine. E P., 2005.
www.croptrust.org/documents/WebPDF/wyereport.pdf.

Backus, G.B.C., P. Berkhout, D.J.F. Eaton, L. Franke, A.J. de Kleijn, B. Lotz, E.M. van Mil, P. Roza and W. Uffelmann, *EU policy on GMOs; A quick scan of the economic consequences.* Den Haag: LEI Report 2008-070, 2008.

Bessen, J. and M.J. Meurer, *Patent failure: How judges, bureaucrats, and lawyers put innovators at risk*. Princeton NJ: Princeton University Press, 2008.

Bijman, J., and D.J.F. Eaton, *Conservering van genetische bronnen voor de landbouw in Nederland; Organisatie en institutionele inbedding*. Rapport 7.03.14. Den Haag: LEI, 2003.
www.lei.nl/uk/index.php3?page=../nl/content/rapporten/rapporten.php.

Bureau des Resources Génétiques. *Charte Nationale pour la gestion des ressources génétiques*. Paris, 1998.

Coase, R.H. The problem of social cost. In: *Journal of Law and Economics* 3, no. 1 (October): 1-44, 1960.

Day Rubenstein, K., P. Heisey, R. Shoemaker, J. Sullivan, and G. Frisvold. *Crop genetic resources: An economic appraisal*. Economic Information Bulletin Number 2. Washington, D.C: United States Department of Agriculture, Economic Research Service, May, 2005.

Day Rubenstein, K., and M. Smale. 2004. *International Exchange of Genetic Resources, the Role of Information and Implications for Ownership: The Case of the U.S. National Plant Germplasm System*. EPTD Discussion Paper No. 119. Washington, D.C: International Food Policy Research Institute (IFPRI), July, 2004.

Eaton, D. J.F, E. Kalaugher and J. Bijman, *International agreements relating to plant genetic resources for food and agriculture and implications for Dutch policy*. Report 6.04.06. The Hague: Agricultural Economics Research Institute (LEI), April, 2004.

Eaton, D. and B. Visser, Transaction costs of tracking and monitoring the flows of genetic resources. (Chapter 2). In: *A Moving Target: Genetic Resources and Options for Tracking and Monitoring their International Flows*, ed. Manuel Ruiz Muller and Isabel Lapena, 124. IUCN Environmental Policy and Law Paper No. 67/3. Gland, Switzerland: International Union for the Conservation of Nature (IUCN). www.iucn.org/, 2007.

Engels, A. 'De betekenis van autochtoon.' In: *Boomkwekerij*, No. 37, pp. 16-17, September 12. 2003.

'De feiten over de positie van Staatsbosbeheer.' In: *Boomkwekerij*, No. 4, pp. 16-17, January 27, 2006.

'Genenbank biedt meer dan DNA-opslag.' In: *Boomkwekerij*, No. 39, pp. 14-15, September 26, 2008.

Engels, J.M.M, and D. Wood, Conservation of agrobiodiversity. In: *Agrobio-diversity Characterization Utilization And Management*: 355-385. 1999.

European Patent Office, *Scenarios for the Future: How might IP regimes evolve by 2025? What global legitimacy might such regimes have?*. Munich, 2008.

Fowler, C. ,'The status of public and proprietary germplasm and information: An assessment of recent developments at FAO.' *IP Strategy Today* 7-2003.

'Heavy burden: Promoting public policy through the use of material transfer agreements for plant genetic resources.' In: *Journal of International Biotechnology Law* 2, no. 4 (July): 144-149, 2005.

Gandini, G, E Pizzi, A. Stella, and P.J. Boettcher, *The costs of genebanks of livestock genetic resources.* Paper presented at 8th World Congress on Genetics Applied to Livestock Production, Belo Horizonte, MG, Brazil, August 13-18, 2006.

Hiemstra, S.J., A.G. Drucker, M.W. Tvedt, N. Louwaars, J.K. Oldenbroek, K. Agwichew, S. Abegaz Kebede, P.N. Bhat, A. da Silva Mariante. *Exchange, Use and Conservation of Animal Genetic Resources, Policy and regulatory options*. Report 2006/06. Wageningen, The Netherlands: Centre for Genetic Resources the Netherlands. www.cgn.wur.nl, 2006.

Jaffe, A.B. and J. Lerner, *Innovation and its discontents: How our broken patent system is endangering innovation and progress, and what to do about it*. Princeton N.J: Princeton University Press. 2004.

