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DYNAVERSITY

Deliverable 1.2

Analysing the cultural-political and socio-economic context

DYNAmic seed networks for managing European diversity:
conserving diversity *in situ* in agriculture and in the food chain

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1. The global policy landscape around plant genetic resources

1.1. From farmers to breeders, and the rise of the "genetic resource" concept

Humans have been using plants since the dawn of civilization and started domesticating them around 10-12.000 years ago in a number of locations independently. Crop plants and their seeds, as well as wild relatives and edible wild plants, have since then accompanied entire civilisations in their development. While the move to cultivation entailed a certain loss of genetic diversity (the so-called "domestication bottleneck") as only few species and few individuals within those species were selected for becoming domesticated crops, genetic diversity subsequently thrived as these newly formed crops travelled with human groups and were adapted to new climates, soils and pests and exchanged over varying distances. The resulting genetic variability has since then been crucial for the continued adaptation and evolution of mankind's different food plants, through a combination of natural and human selection.

After millennia of farmer-driven conservation, selection and management, the governance of plant genetic diversity changed drastically over the 20th century, both technically and politically. During the 1900s, the re-discovery of Mendel's Laws of Heredity, the rise of pure line breeding and the application of hybrid technology within the Green Revolution allowed to exploit the existing crop diversity at unprecedented scales and speeds. Processes which had been conducted almost exclusively by farmers or amateur gardeners were being increasingly carried out by plant breeders, members of a new emerging profession. The term "genetic resources" started being used within the scientific community, to describe (in an approach which was subsequently criticised as being somewhat reductionist, as discussed in later sections) the sum of genes which made up wild and domesticated plants and which could be acted upon in breeding and professional research (Bonneuil and Fenzi, 2011). National and international research centres, as well as private companies, started setting up breeding programmes for improving the world's major crops with the immediate aim of alleviating hunger in developing countries by developing more productive varieties. The result was the development of high-yielding varieties, more responsive than landraces to external inputs and mechanisation and usually much more uniform genetically than the relatively heterogeneous plant material which farmers had grown in their fields until then. Many of the new commercially bred varieties, often a result of hybridisation, were widely distributed to farmers through public, private or mixed channels, depending on the national context and the type of crop. The programmes of the recently established Consultative Group on International Agricultural Research (CGIAR) played a central role in developing and making available new varieties of a number of globally important crops to developing country farmers worldwide (Pingali, 2001). Critiques to the newly established CGIAR network point out its links with the World Bank and the influence exerted over its programmes by industrialised nations and their emerging corporations to ensure that the world's seed resources would be made available for commercial plant breeding (Kingsbury, 2009).

The UPOV Convention (Convention of the International Union for the Protection of New Varieties of Plants – according to the acronym in French) arose out of this fervent period, providing breeders – particularly those operating in the private sector - with an intellectual property right instrument which awarded them with returns on their or their institution's investments. Plant variety protection (PVP) is one type of intellectual property (IP) right, alongside others like patents, copyright and trademarks. It is specifically designed for plant varieties, and grants breeder exclusive rights on propagating material (such as seeds) of new plant varieties they have developed. The Convention was adopted in December 1961 but entered into force in 1968 once it had been ratified by three countries. In its original form, it was conceived as a sort of open-source system for breeders, granting other breeders and farmers the right to use material under PVP for further research and breeding and for cultivation or on-farm experimentation (Andersen, 2008, 2016).

UPOV over time

There have been three updates of the Convention, in 1972, 1978 and 1991. There is growing concern that the latest version of the Convention, UPOV 91, strengthens plant breeders rights to the expense of farmers' rights. Article 15.1 of UPOV 91 maintains a compulsory exception to the application of breeders' rights in case of "acts done privately and for non-commercial purposes", while Article 15.2. provides an *optional* exception "to permit farmers to use for propagating purposes, on their own holdings, the product of the harvest which they have obtained by planting, on their own holdings, the protected variety". Member countries can or cannot implement this provision, with some flexibility in how they define the context to which the exception applies. However, the exception prohibits all exchange and selling of protected material - as farmers are only allowed to reuse their seed on their own holding. Furthermore, this exception has to be implemented "safeguarding of the legitimate interests of the breeder," which means that even where seed saving is allowed, larger volumes of seed saving would likely fall out of the scope of the exception (UPOV, 1991, 2013; FAO, 2014).

1.2. Genetic erosion and the *ex situ* conservation era

It was in this rapidly changing scenario that breeders themselves and scientists got increasingly concerned about the phenomenon of "genetic erosion" - which had been described already by Vavilov (Vavilov, 1926) and later colleagues in the 1930s (Harlan and Martini, 1936) - and its acceleration in the 1970s as new high-yielding cultivars replaced many landraces (Harlan, 1972; Pistorius, 1997). New varieties guaranteed higher yields thus contributing to hunger alleviation in many areas, but failed to serve the needs of the many farmers in more marginal areas and with less access to finance and technology, who still found the best response to food security and stability of production in their local landraces and mixtures. Breeders themselves were well aware of the importance of landraces, mixtures and crop wild relatives as reservoirs of important genetic diversity and traits for breeding itself. Two important FAO technical conferences on plant genetic resources (PGR) in 1967 and 1973 set the technical and financial (donor-based) bases for kick-starting global conservation actions. The establishment in 1974 of the International Board for Plant Genetic Resources (IBPGR) within the framework of the CGIAR allowed the organisation of collection missions worldwide over the following ten years, contributing to the collection and *ex situ* storage in national and international (CGIAR) genebanks of a great deal of material as well as to the production of guidelines, descriptors and protocols (Pistorius, 1997). The 70ies and 80ies were years of almost absolute dominance of *ex situ* conservation approaches, with seed banks closely linked and functional to breeding programmes and mostly located in countries where techniques, capacities and funds were available. Since then, the issue of seeds became not only a technical-scientific problem, but also a political one, entailing a tug of war between the diversity-rich countries of the global South (from which many key resources were being collected) and the technology-rich countries of the North (which were those mostly exploiting those resources for research and development, and benefiting from commercial and IP outcomes). Pat Mooney's book, "Seeds of the Earth", published in 1979 (Mooney, 1979), voiced a strong critique about the management of seeds by germplasm banks, especially international ones, and their links with conventional breeding programmes designed on an industrialised agricultural model and serving the needs of advanced countries and their economies.

1.3. The International Undertaking (IU) on Plant Genetic Resources

Debates of this kind led to the 1983 FAO Conference, in which the countries of the South of the world called for the establishment of an International Undertaking (IU) on PGR, which could answer the following kind of questions:

- Who owns the seeds collected with money from public donors and stored in countries other than those where they were collected?
- Who is responsible for their long-term preservation?
- Who will ensure that the formula of free exchange in seeds between banks will continue in the future?
- What are the benefits for farmers who have produced, selected, stored and made available the seeds stored in the banks?

The drafting of the IU was managed within the FAO Conference, and in parallel a new intergovernmental body with the mandate to monitor and manage the operation of the IU was created: the FAO Commission on Genetic Resources for Food and Agriculture.

FAO's Commission on Genetic Resources for Food and Agriculture (CGRFA)

The CGRFA is the only permanent intergovernmental body that specifically addresses biological diversity for food and agriculture. It aims to reach international consensus on policies for their sustainable use and conservation and the fair and equitable sharing of benefits derived from their use. The Commission initiates, oversees and guides the preparation of global sectoral and cross-sectoral assessments about the state of biodiversity and genetic resources in the respective sectors, along with their uses, drivers that contribute to their erosion, and challenges and opportunities in conserving and using them sustainably. The global assessments are prepared through participatory, country-driven processes on a 10-year basis.

In response to the gaps and challenges identified in the assessments, the Commission may guide drafting and implementation of policy responses, such as Global Plans of Action through which governments take action to promote the conservation and sustainable use of genetic resources in their respective sector.

The Commission developed the Genebank Standards for Plant Genetic Resources for Food and Agriculture[1] to help minimizing the loss of genetic diversity in seed, field and in vitro collections held *ex situ*. Recognizing the importance of strengthening complementarity of *ex situ* and *in situ* conservation strategies, the Commission endorsed the Voluntary guidelines for national level conservation of crop wild relatives and wild food plants[2] in 2017. Similar guidelines for national level conservation and use of farmers' varieties/landraces are under development.

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[1] http://www.fao.org/agriculture/crops/thematic-sitemap/theme/seeds-pgr/gbs/en/

[2] http://www.fao.org/3/a-i7788e.pdf

The International Undertaking was a voluntary – thus not legally binding – agreement by which countries agreed that they would seek “to ensure that plant genetic resources of economic and/or social interest, particularly for agriculture, will be explored, preserved, evaluated and made available for plant breeding and scientific purposes”. The International Undertaking was based on the then universally accepted principle that plant genetic resources were “a common heritage of mankind and consequently should be available without restriction”. In line with that principle, adhering governments and institutions holding plant genetic resources under their control were expected to adopt policies that would allow “access to samples of such resources and to permit their export where the resources have been requested for the purposes of scientific research, plant breeding or genetic resource conservation”. They also agreed that samples should be “made available free of charge, on the basis of mutual exchange or mutually agreed terms”. An important aim of the International Undertaking was to clarify the legal status of the *ex situ* collections of the CGIAR Centres and other gene banks, providing them with a legal basis to place the PGR they held in their collections officially under the auspices of FAO.

