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Crop wild relative network showcases – analysis and best practices

Citation

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Executive Summary

A review and analysis of networks conserving crop wild relatives (CWR) *in situ* was undertaken to identify the attributes that have contributed to their success. The review resulted in 29 CWR genetic reserve network initiatives, nine showcases classified as potential genetic reserve networks, three people and institution networks and 17 networks associated with projects. The results show that the typical genetic reserve network is designed following a monographic approach. They were set up during the last decade at a local conservation scale and each genetic reserve is located in an existing protected area by a national agency. The main purpose of the networks is to conserve between one and ten CWR species that are not threatened, and they are typically structured as a configuration of several small reserves, in both private and public lands, with a total area of less than 200 ha. Genetic reserve networks have generally been implemented with a warranted period of more than 15 years, but with limited financial and human resources—which are usually provided by national administration bodies. However, they are not established under a CWR institutional framework. Several partners are involved in the genetic reserve conservation activities—mostly national governments and research groups. In addition, the typical genetic reserve network participates as a stakeholder in an external supporting network with adjoining initiatives, such as indigenous conservation programmes, citizen science associations, or national networks to conserve flora. Implementation of CWR management plans is lacking, although several conservation actions are carried out, such as demographic monitoring and population genetic analyses, as well as back-up of samples *ex situ*. Aside from conservation, the typical genetic reserve is also used for other purposes, such as agriculture and livestock farming. The genetic reserve networks are usually coordinated by a group of agrobiodiversity managers and conservationists working together, and while local communities are engaged and receive some public recognition, they receive no economic returns. Civil society is also involved, and while there are no specific educational activities offered related to CWR, the reserves typically participate in other conservation and environmental programmes.

A SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis revealed that the main strengths of the genetic reserve networks are related to the experience gained from the previous years of running them, quite stable financial support for some cases, guarantees of long-term conservation, continued participation in scientific projects, and being part of an external network with support from partners and collaborators. The weaknesses identified in the CWR genetic reserve networks are commonly related to the lack of human and economic resources and several issues concerning the management plans (their absence, problems with their implementation or design, challenges regarding their approval, etc.). The main opportunities identified are the locations of reserves in CWR biodiversity hotspots, and strong social engagement. The main threat is the uncertainty about obtaining funds. Other important threats are risk of damage, the uncertainty of land ownership, and the lack of CWR relevance (*i.e*. the importance of CWR conservation is not being properly recognized). Additionally, a strong will and motivation of the local community is likely to be the main factor of resilience and persistence of CWR genetic reserve conservation networks.

Through selected good examples of design and implementation, a record of evidence-based best *in situ* management practice has been generated to develop best practice indications that will serve as a model for the European network for *in situ* conservation and sustainable use of plant genetic resources, as well as for the CWR stakeholder community in general.

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1. Introduction

Crop Wild Relatives (CWR) are plant taxa closely related to crops and constitute a valuable source of plant diversity as a reservoir of genetic variation for utilization, primarily breeding (Maxted *et al*., 2006). In response to the challenges that global change imposes on food security, this group of plants can be the key to successful climate smart crop improvement (Maxted *et al*., 1997a; Hajjar & Hodgkin, 2007; Bellon *et al*., 2017; Maxted *et al*., 2020;). Their potential ability to supply trait variability can contribute to crop improvement in this uncertain scenario (Dempewolf *et al*., 2017).

A wide range of habitats of the world host CWR. However, considering that many of these habitats are experiencing a continuous increasing degradation and fragmentation, the protection of CWR is becoming more urgent, and both *in situ* and *ex situ* conservation are essential for their preservation (Maxted *et al*., 1997b; Jarvis *et al*., 2008). The *in situ* conservation in their habitats is indispensable to let the CWR evolve in their natural environment. Thus, there is a pressing need to implement the *in situ* management and monitoring of CWR populations in genetic reserves as well as the establishment of back-up collections in associated gene banks. Although notable attention has been paid at planning the design, implementation, and management of CWR in genetic reserves (Iriondo *et al*., 2008; Maxted *et al*., 2000) their practical establishment is very limited. There are very few precedents of *in situ* conservation of CWR and little practical experience (Maxted *et al*., 1997b). Moreover, these conservation actions are scattered, isolated, uncoordinated, and thus, the information about them is highly dispersed and hard to access. Sometimes conservation actions target CWR not because they are CWR but because they are threatened or rare. Maxted & Kell (2009) suggested that the lack of remarkable examples of CWR genetic reserves could possibly be explained by the difficulties at bringing together all the stakeholders needed to identify the priority CWR taxa and the most appropriate sites for their conservation and to actively manage them in genetic reserves. The lack of collaboration between all the actors involved could be an important impediment: administrations responsible for wild plant conservation are different from the ones responsible for agricultural resources (Maxted and Kell, 2009; Maxted *et al.*, 2015; Maxted, Labokas and Palmé, 2017).