Janssens, B., A.F. de Savornin Lohman, L. van Soest en C. de Zwijger-De Brabander, *Oude graslanden in Nederland; Verkenning naar motieven, bedrijfsvoering en perspectieven voor in situ beheer*. LEI, Den Haag, rapport 3.02.04, 2002.

IPGRI, *European Workshop on National Plant Genetic Resources Programmes. Report of an International Workshop, 24-26 April 2003, Alnarp, Sweden*. International Plant Genetic Resources Institute, Rome, Italy, 2005.

Kalaitzandonakes, N. and J. Bijman. 2003. 'Who is driving biotechnology acceptance?' *Nature Biotechnology* 21 (April): 366-369.

Koo, B., P.G. Pardey, and B.D. Wright, The economic costs of conserving genetic resources at the CGIAR Centres. In: *Agricultural Economics* 29, no. 3 (December): 287-297, 2003.

Koo, B., P.G. Pardey and B.D. Wright. (Editors), *Saving seeds: The economics of conserving crop genetic resources ex situ in the future harvest centres of the CGIAR*. Wallingford, UK: CABI. 2004.

LEI and Centraal Bureau voor de Statistiek (CBS). *Land- en tuinbouwcijfers 2008.* Den Haag: LEI Report 2008-048, 2008.

Maggioni, L, 'The ECP/GR, an example of cooperation for crop genetic resources in Europe'. In: *Proceedings of an international workshop: Strengthening policy and institutional frameworks for conservation and sustainable use of plant genetic resources. National programmes and networks as strategic tools*, 1-10 October 2002, Zschortau, Germany. Rome: IPGRI. 2002. www.ecpgr.cgiar.org/Introduction/Proceedings_ArticleLM.pdf.

Ministry of Agriculture, Nature Management and Food Quality. *Sources of existence: conservation and the sustainable use of genetic diversity. Policy document of the Government of The Netherlands*. The Hague, March, 2002.

Mitteau, M., 'The French National Plant Genetic Resources Programme'. In: IPGRI IPGRI. *European Workshop on National Plant Genetic Resources Programmes. Report of an International Workshop, 24-26 April 2003, Alnarp, Sweden*. International Plant Genetic Resources Institute, Rome, Italy, 2005.

Qualset, C.O. and H.L. Shands. *Safeguarding the Future of U.S. Agriculture: The need to conserve threatened collections of crop diversity worldwide*. Genetic Resources Conservation Program. Davis, California: University of California. 2005. www.croptrust.org/documents/WebPDF/TrustReportfinal.pdf.

Soest, L.J.M. van, and N. Bas, 'Genetic Resources of Trifolium in The Netherlands'. In: G. Parente and J. Frame (eds.), *Crop development for cool and wet regions of Europe. Proceedings of the final conference in Pordenone, Italy*. European Commission, Luxemburg, pp. 315-318, 2000.

Stoll, P., The FAO 'Seed treaty' - new international rules for the conservation and sustainable use of plant genetic resources for food and agriculture. *Journal of International Biotechnology Law* 1, no. 5 (December): 239-243, 2004.

Teulings, C.N., A.L. Bovenberg and H.P. van Dalen, *De Calculus van het publieke belang*. Den Haag: Kenniscentrum voor Ordeningsvraagstukken, Ministerie van Economische Zaken, 2003.

Theeuwes, J. 2004. 'Een kritische beschouwing van de Calculus van het publieke belang.' Essays over de Calculus van het publieke belang. Den Haag: Kenniscentrum voor Ordeningsvraagstukken, Ministerie van Economische Zaken.

Treuren, van R., A. Magda, R. Hoekstra and T.J.L. van Hintum, 'Genetic and economic aspects of marker-assisted reduction of redundancy from a wild potato germplasm collection.' In: *Genetic Resources and Crop Evolution* 51, no. 3: 277-290, 2004.

Treuren, van R. and B. Visser, In: *Traditional grasslands: conservation measures needed?* Genetic Resources Policy Brief, Centre for Genetic Resources, the Netherlands, Wageningen, 2005.

Witcombe, J.R., Does plant breeding lead to a loss of genetic diversity. In: *Agrobiodiversity Characterization Utilization And Management*: 245-272, 1999.