Common heritage of mankind

Since the beginning of agriculture some 10 000 years ago cultivated plants have been selected and exchanged between peoples and communities within and between all regions of the world. This continuous exchange and selection of cultivated plants over the millennia has led to an immense legacy of crop varieties, all adapted to the specific conditions of their environments. The dissemination of genetic resources has entailed an increasing degree of interdependence on crop genetic material among countries. Against the background of this interdependence, agricultural crops came to be generally perceived as a common heritage of mankind. ‘Common heritage of mankind’ is a principle of international law which holds that defined territorial areas and elements of humanity’s common cultural and natural heritage should be held in trust for future generations (Halewood et al., 2013). Therefore, they should be managed as an international public good and protected from exploitation by individual countries or corporations.

While the IU attracted wide support, a number of countries expressed concerns which can be summarized along the following lines:

- The concept of free availability of PGR might be in conflict with certain other international commitments , especially the International Convention for the Protection of New Varieties of Plants (hereafter “UPOV Convention”) and the plant breeders’ rights this convention provided for (this was a concern felt by industrialised nations, in particular)
- The global system on PGR envisaged by the IU was unbalanced, failing to recognize the important contributions of farmers to the development of PGRFA by granting any interested user the right to exploit resources which had been developed through their effort and knowledge (this one was more of a concern to diversity-rich but less industrialised countries of the South)
- Any system of PGR should more fully reflect the sovereign rights that countries have over their genetic resources (advocates for local communities particularly in the South claimed that the idea of “common heritage of mankind” could lead to misappropriation of their resources, if they were considered to be public goods)

Between 1987 and the early 1990s (also in response to the come into force of the Convention of Biological Diversity – see below), discussions within the FAO Commission led to the drafting of three resolutions (FAO 4/89 on the agreed interpretation of the IU, FAO 5/89 on farmers' rights and FAO 3/91 on States' sovereignty over genetic resources) which were annexed to the IU. More details on the whole process leading to the IU and its amendments can be found in Andersen, 2016.

1.4. The Convention on Biological Diversity and *in situ* conservation

The scene was to change dramatically as the negotiations related to access to genetic resources in general – including PGR – and the fair and equitable sharing of benefits arising from their use, began to take place in the context of a new international policy instrument towards the end of the 1980s: the Convention on Biological Diversity (CBD). Before 1986, the term biodiversity (contraction of the until then used expression "biological diversity") did not exist. It was during the National Forum on Biodiversity, held in Washington that year, that it made its first public appearance, backed by images of exotic wildlife or lush forests under threat by uncontrolled human development. This perspective captured the general public's attention much more effectively than any landrace or crop wild relative could do. Another factor contributed to the rapid spread of the biodiversity crisis: new technologies applied to biology in the pharmaceutical and chemical fields and the application of intellectual property rights (IPRs) to life forms. In the 1980s, technology capable of investigating and manipulating the essential part of biological systems, DNA and genes, started to be applied commercially, with the result of making biodiversity (specifically, genetic resources) a marketable commodity. As Von Weizsacker pointed out, "the terms biotechnology and biodiversity sound like made for each other" (Flitner, 1998). The application of intellectual property (until then mostly confined to the industrial sector) to biodiversity products (to the manipulated genetic resources) guarantees the economic remuneration necessary to repay the expenses in research and development. IPR application was brought onto the international arena since 1986 with the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) - which ultimately led to the World Trade Organisation (WTO) in 1995 - and the negotiation of the TRIPS agreement (Agreement on Trade Related Aspects of Intellectual Property Rights) in 1994 (Andersen, 2016).

The fact that (again) developed, technology rich countries were making a profit based on the biological diversity of the technology-poor but diversity-rich south, sparked the tug of war that had already been ignited by the "seed wars" of the 1960s once again, only that this time *all* genetic resources (not only those of direct relevance for agriculture) were involved. Donor countries no longer accepted the vision that genetic resources were common heritage of mankind, hence under an implicit free access regime, but wanted to exert their sovereignty over the material sourced in their territory and be granted participation in any economic gain that the biotech industry made by exploiting their national biological heritage. Against this cultural and political battleground, the Convention on Biological Diversity (CBD) was negotiated. It was approved in 1992 during the World Summit of Heads of State in Rio de Janeiro during the United Nations Conference on Environment and Development (UNCED). The CBD became operational and binding for the signatory countries in December 1993, having reached the necessary number of accessions. To date, there are 196 acceding countries (the Parties). The CBD enshrines a fundamental change in perspective regarding access to genetic resources: these cease to be an asset with free access (Common Heritage of Humankind) to become a good on which the governments of the states where they are located have sovereignty. This had already been recognised in FAO Resolution 3/91 annexed to the IU, possibly under the influence of the ongoing negotiations leading to the CBD itself. Furthermore, the CBD states that conservation is closely linked to the sustainable use of resources (i.e. promotes their exploitation, including by industry) and that access to genetic resources and their immaterial values such as the associated traditional knowledge must be regulated (i.e. it attempts to set a mechanism for benefit sharing with the provider country). Access should be regulated by the obtainment of Prior Informed Consent (PIC) of the holding communities and by an agreement (called Mutually Agreed Terms; MAT) for the equitable sharing of any benefits deriving from the use of such resources (benefit sharing), which should be mediated by the Environmental Ministry of the holding state.

Although the CBD was negotiated mostly by officials from Ministries of the Environment and with a primary focus on wild biodiversity, the agreement encompasses all genetic resources, both wild and domesticated. Hence, it influenced the scene of crop genetic resource conservation in many ways. First of all, a distinction started to be made between the generic term "plant genetic resources (PGR)" which had until then been applied implicitly to seeds of agricultural crops, and the specific "plant genetic resources for food and agriculture (PGRFA)", to distinguish those resources of relevance to food and farming from all others. And the concept of access and benefit sharing (ABS) was introduced into policy and practice. Among the useful new perspectives (Bragdon et al., 2005), the CBD recognised the importance of *in situ* conservation, requiring Parties to implement a number of measures also aimed at domesticated plants (the CBD has a special programme of work on agricultural biodiversity (decision V/5, annex, adopted in 2000[3]), and considering *ex situ* only as a complementary measure (and preferably to be carried out in the country of origin of the genetic resource). The dominance of the *ex situ* model in the seed world started to be questioned, making space for alternative conservation and use models in which the role of farmers would regain some terrain and in which landraces and CWRs regained some visibility not only as reservoirs of genes in refrigerators. At the same time, the introduction of the concept of national sovereignty and the need to negotiate bilateral access agreements raised the issue of how to deal with access to those PGRFA already collected and stored in national and international genebanks OUT of the countries of origin of the resources. It was agreed that the CBD only applied to those acquired after its entry into force (i.e. not to those acquired before December 1993). However, fitting PGRFA in the CBD's framework still posed some challenges, because of their distinctive features which differentiates them from other biological diversity: cultivated PGRFA (but to a certain extent CWRs too) depend on continuous human management and are a cornerstone of the breeding process, whether this is carried out by farmers or breeders (public or private, corporate or small). Breeding requires a wide range of variability to meet a wide range of production needs, compared to the needs, say, of a pharmaceutical industry interested in extracting a single molecule from a single wild plant for medical or cosmetic use. Bilateral negotiations for each single genetic resource employed in a breeding programme would be too cumbersome and have a disastrous outcome rather than facilitating sustainable use of resources for continued crop improvement. Also, defining a single country of origin for a PGRFA (particularly if a domesticate) is often impossible. We have already discussed how crops have been moved across continents throughout history and varieties have been crossed, introgressed and mixed for millennia. Who should a breeder negotiate access with and with who, as original provider, should he enter into a benefit-sharing agreement? All countries of the world are by now mutually interdependent on the facilitated circulation of PGRFA, while any barriers to the availability of an important PGRFA can pose serious constraints on crop improvement and food security over time (Fowler and Moore, 2005; Khoury et al., 2015; Galluzzi et al., 2016).

[3] https://www.cbd.int/agro

1.5. The International Treaty on Plant Genetic Resources for Food and Agriculture

The CBD's Conference of the Parties in its Nairobi meeting in 1992 acknowledged the special nature of PGRFA and delegated the resolution of the above issues to series of subsequent negotiations within the FAO framework. FAO's Commission on PGRFA was called upon to strengthen the global system governing PGRFA by bringing the International Undertaking into mutual harmony with the provisions of the CBD (particularly with regard to access to *ex situ* collections acquired prior to the entry into force of the CBD), and elaborating on the question of Farmers' Rights. While the FAO's Commission on genetic resources began a process to revise the International Undertaking, it also produced the First State of the World Report on PGRFA and adopted the Global Plan of Action (GPA) Action in 1996 in Leipzig, which contains a set of recommendations and activities aimed at filling gaps, overcoming constraints and facing emergency situations identified in the Report[4]. The Global Plan of Action would permit the Commission to recommend priorities and promote the rationalization and coordination of efforts for the conservation and sustainable use of PGRFA at the community, national, regional and international levels. It is articulated along four main sections: *in situ* conservation and development; *ex situ* conservation; use of PGRFA; and institution and capacity building. A Second Global Plan of Action was developed in 2011.

In 1994, twelve CGIAR Centres signed agreements with FAO, by which most of their collections were placed under the auspices of FAO. In so doing, the CGIAR formally agreed to hold the materials contained in their collections "in trust for the benefit of the international community". This was consistent with the idea of an internationally coordinated network of gene bank collections that had been expressed in the International Undertaking and provided a legal interim solution to the issue of *ex situ* collections not addressed by the CBD, until the revision of the International Undertaking would be completed.

It took seven years to complete the IU's revision. The outcome was a new legally binding instrument, the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA). The Treaty's innovative solution to access and benefit-sharing is its declaration that 64 of our most important crops and forages - that together account for 80 percent of all human consumption - will comprise a pool of genetic resources (the Multilateral System, MLS) that are accessible to everyone. These crops are listed in the Annex 1 to the ITPGRFA. In line with the CBD, the ITPGRFA reaffirms the sovereign rights of countries over their PGRFA: indeed it is in the exercise of these rights that the Contracting Parties agree to place within the MLS any collection – provided it is in the public domain and under the direct control of the Party - of those PGRFA that are most important for food security and on which countries are most interdependent. If they wish, Parties can voluntarily include collections of non-Annex 1 crops in the MLS. Those who access genetic materials through the MLS agree, by signature of a Standard Material Transfer Agreement (SMTA), that they will freely share any new developments with others for further research or, if they want to protect the developments in a way which restricts future use by others, they agree to pay a percentage of any commercial benefits they derive from their research into a common fund (the Benefit Sharing Fund) to support conservation and further development of agriculture in the developing world. Hence, benefits arising from the utilization of PGRFA are not shared directly with the provider as expected under the ABS system practiced under the CBD, where benefits are to be directly shared with the provider through case-by-case agreements. As of today, the vast majority of the cash flow into the BSF has come from Contracting Parties' voluntary contributions. Over the

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[4] http://www.fao.org/tempref/docrep/fao/meeting/015/aj631e.pdf

last two years, the French seed sector, Groupement National Interprofessionel des Semences et Plants (GNIS), made regular annual voluntary contributions, becoming the first private sector institution to regularly contribute to the fund. In 2018 the first and only (to date) user-based "royalty" has been paid, by a Dutch seed company that obtained new commercial varieties from MLS germplasm accessed from two European national genebanks. Discussions are ongoing within the Treaty on how to improve the functioning of the MLS, one of the aspects being how to enhance monetary payments into the BSF, in exchange for commercial utilisation of MLS germplasm. Activities supported by the BSF must respond to the three basic priorities of the Treaty's Funding Strategy: 1) information exchange, technology transfer and capacity-building; 2) Managing and conserving plant genetic resources on-farm; and 3) Sustainable use of plant genetic resources. To be eligible for support from the Fund, project proposals must be submitted by any governmental or non-governmental organization, including genebanks and research institutions, farmers and farmers' organizations, and regional and international organizations, based in developing countries that are Contracting Parties to the International Treaty. Since a modest beginning with a few small-grant projects in 2009, the International Treaty's Benefit-sharing Fund has increased its funding capacity in subsequent cycles (three cycles have been completed and one is running as of today), investing a total of over US$20 million distributed among 61 projects across 55 developing countries (excluding those of the fourth cycle which is still running). The Crop Diversity Trust (established in 2004) is another pillar of the Treaty's funding strategy, dedicated to the enhancement and safety back-up of national and international *ex situ* collections under the IT. The Trust functions as an endowment fund, providing long-term grants to safeguard *ex situ* collections of unique and valuable crop diversity held in genebanks around the world. Priority is given to 25 crops among those listed in Annex 1 of the International Treaty, of importance to the food security of least developed countries. The Crop Trust signed its first long-term partnership in 2006, with the International Rice Research Institute (IRRI). It is now working to reach the fund's target size of USD 850 million, which would ensure the long-term conservation and availability of the *eleven* collections of the CGIAR, other collections in Article 15 of the International Treaty and the maintenance of the *Svalbard Global Seed Vault* (see below), as well as the development of improved information systems for plant genetic resources for food and agriculture. To date, the USD 300 million target has been reached; approximately 95% of the endowment's value has been provided by national governments, while the remainder has been provided by the private sector. The Svalbard Global Seed Vault opened in 2008, thanks to a partnership between the Government of Norway, NordGen, and the Crop Trust. It is a long-term seed storage facility, built to stand the test of time and the effects of natural or man-made disasters. The Seed Vault represents the world's largest collection of crop diversity and aims at safely storing duplicates (backups) of seed samples from the world's crop collections. In 2011, the Crop Trust started project on Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives. It aims at identifying those wild crop varieties that are missing from existing crop collections, are most likely to contain diversity of value to making agriculture more productive and are most endangered. These crop varieties are then collected from the wild and conserved in genebanks; evaluated for useful traits and prepared for use in crop improvement (pre-breeding) programs; and made available globally through their inclusion in pertinent information systems.

The MLS and how crop commons went global

Collective pooling of PGR(FA) has been a traditional form of support for agricultural development, crop improvement and agricultural research. Pooled PGRFA were considered “commons”, i.e. resources that are not subject to exclusive state or private controls and are instead shared by groups of people of varying sizes, who jointly use and manage them through collective actions. The geographical scope of traditional commons (of PGRFA or other goods) was limited, as was the number of actors involved in their collective management (Ostrom, 1990).

As crops moved around the world, and the scope of agricultural innovation and production systems have expanded, so has the scope and coverage of pools of shared plant genetic resources that support those systems. Since the 1960s, the creation of PGRFA collections, international genebanks and global breeding programmes formally shifted the creation and management of PGRFA pools to an international level, making them the subject of global interest, international regulation and concern.

Today, the most directly relevant international law affecting collective pooling and management of PGRFA is the ITPGRFA. The Treaty’s MLS is concerned with the pooling of shared PGRFA (commons) which are not subject to private ownership and controls and are to be made available on an international (potentially global) scale. The rules governing participation and membership are designed to increase members’ contributions to the overall conservation and sustainable use of PGRFA, as well as to promote equitable distribution of benefits associated with their use.

Beyond the ITPGRFA, there is virtually no concrete support within international access and benefit-sharing laws for the common pooling and management of genetic resources. The emphasis in the implementation of the CBD has largely been one of creating legal mechanisms to close loopholes so that no one can get access to a given genetic resource without permission from the competent national authorities on a case-by-case basis. The CBD-inspired bilateral negotiation mechanisms have almost invariably failed to support either facilitated access or benefit sharing, and have in many cases ended up paralysing research and development (public and private) around genetic resources (Halewood et al., 2013).

The Treaty does not stand in the way of plant protection rights, but favours less restrictive forms of intellectual property rights, such as the plant variety right enshrined in the UPOV agreement, which guarantees the "availability" of the product without any restrictions on further breeding and research (the breeders’ exemption) and for farming (farmers’ privilege). While the term “PGRFA under the management and control of the Contracting Parties”, encompasses both PGRFA held *ex situ* and under *in situ* conditions (Moore and Williams, 2011), in practice the MLS’s access and benefit sharing mechanism is mostly an *ex situ*-focused instrument. Indeed, the status of *in situ* genetic resources is more difficult to define, and in many instances, they are not clearly under the management and control of Contracting Parties, nor in the public domain. This is the case of resources that are subject to proprietary rights of local communities or other private entities, hence falling out of the MLS’ scope, unless the owners decide to include them in the system voluntarily. This has been done by the Swiss seed network Pro Specie Rara or the communities of the Potato Park in Cuzco (Peru). Other sections of the Treaty, such as those on sustainable use (Art. 6) and farmers’ rights (Art. 9), place a strong focus on promoting *in situ* and on farm conservation of landraces, while Article 5 promotes *in situ* conservation of CWR, including in protected areas. However, there is a lot of work to be done in order to implement these provisions which tend to remain vague and unevenly considered in national legislations across Parties. As Olivier de Schutter commented back in 2009, “this is in sharp contrast with the enforcement, at international level, of plant breeders’ rights and biotech-industry patents”.

The Global Information System on PGRFA (GLIS)

Article 17 of the International Treaty states that "Contracting Parties shall cooperate to develop and strengthen a global information system to facilitate the exchange of information, based on existing information systems, on scientific, technical and environmental matters related to plant genetic resources for food and agriculture." The Vision and first Programme of Work on the Global Information System (GLIS) are contained in the Resolution 3/2015 of the Treaty's Governing Body. The programme of work contains seven objectives and concrete activities for the period 2016-2022. Since 2016, a Scientific Advisory Committee is in place, to provide guidance on the development of the System and its components and, among others, advise the Secretary about new areas of work with potential impact on the system. Since 2017, the Global Information System introduced the Digital Object Identifiers for PGRFA and started developing partnerships and connections with existing information systems, such as the World Information and Early Warning System (WIEWS)[5], Genesys[6], GRIN-Global[7], and the European Search Catalogue for Plant Genetic Resources (EURISCO)[8]. In the 2020-21 biennium, linkages with the Documentation and Information System (Web-SDIS) of the Southern African Development Community (SADC) genebank[9], as well as the Convention on Biological Diversity's Clearing House Mechanism[10] will be strengthened. The Governing Body has also requested the Secretary to continue enhancing cooperation with the DivSeek International Network, the Global Open Data for Agriculture and Nutrition (GODAN), the CGIAR Big Data Platform, and the Global Biodiversity Information Facility (GBIF).