Wright, B.D. 'Crop genetic resource policy: The role of *ex situ* genebanks'. In: *Australian Journal of Agricultural and Resource Economics* 41, no. 1: 81-115, 1997.

Websites

www.absfocalpoint.nl
www.advantaseeds-europe.com
www.ars-grin.gov
www.barenbrug.nl
www.bioexploit.net
www.bioversityinternational.nl
www.bosgroepen.nl
www.bosschap.nl
botu07.bio.uu.nl/nvbt/links.htm
www.brg.prd.fr
www.bronnen.nl
www.cbsg.nl
www.cgn.wur.nl
www.cgrfa.org
www.deoerakker.nl
www.deruiterseeds.com
www.ecpgr.cgiar.org
efabis.tzv.fal.de
www.enzazaden.nl
www.euforgen.org
www.fao.org

www.genenbankbomenenstruiken.nl
www.genres.de
www.groenegenetica.nl
www.hilleshog.com
www.hogeveluwe.nl
www.hzpc.com
www.inovafruit.nl
www.joordens.nl
www.kws.de
www.landschappen.nl
www.limagrain.com
www.nao.nl
www.nationale-plantencollectie.nl
www.natuurmonumenten.nl
www.nbvb.nl
www.nordgen.org
www.nunhems.com
www.plantum.nl
www.ragtsemences.com
www.rfp-europe.org
www.rijkzwaan.com
www.sesvanderhave.com
www.staatsbosbeheer.nl
www.syngenta.com
www.vanrijn-kws.com
zaadgoed.nl

Appendix 1

The Public Interest Calculus

The Public Interest Calculus is a framework developed by the economists Teulings, Bovenberg and van Dalen (2003) at the request of the Netherlands Ministries of Economic Affairs and of Finance. The purpose of the framework is to provide a means for assessing when there is a role for government in regulating economic affairs, and what the nature of this role might be. The framework includes a decision tree for assessing whether government intervention in markets is justified, and if so, whether this should entail a regulatory role or one of direct intervention.

Given that the discussion concerning public support for conservation and management of genetic resources can be situated within a broader discussion of regulatory roles in general, it is both interesting and relevant to examine what the outcome of the Public Interest Calculus (PIC) would be in the case of agricultural genetic resources.

The reasoning behind the PIC framework hinges on the economic concept of external effects. External effects occur if the action of one party or a transaction between two or more parties has positive or negative consequences for another party who is not involved in the relevant decision-making. A common example is pollution, where the decision, for example, of a farmer to apply pesticides to a field does not necessarily include consideration of the full effects of this action on the toxicity of water to other users. If external effects are complex in that many parties may be affected, then this decreases the likelihood that a private bargain or compromise can be struck, meaning that government intervention might lead to a better outcome.

According to the PIC framework, there is a justification for direct government intervention in the management and conservation of genetic resources. The reasoning is essentially that the economic welfare in the future, and particularly of future generations, is likely to be compromised by 'private' management of GRFA. The decisions of farmers concerning which varieties of a crop to sow, or which breeds of livestock to rear, are generally based on the farmers' immediate interests. If such a decision, by choosing for a modern variety or breed, contributes further to genetic erosion, and even to the variety or breed extinction, the farmer does not bear all these consequences. These external effects, many of which may only be perceived by future generations, imply, according to the PIC that some kind of intervention is necessary to ensure optimal management of genetic resources.

The PIC framework also includes some criteria for assessing whether, in the presence of external effects, it is better to promote competition among providers of a good or service, instead of the government attempting to provide this directly. If the nature of the good or service is such that it is likely that multiple actors could offer it, as opposed to only one, then governments might examine options for regulating their activities. However, in the case of promoting genetic resource conservation, for example in a genebank, the available expertise and the nature of the costs involved means that there are likely to be few advantages to promoting competition among different 'providers'. According to the PIC framework, government should then choose between contracting terms with a single provider that are based on inputs or on outputs. The latter are generally preferred, but not always possible.

The PIC framework does not however provide much guidance when one considers different and specific activities that can be viewed as part of the management and conservation of GRFA. (This is similar to the critique of the PIC by J. Theeuwes, 2004). To some extent, the nature of the benefits and associated external effects can be differentiated according to some of these categories.