In November 2019, the Governing Body requested the Advisory Committee to provide inputs on how to deal with digital sequence information/genetic sequence data in the framework of the development of the Global Information System.

1.6. Improving Access and Benefit-Sharing under the Convention on Biological Diversity: the Nagoya Protocol

While the complex architecture of the IT was being constructed, evidence was accumulating that access and benefit sharing through CBD was rarely happening because of difficulties in national level implementation of effective and straightforward legal frameworks and mechanisms. In 2002, at the sixth Conference of the Parties to the CBD (COP 6), a voluntary guideline was agreed based on a draft submitted by the Swiss government, and was named “Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization.” Their purpose was to support Parties and stakeholders in the drafting of ABS contracts, especially in relation to obtaining prior informed consent (PIC). Despite being voluntary rather than legally binding, the Guidelines are recognized as an important first step for the implementation of the ABS provisions of the CBD, which was taken further when Parties to the CBD embarked in the negotiation of the Nagoya Protocol on Access and Benefit-sharing, a supplementary, legally-binding instrument to the CBD. The Protocol was adopted in 2010 and entered into force in 2014 (119 Parties). Its aim is aiding the national level implementation of the fair and equitable sharing of

5 http://www.fao.org/wiews/en/
6 https://www.genesys-pgr.org/
7 https://npgsweb.ars-grin.gov/gringlobal/search.aspx
8 https://eurisco.ipk-gatersleben.de/
9 https://www.sadc.int/sadc-secretariat/services-centres/spgrc/
10 https://www.cbd.int/chm/

benefits arising out of the utilization of genetic resources, striking a balance between the sovereign rights of states over their natural resources and the public benefits of the products derived from these resources. Article 4 of the Nagoya Protocol recognizes the ITPGRFA as a specialized instrument, dedicated to a subset of all genetic resources, those of relevance for food and agriculture.

IT or Nagoya?

Where a country is Party to Nagoya but not to the IT, the Nagoya Protocol will apply to all transactions involving genetic resources. If a country is Party to the IT *and* to Nagoya, the former will apply to genetic resources of Annex 1 crops under the management and control of the Party and in the public domain (most likely *ex situ*) and whatever other material the Party voluntarily includes in the MLS; the latter will apply to all other material. In such a context, managers of collections which are not in the public domain (public, collective, …) can decide whether to place these in either of the two systems.
In any case, whatever genetic resource falls within the scope of the IT its access will be regulated according to the rules of the Multilateral System, while whatever falls within Nagoya will be regulated based on the bilateral approach established by the CBD requiring prior informed consent and mutually agreed terms.

The Nagoya Protocol is the most recent legally binding policy instrument to appear on the complex scene of conservation and sustainable use of genetic resources. Its implementation and harmonisation with other existing instruments (particularly the International Treaty) are challenging, and many international cooperation programmes are in place to support countries in this harmonisation. Novel challenges are also continuously emerging in the implementation of any access and benefit sharing policies, such as those related to dealing with ABS in case of digital sequence information, which is increasingly present in all branches of life sciences and modern biology.

CWR in global policy and practice

At the global level, the value of CWR and the requirement for more effective CWR conservation is recognized in a number of policy instruments. The Global Plan of Action for the conservation and sustainable utilization of plant genetic resources for food and agriculture (GPA) includes conservation of CWR as a priority area, and Article 5 of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) promotes *in situ* conservation of CWR, including in protected areas; in 2013, the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) stressed the importance of establishing genetic reserves for *in situ* conservation of priority crop wild relatives (CWR), which in some circumstances could also include traditional cultivars, and requested the preparation of a concept note on the possible establishment of a global network for *in situ* conservation of crop wild relatives and wild food plants. After various iterations, in 2019 the Commission endorsed the recommendation of the ninth session of the Intergovernmental technical working group on PGRFA that the establishment of a global network is premature. The Working Group instead recommended the organisation of an international symposium, to be held in cooperation with the Treaty. The Conference of the Parties to the CBD (COP) underlined the importance of CWR in Target 13 of the CBD Strategic Plan (CBD, 2010a) which states that “by 2020 the status of crop and livestock genetic diversity in agricultural

ecosystems and of wild relatives has been improved" and that "*in situ* conservation of wild relatives of crop plants could be improved inside and outside protected areas", as well as in the CBD Global Strategy for Plant Conservation 2011–2020 (CBD, 2010b): its Target 9 states that "70 per cent of the genetic diversity of crops including their wild relatives and other socio-economically valuable plant species conserved".
There are many existing national institutions, organizations and initiatives that can be relevant to improving the conservation status of crop wild relatives. Some key actors are described here:

- FAO's Commission on Genetic Resources for Food and Agriculture, which produces technical guidelines and mechanisms to promote the conservation and sustainable use in situ and on farm
- Bioversity International, a global research-for-development organization and part of the CGIAR Consortium
- The Global Crop Diversity Trust
- Botanic Gardens Conservation International, a plant conservation charity based in Kew, England, working with 800 botanic gardens in 118 countries, whose combined work forms the world's largest plant conservation network
- The Crop Wild Relatives Specialist Group of the IUCN Species Survival Commission, a network of crop wild relative experts around the world dedicated to working jointly to promote the conservation and use of crop wild relatives

1.7. The UN Declaration on the Rights of Peasants

An indirect effect on the development of policies dealing with conservation, sustainable use and access and benefit sharing of agricultural biodiversity may be exerted in the near future by the country-level implementation of the United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas[11] which was approved in 2018 by the Third Committee (Social Humanitarian and Cultural) of the UN General Assembly. This decision had been strongly advocated by international actors working to promote family farming and peasant agriculture, such as Via Campesina[12], FIAN[13] and CETIM[14]. The Declaration aims to better protect the rights of all rural populations including peasants, fisherfolks, nomads, agricultural workers and indigenous peoples and to improve living conditions as well as to strengthen food sovereignty, the fight against climate change and the conservation of biodiversity.

2. The evolving concept of genetic resources conservation

2.1. Early years and the dominant *ex situ* conservation paradigm

The development of international frameworks around plant genetic resources was certainly driven by rapidly evolving global commercial interests; however, it also largely reflects (and was informed by) scientific discussions on the most appropriate conservation models and strategies, which

[11] https://undocs.org/en/A/C.3/73/L.30
[12] https://viacampesina.org/en/
[13] https://www.fian.org/es/
[14] https://www.cetim.ch/

coevolved alongside the trajectory of policies. Within such discussions, an early distinction was made between genetic resources of wild vs. domesticated species, for which different conservation models were proposed. The first and foremost work describing these divergent approaches is that of Frankel (Frankel et al., 1995). This scientific framework implies that genetic resources of wild plants are best preserved in their natural habitats, in the spontaneous ecological communities to which they belong (i.e. *in situ*), while genetic resources of species of agricultural relevance are best conserved *ex situ* in genebanks. From here, they can be easily and efficiently accessed for breeding and research purposes, while being rapidly and efficiently saved from the genetic erosion which was occurring due to the rapid expansion of industrialised agriculture. During the early decades of international PGRFA conservation efforts, most scientists and policy makers assumed that farmers had no interest nor incentive to keep conserving and managing the traditional agro-ecosystems in which landraces and crop wild relatives prospered: the use of these resources was linked to underdevelopment, low production and therefore poverty and farmers would invariably choose to shift to modern varieties once they had the chance to do so. Based on these assumptions, they saw no possibility or advantage in involving them in dedicated *in situ* conservation programmes for PGRFA (Hawkes, 1977; Plucknett et al., 1987). Otto Frankel, one of the main actors in the international efforts to halt genetic erosion, stated that "the *in situ* conservation of local varieties is socially and economically impossible", while Hawkes wrote that "there is no moral duty to force farmers to cultivate landraces". Furthermore, most stakeholders at the time were aware that setting up an *in situ* conservation program for PGRFA would mean providing for an active involvement of farmers, introducing a social variable that would be difficult to manage within scientific projects. Under the *ex situ* paradigm, PGRFA were kept in controlled environments, removed from their place of origin and from the dynamic effects of natural and human selective pressures. Many CWRs of particular interest for breeding and which could be stored in genebanks and regenerated easily were also collected and used in breeding, but this is an overall small proportion compared to the cultivated PGRFA which ended up in *ex situ* collections. A recent study analysing the status of 1,076 taxa related to 81 crops, found that over 95% are insufficiently represented compared to the full range of geographic and ecological variation in their native distributions. For 313 (29.1% of total) taxa associated with 63 crops, no germplasm accessions exist, and a further 257 (23.9%) are represented by fewer than ten accessions. The eco-geographical modelling conducted by the study identified over 70% of taxa as high priority for further collecting in order to improve their representation in gene banks (Castañeda-Álvarez et al., 2016). Furthermore, there is little evidence that the *in situ* conservation of wild relatives has advanced significantly, especially outside protected areas. Some CWR populations have received specific attention in protected area management plans (FAO, 2010), and the table below summarises some experiences. However, various authors agree that the handful of active genetic reserves for CWR conservation maintain an even smaller proportion of CWR diversity than is conserved *ex situ* (Maxted et al., 1997; Meilleur and Hodgkin, 2004; Heywood and Dulloo, 2006).