Nor does the PIC analysis offer guidelines for determining how much of each of these activities is enough. The framework suggests the use of cost-benefit analysis but this is limited in the case of GRFA by lack of detailed information on the benefits associated with different levels of activities of conservation and management. Some sort of weighing up of estimated costs against benefits might be feasible where the latter are measured, not in monetary terms, but perhaps in physical units (e.g. number and diversity of resources conserved ex situ). It might furthermore be possible for expert opinion to be used to achieve some kind of relative ranking of discrete options. This would allow a more systematic assessment of the costs versus the benefits, but will clearly not offer an 'objective calculus' for public decision-making. (It can also be questioned how many resources should be expended in undertaking such an analysis. A key concern here is the policy space, or room for manoeuvre, in terms of either devoting more or fewer resources to GRFA, following the results. Another perspective might be to limit or avoid such an analysis if the budget allocation for GFRA is relatively fixed.)

Appendix 2

Questions posed during interviews

The general structure of the questions is as follows:

1) *Interaction with CGN*
   a) What types of interaction does the organisation have with CGN?
      - Exchange of genetic resources (provide to CGN; request from CGN)
      - Research e.g. collaboration
      - Support for policy
      - Information exchange (specify)
      - Education, public awareness activities/support
      - Other, namely________________________________

2) *Trends affecting the organisation*
   a) What are currently the major trends in the management and use of genetic resources affecting your organisation?
      Such as: trends in the sector and market (competition, market demands, etc.), technological developments, regulation of biotechnology, acceptance of genetic modification, evolving intellectual property rights
   b) What do these trends imply for the organisation, and how is it responding?
   c) Do you expect such trends to continue over the next five years (to 2014) and/or are there other developments on the horizon?
   d) What are the implications of these trends for the organisation's interaction with CGN?

3) *LNV financial support: WOT-GB*
   a) In your view, what are the most important reasons for LNV support for WOT-GB?
   b) What would be the implications of reduced government support to the WOT-GB for your organisation?
      N.B. This question is not meant to suggest that reduced government support to WOT-GB is being considered.

List of interviewees

In some cases, individuals interviewed preferred not to be identified personally.

Type of Genetic Resources	**Commercial companies and industry associations**	**Non-profit associations, NGOs**	**Research and training organisations**	**Government and public sector organisations**
General				MinBuza (A. v. Ardenne, PR Rome)
Plant	Plantum (A. v.d. Hurk) International Seed Federation (O. de Ponti)	Nederlandse Vereniging van Botanische Tuinen (B. v.d. Wollenberg) De Oerakker Netwerk Eeuwige Moes (A. Bootsma)	WUR Plant Breeding (R. Visser, B. Vosman) Centre for Biosystem Genomics - CBSG (W. Stiekema) TU Delft (J. Kinderlerer)	LNV-DL (H. Smolders)
Animal	Productschap Vee, Vlees en Eieren (M. Vonk) AltaGenetics Hendrix Genetics IPG/TOPPIGS	Stichting Zeldzame Huisdierrassen (G. Boink) Vereniging Natuurmonumenten (H. Piek) Geldersch Landschap (W. Geraedts) It Griene Nêst (J. Spyksma)		CGN (S.J. Hiemstra) FAO (I. Hoffman)

Table A2.1 **Number of accessions distributed by CGN 1997-2008 per type of recipient**

Type Recipient	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Private sector	631	428	4,719	3,628	4,085	2,758	4,170	1,405	3,801	1,743	2,615	2,598	32,581
Public research, inclusive universities	3,836	530	1,283	1,732	1,609	1,638	2,564	2,103	1,524	2,924	1,514	2,029	23,286
Foreign genebank	125	121	89	27	38	9	40	30	171	44	20		714
NGO	39		37	169	58	67	36	100	42	106	95	10	759
Individual person	3	10	8	43	14	5	110	46	92	77	99	124	631
Botanical garden		1			42		9	31		7	37	31	158
Education/recreation			8	13	14		16			7		6	64
Expedition	51	13			3		8	41	66	9	1		192
Other											11	172	183
Total	4,685	1,103	6,144	5,612	5,863	4,477	6,953	3,756	5,696	4,917	4,392	4,970	58,568

Source: CGN.

LEI develops economic expertise for government bodies and industry in the field of food, agriculture and the natural environment. By means of independent research, LEI offers its customers a solid basis for socially and strategically justifiable policy choices.

LEI is part of Wageningen University and Research Centre, forming the Social Sciences Group with the department of Social Sciences.

More information: www.lei.wur.nl

LEI report 2009-058