Some examples of conservation of CWR in protected areas

In Ethiopia, wild populations of coffee (*Coffea arabica)* are being conserved in the montane rainforest. The Sierra de Manantlan Reserve in Southwest Mexico has been established specifically for the conservation of the endemic perennial wild relative of maize (*Zea mays*). The Erebuni Reserve has been established in Armenia to conserve populations of cereal wild relatives (for example *Triticum araraticum, T. boeoticum, T. urartu, Secale vavilovii, S. montanum, Hordeum spontaneum, H. bulbosum* and *H. glaucum*). The Lizard Peninsula in southwestern England was found to be particularly rich in CWRs, conserving 93 CWR species out of the total 148 found in England. Examples are wild chives (*Allium schoenoprasum*), wild garlic (or ramsons), (*Allium ursinum*); wild asparagus (*Asparagus prostratus*); marine beet, (*Beta vulgaris* subsp. *maritima*); sea carrot, (*Daucus carota* subsp. *gummifer*); marine raddish, (*Raphanus raphanistrum* subsp. *maritimus*); Western trifolium, (*Trifolium repens*). Since this assessment, the managers of the protected areas which already existed on the island included the active conservation of CWR in their management plan, with a view to enable and favour future use of the resources. In Germany, the "100 fields for biodiversity" project focuses on the conservation of wild plant species (including CWR) outside protected areas through the establishment of a nationwide conservation network for wild arable plant species.

Genetic reserves included within larger protected areas exist for the conservation of *Vigna* species in Uganda. In other cases, specific programmes are carried out within genetic reserves to support the participation of local communities in conservation: in Vietnam, incentives are in place to support local communities as 'curators' of crop diversity.

Other types of nature protection and traditional management systems at a landscape scale are community conserved areas. These are defined as natural and modified ecosystems, containing significant biodiversity resources, both wild and cultivated, and providing ecological services and cultural values. They are voluntarily conserved by indigenous peoples and local and mobile communities through customary laws or other means. Examples of these areas are found in various countries, such as in the Western Terai Landscape Complex (WTLC, Nepal) where community biodiversity registers have been developed (Gautam et al., 2008) and in the highlands around Cuzco in Peru. Here, the Potato Park (Argumedo, 2008) aims at conserving the landscape, indigenous livelihoods and way of life, revitalizing customary laws and institutions and ensuring the survival of the genetic heritage of the Andes, a centre of origin and diversity for crops such as quinoa, kiwicha, tarwi, oca, mashua and potato, hence rich in wild relatives of these important crops (Amend et al., 2008).

Particularly in the face of unprecedented climatic disasters, social conflict, and political uncertainty, many authors recognize the need for integrating *in situ* and *ex situ* strategies to effectively conserve CWR. Recently, the concept of *trans situ* conservation has been introduced (Riordan and Nabhan, 2019), which aims at dynamically integrating multiple *in situ* and *ex situ* measures, from conservation to research to education, spanning local to global scales. A pilot study on the USA-Mexico border explores three components of *trans situ* conservation: *in situ* protection on working and public lands; seed and living plant collections in local and regional botanical gardens, arboreta, and nurseries; and genebank accessions in the USDA National Plant Germplasm System.

2.2. Questioning *ex situ* conservation and the rise of *in situ*/on farm approaches

The dominant *ex situ* approach to PGRFA conservation started to be questioned in the late 1980s, as the results of research performed by rural sociologists and anthropologists demonstrated the relative in-effectiveness of a purely static means of conservation which removed the plants from their natural and cultural environment. The reductionist and "resourcist" view which had until then emphasised crop diversity as a resource for economic exploitation by breeders and seed companies (Fenzi and Bonneuil, 2016) started to be countered by a more holistic and systemic vision which looked at (crop) biodiversity as a multi-dimensional, ecosystem-wide issue. This shift was supported by the renewed *in situ* emphasis contained in the discussions leading to the Convention on Biological Diversity and by the increasing criticism which was being moved against

“Green Revolution” approaches to agricultural development. Researchers highlighted how in sub-optimal or marginal agro-ecosystems where intensification of production (through machinery, water or chemical inputs) was impossible or in socio-cultural contexts were local farming and food traditions were still strong, farmers did NOT choose modern varieties even when they had the opportunity to do so. Apart from cultural factors, the main agronomic reason for sticking to local, traditional genetic resources and management models was the need to ensure stability of performance through the unpredictability of marginal, less controllable environments, rather than obtaining peak productions in any given year. Altieri and Merrick’s article “*In situ* conservation of crop genetic resources through maintenance of traditional farming systems” in 1987 sets the scientific stage for concretely considering how to apply *in situ* conservation to PGRFA and “recognize the active role of farmers in the conservation of genetic resources" (Altieri and Merrick, 1987).

This shift in perspective was rapidly accompanied by the idea of widening the conservation focus from single varieties to entire agroecosystems, with all their complex biological and human interconnections. Actors involved in the research and implementation of this renewed paradigm, are not comfortable with the use of the term “genetic resources” which they attribute to a “modernist paradigm” where the plant is perceived as a sum of genes, a "machinery that must be optimized to modernize national agriculture"; they instead favour a broader, more holistic approach in which the genetic dimension of crop diversity is embedded and linked back to the knowledge and culture from which it had been alienated (Fenzi and Bonneuil, 2016; Fenzi, 2017).

This idea established a link between sustainable rural development and maintenance of not only PGRFA but of all agrobiodiversity by farmers (Oldfield and Alcorn, 1987), including landraces as well as crop wild relatives and useful wild plants. Later in the 1990s, more scientific research provided evidence of how folk crop varieties may play a role in sustainable agriculture (Cleveland et al., 1994) and how genetic diversity, maintained in the fields at different levels (inter- and intra-specific, spatial and temporal), provides a number of socioeconomic, environmental and genetic values. Initially, this evidence was mostly limited to developing countries’ small scale, marginal agricultural systems. At the end of the decade, Pistorius and van Wijk warned: "The discussion on conservation strategies must be extended to the discussion on the opposition between, on the one hand, industrialized agriculture, globally organized, and, on the other, non-industrialized production strategies, traditional, locally organized" (Pistorius and van Wijk, 2000). Indeed, developed countries were soon involved in the reconsideration of agricultural biodiversity’s role in providing for healthy, more sustainable, local and fair agroecosystems, even in areas of the world where industrialised agriculture had already become dominant. It was no more a matter of picturesque small farmers in traditional clothes in the global south, but also of “modern” farmers in the developed world wishing to emancipate themselves from the imperative of industrialised, uniform, commercial agriculture and to go back to more sustainable, diverse and healthy forms of tending the land. As the scope of *in situ* PGRFA conservation left the realm of romanticism and gained more terrain in the practical world, it became known under a name which better reflected the specificities of conserving agricultural rather than purely wild biodiversity, and the term “on-farm” conservation started to be routinely used. Since the early 2000s, a great deal of scientific literature has been produced on this approach (Brush, 1995, 2000; Wood and Lenne, 1997; Almekinders, C.J.M., Louwaars, 2000; Pistorius and van Wijk, 2000; Berg, 2009). The following points attempt to provide a synthesis of the main arguments in favour of on-farm conservation in sustainable agro-ecosystems:

- PGRFA cannot be conserved out of their evolutionary context (where evolutionary forces are both natural and man-driven). It’s not only a matter of conserving alleles and genotypes, but also of diverse plant populations, the cultivation systems where they are embedded, the genetic interactions with other varieties and wild relatives, and the effect of cultural and agronomic management

- Agroecosystems are by nature dynamic systems which keep renewing diversity and generating new PGRFA; systems located in crop centres of origin or diversification are natural laboratories for crop evolution (including introgression with wild relatives) and agricultural research on domestication and locally adapted breeding
- Conservation is implemented through use, and traditional knowledge is preserved; a safety back-up can be provided by *ex situ* conservation (and vice-versa), with regeneration happening naturally thanks to farmers' seed saving
- The resilience and stability of agro-ecosystems is promoted, while useful germplasm for stress-prone environments where diverse planting material is most needed, is conserved and continually adapted.

Further scientific discussions dealt with how to strike a balance between maintaining a given PGRFAs unaltered (as under the *ex situ* model) and allowing for dynamic evolution of the PGRFAs in agroecosystems, as naturally occurs in farmers' fields. In their 2002 work, Maxted et al. (Maxted et al., 2002) codified these two possible pathways:

1. "Real" on-farm *conservation*, centred on the conservation of the genetic diversity of a given resource within a specific system
2. On-farm *management*, whose focus is the maintenance of the agricultural system as a whole and not a single genetic resource in itself

The focus of the former is the conservation of individual PGRFA and their specific phenotypic and genotypic identity within on-farm systems. PGRFAs are used directly by the farmers who maintain such resources, but they also have potential for use by breeders or other outside users interested in exploiting the diversity. It essentially provides for a more static form of on-farm conservation which is thus closer to *ex situ* approaches, while being carried out in the field. In contrast, on-farm management focuses on maximizing the diversity of PGRFA held within any on-farm system. The diversity is maintained to maximize direct benefit to the local farmers (Suneson, 1956; Ceccarelli, 2015), particularly those in marginal environments (Di Falco and Chavas, 2006; Ceccarelli et al., 2010; Alves et al., 2018), and potential use by external breeders or other users is of less importance. The former approach tends to consider any variation in the identity of single crops and varieties in an on-farm system or in its composition a threat to its survival, while the latter describes a more dynamic system whereby the identity of single varieties, genes and alleles may change over time, as the farmer in charge of managing the system experiments with genetic resources (local or foreign), exchanges seeds, allows for wild plants to grow close to cultivated ones, selects the best plants according to his/her preferences and responds to environmental, cultural and market influences. Naturally, on-farm management still implies the maintenance of an overall level of diversity which makes the system sustainable, but this is achieved through favouring diversity-friendly management practices rather than focusing on the conservation of single resources.

2.3. Widening the on farm approach

Over time, on farm conservation became the terrain in which other important activities around PGRFA developed, among which participatory, decentralised breeding, restoration of maintenance of informal seed systems, reintroduction of heritage varieties or landraces into farming systems from which they had been displaced, emergency seed stock programmes, training and educational activities and tourism. The climate crisis has contributed to strengthen attention paid to using crop diversity within production systems as a way to reduce risk and unpredictability due to biotic and abiotic changes. A greater understanding of the amount and distribution of genetic diversity on-farm and of the role of informal seed systems in maintaining such diversity is also accumulating. One of the challenges for the future is related to achieving greater integration across *ex situ*/*in situ*/on farm conservation strategies and collaboration among relevant actors from each field. One aspect of this challenge relates to how to better harmonise and coordinate the on farm management of cultivated genetic resources with *in situ* conservation of CWRs, in order to plan common or at least intersecting conservation approaches rather than keep them somewhat artificially separate. Until recently, indeed, *in situ* conservation of CWR has been almost exclusively carried out through the identification and creation of genetic reserves whose management has somehow fallen between the cracks of the environmental and agricultural sectors. On the contrary, CWRs often occupy transition ecosystems between the wild and the cultivated and in so doing coexist with the latter in field margins or within fields themselves. As their cultivated counterparts, CWRs are often at least to a certain extent dependent on the continued management of the agro-ecosystem, where they contribute to geneflow and, therefore, crop adaptation/evolution. The other aspect of this challenge is how to integrate the even more contrasting models of *ex situ* on the one side and *in situ*/on farm on the other, which also translates into creating better links between the so-called formal and informal research and development systems. While there have been recent efforts at mutual acknowledgment and collaboration (ECPGR, 2017), this is a field that still needs to be developed.

3. European PGRFA programmes and actors

3.1. Early years: genebanks and *ex situ* conservation

Several genetic resource conservation programmes and networks of collaborating institutions have been in place in Europe since the early 20th century, scattered between Western, Eastern, Southern and Northern Europe. On the earliest such experiences stems directly from the work of Nikolai Vavilov, and was coordinated by the institute Vavilov set up in Leningrad in 1921 (Institute of Applied Botany in Leningrad, renamed Vavilov Institute in 1967): the network of genetic resource centres of socialist countries belonging to the Council for Mutual Economic Assistance (CMEA)[15]. As in the rest of the world, the subsequent evolution of genetic resources conservation efforts in Europe is closely linked to the success of Green Revolution approaches to breeding and crop development and to its dramatic effects on plant genetic diversity. In response to their concern about genetic erosion, European scientists and institutions actively participated in the fervent collection and *ex situ* storage activities of the 1960s and 1970s. The European Society for Research and Plant Breeding (EUCARPIA), was the first organisation to set up a collection network and was instrumental in the establishment of European genebanks. It has been strongly criticised for being instrumental to the creation of well-organised breeding programmes, thus

[15] Report of the FAO/UNDP governments consultation on the European cooperative programme for the conservation and exchange of genetic resources for plant breeding, Held in Geneva in December 1979, http://www.ecpgr.cgiar.org/fileadmin/templates/ecpgr.org/upload/HISTORICAL_DOCUMENTS/1979_FAO_UNDP_Government_consultation_on_ECPGR_Geneva_1979.pdf

contributing to creating a standardized market for increasingly homogenous, productive and certified seeds and aggravating European genetic erosion (Fenzi, 2017).
Its initiatives started off in the 1960s with a more generalist eco-geographical orientation resulting in the establishment of eco-regional genebanks, but then shifted to a more crop-specific focus, leading to the founding of institutions such as the potato-focused genebank in Braunschweig, Germany.
The establishment of the IBPGR in 1974 gave further impetus to collection and gene-banking activities: in 1975 the IBPGR started coordinating the Mediterranean germplasm programme, which involved five countries (Italy, Greece, Cyprus, Portugal, Spain) and saw the Bari genebank act as a central storage point[16]. In 1979, the Nordic Gene Bank was created as part of a concerted initiative between Denmark, Finland, Iceland, Norway and Sweden[17]. As part of its Agricultural Research Programme, the EC established a programme "for better use of gene banks and resistance breeding" which began its operations in 1979 in close collaboration with IBPGR, FAO, UNDP and EUCARPIA. Its major tasks included the standardization of descriptors for the exchange of material and information; a study to produce a data management programme for the Bari and Braunschweig genebanks; a breeding programme focused on disease resistance in eight selected crop species; joint evaluations across European countries of genetic material and joint collection missions such as the programme on non-oleiferous cruciferous species carried out between 1980 and 1983.
The European Cooperative Programme for Plant Genetic Resources (ECPGR) (formerly "European Co-operative Programme for the Conservation and Exchange of Crop Genetic Resources" - ECP/GR) was founded in 1980 on the basis of the recommendations of UNDP, FAO and EUCARPIA, concerned that the ongoing European initiatives around genetic resources were scattered and uncoordinated. The first Governing Board Meeting of the ECPGR was held in December 1980 in Geneva. ECPGR's original objectives included "to collect information on germplasm collections (seeds and propagated plant material) to make them available to all, to encourage collection expeditions to search for genetic material that is lacking in existing collections, to encourage the characterization and evaluation of germplasm and widely disseminate the results, and finally to advise on information and documentation systems to enable the exchange of data between genebanks[18]". The ECPGR's data management activities have led to the creation of the European Search Catalogue for Plant Genetic Resources (EURISCO) internet platform which serves as a central point of access to a network of national information systems that store and manage data on plant genetic resources. EURISCO provides both passport data and phenotypic information about 1.8 million crop plant accessions (6233 genera and 41 649 species) maintained in national *ex situ* collections in Europe, using standardised formats which facilitate data exchange (FAO/Bioversity Multi-Crop Passport Descriptors for passport data and a EURISCO specific format for phenotypic data). EURISCO was initially developed between 2001 and 2003 within the EU-funded project EPGRIS (European Plant Genetic Resources Information Infra-Structure) coordinated by the Centre for Genetic Resources in the Netherlands (CGN), and with the participation of the Czech Republic, France, Germany, Portugal, the International Plant Genetic Resources Institute (ex IBPGR, now Bioversity International) and the Nordic Gene Bank (NGB, now NordGen). In 2003, EURISCO became online accessible and was hosted by Bioversity International on behalf of the ECPGR. In 2014, the Leibniz Institute of Plant Genetics and Crop

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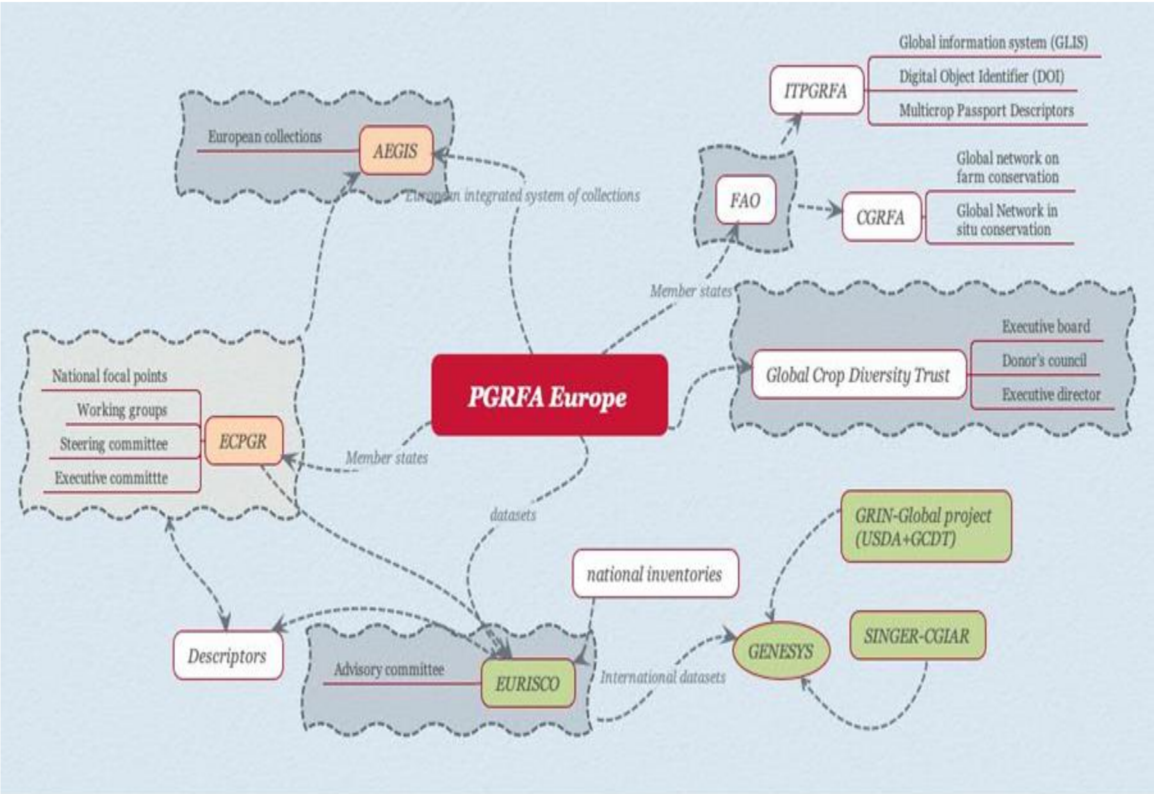
[16] idem

[17] idem

[18] Report of the third governing meeting, held in Brussels, October 1992
http://www.ecpgr.cgiar.org/fileadmin/templates/ecpgr.org/upload/HISTORICAL_DOCUMENTS/1982_FAO_UNDP_ECPGR_third_Governing_Board_meeting_Brussels_1982.pdf

Plant Research (IPK), Gatersleben, Germany, took over responsibility for the operation and development of EURISCO. EURISCO enables National Focal Points to label PGRFA accessions as part of AEGIS[19], an ECPGR initiative, aiming at improving the coordination of the conservation and management of PGRFA as well as the access to them, to ensure a safe long- term conservation (with common agreed standards) of genetically unique and important accessions.
The ECPGR Secretariat is now hosted by Bioversity International and is composed of 20 crop-specific and three thematic working groups (wild species conservation in genetic reserves; on-farm conservation and management; documentation and information). Following the recommendations made by the Thirteenth meeting of the Steering Committee in 2012, the following Task Forces were established in order to submit draft documents to the Steering Committee for adoption and use during Phase IX of the ECPGR (2014-2018): Engagement of users in ECPGR activities; *In situ* conservation of crop wild relatives; On-farm management and conservation of landraces. The creation of the ECPGR marked the beginning of more coordinated actions for PGRFA conservation across European countries, which finance and oversee the network directly. Another network with a much narrower activity scope but still relevant for PGRFA use is the European Consortium for Organic plant breeding (ECO-PB)[20], which was founded in 2001 and functions as a platform for discussion and exchange of knowledge and experiences, while supporting organic plant breeding programmes through independent, competent expertise. ECO-PB is a member of the International Federation of Organic Agriculture Movements (IFOAM).



Mind map describing the main stakeholders and tools involved in formal PGRFA management

19 http://aegis.cgiar.org/
20 https://www.eco-pb.org/

3.2. The 1990s and the gradual shift towards *in situ*/on farm conservation

Since the 1990s, European-wide scientific programmes advanced research and development actions in the field of PGRFA. The European Genetic Resources Programme, GENRES I, started in 1994 (EC Reg. 1467/1994). It aimed at enhancing the conservation, characterisation, collection and utilisation of genetic resources in agriculture, supporting national actions in member States. GENRES I ran for five years, with a budget of ten million euros which co-financed twenty-one projects: sixteen on plant, four on animal and one on forest genetic resources.
In those years, a very important Directive was drafted (Directive 98/1995) which introduced the concept of 'conservation variety', a new type of agricultural variety that could be marketed within Europe. The justification for this opening was recognising the importance of ensuring that plant genetic resources are conserved, by providing a "legal basis to permit, within the framework of legislation on the seed trade, the conservation, by use *in situ*, of varieties threatened with genetic erosion'. To all intents, opening the existing EU variety catalogue to conservation varieties and thus to marketing them was seen as a means of reducing their genetic erosion. For the first time a conservation initiative becomes part of seed regulations rather than only a prerogative of scientific bodies, researchers and *ex situ* seed-banks (Bocci, 2009). However, it would take many years before this Directive could be translated into practice (see later).
In 2004, after the ratification of the International Treaty by the European Union, GENRES II was launched (EC Reg. 870/2004), which established *"a community program for the conservation, characterization, collection and utilization of genetic resources in agriculture*". While its goals are largely overlapping with those of GENRES I, this second cycle of funding also covered the creation of an Internet network to make national inventories of genetic resources more accessible. Seventeen projects were financed by GENRES II (eleven on plant, five on animal, one on forest genetic resources), during its four years of operation and under a total budget of ten million euros. The results of an independent evaluation of GENRES II concluded that the conservation, characterisation and collection objectives were well achieved, and recommended a greater participation of end-users in order to achieve the programme's objective of using genetic resources more efficiently and to strike a balance between *ex situ* and *in situ*/on farm conservation activities. The need was also highlighted for significant budget resources for both science-related actions (e.g. genetic and phenotypic characterisation, evaluation, storage infrastructures, coordinated databases and inventories) and practical actions directed at farmers and other end-users. However, the independent evaluators also noted that "the majority of plant Actions focused on *ex situ* conservation, ranging from DNA banks, to cryopreservation of vegetative tissue or of pollen, to storage of seeds and field collections, which represent a better use of EU funds than trying to maintain the same material as living plants *in situ*". Indeed, another policy instrument of those years established more targeted frameworks for *in situ/*on farm conservation: EC Regulation 1698/2005 on "support for rural development by the European Agricultural Fund for Rural Development" contained provisions for on farm conservation of landraces in Member states. In parallel, the Natura Network 2000 (Directives 79/409/EEC and 92/43/EEC) on nature protected areas established an enabling environment for the conservation of CWRs. Another very important policy milestone was the approval of Directive 62/2008, which made operational the provisions laid out ten years earlier, but never implemented, by the conservation varieties Directive 95/98 mentioned earlier. Directive 62/2008 only set the guidelines for agricultural species, while Directives 145/2009 and 60/2010 on vegetable and forage species soon followed.
Taking stock of these policy developments, as well as of the independent evaluation of GENRES II, the European Commission launched two "Preparatory actions on EU plant and animal genetic

resources in agriculture" which took place from 2013 to 2018[21]. The aim of the first study was to deliver inputs on how to improve communication, knowledge exchange and networking among all actors involved in conservation of genetic resources in agriculture. To this end, it mapped all actors involved in the conservation of genetic resources at European level, dividing them across ten categories: consulting services, botanical gardens, breeders, experts in agricultural genetic resources, end-users, farmers, national governments, gardening organizations and amateur groups, NGOs and researchers. The following table provides the description that was given for each category:

Consulting services	Services that make new knowledge available to farmers and help them to develop their skills in agriculture and management (e.g. chambers of agriculture are services of advice)
Botanical gardens	Institutions dedicated to the collection, cultivation and display of a wild range of plants, often run by universities or researchers
Breeders	Breeders apply the science of changing the traits of animals and plants to produce the desired characteristics. The preparatory action plan recognizes that farmers are among the actors who carry out breeding, as well as professionals employed by government institutions, universities, industry associations and research centres or private companies.
Experts in agricultural GRs	A group of experts in genetic resources as those present in several coordinating bodies such as the international organization such as FAO or the ECPGR
End-users	Restaurants that encourage the consumption of rare breeds or minor crops, short supply chain initiatives, the tourism sector, retailers and consumers. It is interesting to see that this report associates restorers and consumers to minor crops and not to commercial varieties, since the former are more easily associated to food quality and health concerns.
Farmers	Farmer networks and farming organisations covering all the different types of (conventional and organic) agriculture
National governments	All competent authorities involved in the conservation and sustainable use of genetic resources
Gardeners' networks and amateurs	Not defined! But the preparatory action recognizes their important role in preserving genetic resources
NGOs	Seed saving networks or organizations, NGOs that promote the use and consumption of products of rare species or breeds (e.g. Slow Food)
Researchers	Key players in the identification and classification of genetic resources (many correspond to genebank managers)

Interviews, case studies and consultative workshops, together with an extensive literature review were carried out to collect information; subsequent analyses of the data, whose results were validated among stakeholders, led to a number of recommendations on how to further improve

21 www.geneticresources.eu

conservation mechanisms and operations as well as foster the valorisation of these genetic resources along the agro-food and forestry supply chains[22].

The objective of the second action was to better understand the stakes of neglected genetic resources in European agriculture and to tap into their economic potential. It provided inspiring examples of how to make the conservation of neglected breeds and varieties economically viable, thus encouraging farmers and other stakeholders to engage in similar projects across the EU (four valorisation projects, two plant and two animal genetic resources, were implemented by the action)[23].

3.3. The increasingly important role of seed networks and civil society actors

The merit of the Preparatory Actions is to have successfully shifted from a mainly *ex situ*-centred approach to genetic resources conservation and use to a more integrated scenario in which *in situ*/on farm actors and approaches are recognised an important role. Indeed, since the late 1990s, “informal” actors involved in on farm conservation and seed exchanges started engaging in innovative social practices and technical initiatives stemming from the central theme of seed diversity (such as participatory breeding, community seed banking and the development and dissemination of varietal mixtures and populations). Through these initiatives, effective and inclusive models of collective management and use of genetic resources on farm started to emerge, often linked to the valorisation of local territories and the re-construction of sustainable seed/food systems. The social outcomes of these efforts provided important examples of how to concretely implement international principles enshrined in the International Treaty such as sustainable use and of farmers’ rights (Newton et al., 2010; Pimbert, 2011; Da Via, 2012). These networks and movements have different modes of organization, fields of action and knowledge sharing methods (Balázs et al., 2015), but are generally composed of a basis of farmers and home-gardeners; more often than not, they also involve small seed enterprises (specialised in the seed reproduction and local distribution of landraces), environmentalists, researchers, food processers and consumers, involved in co-learning and participatory approaches to solving the intertwined issues of conservation, health, quality, rural development and sustainability (Corrado, 2010; Da Via, 2012; Koutsouris, 2012; Dogliotti et al., 2014). Most of these networks have joined forces at European levels, participating actively in a number of European collaborative research projects such as SOLIBAM (FP7, 2010-2014)[24], DIVERSIFOOD (Horizon2020, 2015 – 2018)[25], CERERE (Horizon2020, 2016-2018)[26]. These projects have contributed to re-introducing experimentation and breeding into farmers’ fields and have carried out innovative experiments such as those on evolutionary populations, integrated seed systems and food-system approaches to the management and valorisation of PGRFA.

Through the Diversifood project in particular, EU seed movements started participating actively in the temporary experiment opened by the EU (Decision 2014/150/EU) for the marketing of

[22] Preparatory action on EU plant and animal genetic resources – Executive Summary https://op.europa.eu/en/publication-detail/-/publication/5106bd11-3710-11e7-a08e-01aa75ed71a1/language-en/format-PDF/source-109641666

[23] Preparatory action, EU plant and animal genetic resources No 2 - Executive summary https://op.europa.eu/en/publication-detail/-/publication/32013121-97be-11e9-9369-01aa75ed71a1/language-en/format-PDF/source-search

[24] www.solibam.eu

[25] www.diversifood.eu

[26] www.cerere2020.eu

composite cross populations (CCP), also known as evolutionary populations[27], of selected species (wheat, barley, oats and maize). Under this Decision, until 2022 participants can market ‘material’ that does not meet the restrictive criteria set out in DUS protocols, avoiding registration of populations or relaxing the rules regarding variety registration depending on the country, but applying certain quantitative limitations. Thanks to the success stories accumulated so far, European seed networks and organisations are becoming a leading actor of knowledge creation and dissemination around on farm conservation of PGRFA and their dynamic, collective management, bridging the divide between researchers and practitioners as well as reaching out to the common public. Another point of strength is represented by the fact that these movements are gathered under the umbrella of the European Coordination for Let's Liberate Diversity! (EC-LLD), established in 2012 as an international non-profit organization aiming at coordinating the positions and actions of national networks and organisations that encourage, develop and promote the dynamic management of biodiversity on farm and in gardens. EC-LLD draws its origins and inspiration from the annual gatherings of the European movement on agricultural biodiversity known as the Let's Liberate Diversity! Forums, the first edition of which took place in 2005 in France. The Preparatory Actions gave recognition to these organisations and their activities and provided a more fertile background for them to join forces at European level.

Projects such as the afore-mentioned Solibam and Diversifood were made possible by a certain shift in perspective within EU research funding agencies, to which the Preparatory Actions assessments certainly contributed. The shift from a more research-centred, *ex-situ* focused approach to a more integrated, multi-actor perspective in the conservation and use of PGRFA was already evident in the European Research Framework Programmes (FP1 to FP7); a further, more recent key example is that of the European Innovation Partnership for Agricultural productivity and Sustainability (started in 2012). The EIP brings together innovation actors (farmers, advisers, researchers, businesses, NGOs and others) in agriculture and forestry, to form an EU-wide EIP network. Within it, Operational Groups, Multi-actor projects and Thematic Networks are all key building blocks. Operational Groups are project-based and tackle a certain (practical) problem or opportunity which may lead to an innovation and are funded under the EU Rural Development Programmes. Multi-Actor projects and Thematic Networks are supported by the H2020 funding programme (started in 2014), whose evolution over time testifying an increasing interest from the EU in genetic resources. Additionally, the GenRes Bridge project, promoted by the European networks on animal, crop and forest genetic resources, is aiming to develop integrated European strategies on agricultural and forest genetic resources, responding to one of the most critical recommendations developed by the first Preparatory Action.

The new Organic Regulation (EC/848/2018 due to come into force in 2021) further recognises the importance of diversity to improve resilience and the need for the development of organic varieties and ‘heterogeneous material’ for organic production.

[27] Evolutionary crop populations are populations possessing a high level of genetic diversity obtained either by mixing many materials and allowing for spontaneous crossing or undertaking multiple reciprocal artificial crosses as is the case in self-pollinating species such as wheat. When grown at different locations, the diversity within these populations allows them to respond to the specific forces of selection within each agro-ecological context and those genotypes better able to withstand the prevailing growing conditions are expected to contribute more seed to the next generation, rapidly adapting the population to the specific area. Thus, evolving crop populations have the capability of adapting to the conditions under which they are grown, bringing diversity and crop selection back into farmers’ fields.

European policies and programmes on CWRs

In response to Europe's commitments to the CBD, the European Strategy for Plant Conservation 2008–2014 was drafted, whose targets include important measures for CWR conservation:

- **Target 7.1** 60% of species of European conservation priority 9 plant and fungal species, including crop wild relatives, conserved *in situ* by 2014 through the implementation of national strategies for conserving priority species.
- **Target 7.2** Develop database of plant micro-reserves, genetic reserves for crop wild relatives, and where relevant other small *in situ* protected areas
- **Target 9.1** Establishment of 25 European crop wild relative genetic reserves covering the major hotspots of species and genetic diversity
- **Target 13.1** Projects in place in four European sub-regions demonstrating sustainable methods of conserving plant resources (crop wild relatives, landraces, medicinal plants) whilst supporting European livelihoods

With the timid exception of Target 13.1, these measures reflect the global tendency to keep CWR conservation efforts relatively disconnected from the increasingly applied on-farm conservation measures for cultivated species.

In 2015, the ECPGR proposed a more detailed and systematic concept for *in situ* conservation of CWRs (Maxted et al., 2015), based on the identification of priority CWR populations (defined Most Appropriate Wild Populations - MAWPs) to be included in an *in situ* management network of national and regional (European) MAWPs. The resulting integrated strategy therefore combines complementary national (bottom-up) and regional (top-down) approaches to conservation planning, although all management actions are necessarily implemented at national level. The integrated CWR conservation strategy for Europe contains an action plan containing specific management guideline, quality standards and reporting requirements, and entailing periodic review based on a set of monitoring indicators.

The purpose of the integrated strategy is to preserve CWR genetic resources for use, ensuring the availability of a wide pool of diversity as insurance against climate change. A fundamental element of the Concept is making conserved CWR germplasm available to the user community, and to this end strengthen the interface between *in situ*, *ex situ* and use of CWRs. End user including farmers, farming NGOs, public and private breeders should be involved, to ensure the user's demand is fully met. The concept foresees that access to *in situ* germplasm will become increasingly important to exploit the full potential of CWR diversity and that ABS issues to *in situ* material would have to be solved to this end. Progress towards improving the CWR conservation/use interface has already been made. The EC-funded FP7 project, PGR Secure[28] developed novel approaches to the characterization of CWR diversity, improved the availability of conservation, characterization and evaluation data, and facilitated greater engagement of the stakeholder community in the use of conserved CWR genetic diversity. Also, since 2014, the ECPGR Documentation and Information Working Group is working to include characterization and evaluation data and *in situ* conservation data in EURISCO (Maggioni et al., 2014).

The concept recommends the drafting of EU-led legislation integrating *in situ* CWR conservation with the conservation of other wild plant diversity (e.g., rare or threatened species or habitats, or

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[28] www.pgrsecure.org

unique habitats), to invigorate the cooperation and coordination between the diverse agrobiodiversity and biodiversity conservation stakeholders. An example of how complementary conservation measures can be integrated is demonstrated by the ‘Gene Bank for Wild Plant Species for Food and Agriculture’ located at Osnabrück, Germany and its network partners. Here the *ex situ* holding institute functions as a conduit between *in situ* conserved populations at the original location and the availability of *ex situ* conserved samples through collection and re-collection of specific provenances inside and outside PAs.

Promoting awareness of the value of CWR to food and economic security as well as raising additional funding, is also an important element of the concept.

Thanks to their experience in the construction of diverse and sustainable agricultural systems centred on dynamic management of PGRFA, European seed networks have the potential to be a critical partner in efforts to integrate the “wild dimension” into their portfolio of on-farm activities. The farming communities engaged within the networks, as many organic or biodynamic farmers anywhere, are already likely to be contributing to CWR conservation in their fields, thanks to their continuous efforts to reduce the impacts of their production systems on the environment and construct sustainable and diverse agro-ecosystems. However, their contribution to wild plants’ conservation is likely to be happening haphazardly and not in a coordinated or systematic manner. Through the networks, opportunities may exist to more systematically work with farmers to protect locally prioritised species in hedgerows, conservation easements, and other open spaces. Dialogue and exchange with natural parks or protected area managers will be important to ensure synergies or complementarities, or even close collaboration when “diversity-rich” farming occurs within a nature reserve, alongside a formally organised *in situ* conservation of CWRs. Any of the activities envisaged should be conducted in parallel to continued scientific assessments of CWR conservation priorities and in synergy with their *ex situ* conservation, which makes them readily accessible to interested breeders. To this end, a multi-actor, interdisciplinary and decentralized, locally based approach will be crucial to devise means to support this integration technically and politically.

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