Habitat degradation and other threats can affect the CWR intraspecific variation and genetic diversity inside a population, affecting the ability to adapt to ecological challenges (Maxted & Kell, 2009). Genetic variation within and between populations is the key to safeguard the diversity required to provide a valid response to the mounting environmental pressures. One population cannot contain all the genetic diversity of a taxon, thus conservation of different populations in multiple genetic reserves is needed, and these can most efficiently be managed in a coherent network. The implementation of several genetic reserve sites also ensures safer conservation, as a single reserve is more vulnerable to unexpected risks (Maxted *et al.*, 2020). Certain examples of established CWR genetic reserves networks and some studies performed provide valuable insight with specific aspects to consider from a scientific and biological perspective (Gadgil *et al*. 1996; Safriel *et al.,* 1997; Maxted *et al.*, 2007; Iriondo, Maxted and Dulloo, 2008; Iriondo *et al.*, 2011; Maxted *et al.,* 2015)(Iriondo et al., 2011; Iriondo et al., 2008; Maxted et al., 2007; Maxted, *et al*., 2015). They also provide relevant understanding from a social viewpoint that enhances the importance of the development of non-intrusive interventions (IUCN/SSC, 2008) or the roles of stakeholders involved (Smith *et al*., 2009). The lessons that can be learnt from their experiences may provide ideas that can be critical for the successful design, implementation, and networking of new CWR genetic reserves in Europe.

The purpose of this technical document is to gather all available information on current and past examples of *in situ* CWR conservation to identify good examples of design and/or implementation of CWR networks at the local and national levels, both in and outside Europe. Once identified, they have been analysed to determine the specific characteristics that mainly contributed to their success. The knowledge acquired through this exercise should provide key elements to take into consideration in the creation and establishment of a European network of CWR genetic reserves.

This technical document is a deliverable of task 1.5. *CWR network showcase* in the framework of Work package 1, *Networking options*, of the Farmer's Pride project. "Farmer's Pride" is the short name of the project 'Networking, partnerships and tools to enhance in situ conservation of European plant genetic resources', a three-year project funded by the Horizon 2020 Framework Programme of the European Union.

2. Methods

2.1. Identification of *in situ* maintained CWR showcases

An extensive list of experiences related to *in situ* CWR conservation (Álvarez-Muñiz *et al*., 2020) was obtained from: a) previous works that identified CWR conserved *in situ* (Hunter & Heywood, 2011; Magos Brehm *et al*., 2017; Maxted *et al*., 1997a; Maxted *et al*, 2008; Iriondo *et al*., 2008; Maxted *et al*., 2016; Maxted *et al*., 2010; Maxted & Kell, 2009; Meilleur & Hodgkin, 2004), b) information already gathered in Farmer's Pride Project 'Deliverable D1.2: Knowledge of in situ resources/sites', c) a broad survey of scientific publications and web sites, and d) the expertise and knowledge of Farmer's Pride Partners and Ambassadors. The list comprised a wide set of initiatives that tackle the issue from different approaches. The purpose was to collect all types of past and present experiences that operate with different scopes and scales. These experiences were assembled into four different categories:

a. CWR genetic reserve networks: they comprise genetic reserves implemented inside or outside protected areas with the purpose of conserving the genetic diversity of selected CWR. In some cases, the main purpose of protected areas that contain CWR populations may cover a wider scope (e.g., conservation of plant biodiversity in general).

b. Potential genetic reserve networks: areas where CWR are known to occur and there are or there have been initiatives for their conservation. The knowledge acquired through these initiatives on the target CWR facilitates the implementation of CWR genetic reserves. However, this does not necessarily imply that the target CWR are currently actively or passively conserved.

c. People and institutions networks: networks of different nature (e.g., scientific research groups, public administration, protected areas managers) that contribute to the conservation of CWR in different ways (e.g., provision of a public database of CWR).

d. Networks associated to projects: networks of sites that hold CWR and/or people and institutions dealing with CWR conservation projects. These networks were operative while the project was active, but conservation activities may have discontinued when the project ended.

2.2. Documentation of *in situ* maintained CWR showcases

To conduct the process of information gathering, an in-depth search was performed through specific literature and database sources. To collect this information, databases were consulted using key words related to the showcases identified in the previous step. Furthermore, official websites of protected areas and national Ministries of Environment of pertinent countries were common sources of data often used amid many others during this search. As a notable procedure to reach the information most difficult to find, Farmer's Pride partners and collaborators provided their knowledge about the showcase experiences and facilitated direct contact of managers, scientists and politicians directly involved with these initiatives. Members of the IUCN SSC Crop Wild Relative Specialist Group (CWRSG) and other PGRFA experts were also involved.

In order to standardize the process of collecting information, the description of the showcases was organized into four separate sections covering the creation, development, objectives and social components of the network:

a. Creation of the network: synthesis of who was responsible for its creation, when it happened and how the areas where conservation took place were acquired.

b. Current situation of the *in situ* network: whether the conservation is still ongoing or abandoned, how they got funded and which organizations were involved, specifying their roles on the conservation.

c. Objectives and key actions to conserve CWR. We examined if active *in situ* conservation measures were carried out and which activities were undertaken. We collected information about the presence/absence of specific actions with CWR and their prioritization, as well as the implementation of *ex situ* conservation back up actions.

d. Links with social initiatives: the involvement of civil society in the initiative and its organization along with other enterprises that strengthen its social visibility (e.g., education campaigns, other parallel environmental networks) were also evaluated for each network.

2.3. Analysis of characteristics that contributed to success

When all available information for each showcase was collected, the showcases of each type of network were separately analysed to elaborate an overview of the findings and identify a number of main themes that were raised or needed addressing. The showcases belonging to *Potential genetic reserve networks*, *People and institution networks* and *Networks associated to projects* were, for each category, generally evaluated, to assess the most relevant characteristics that distinguish them. The showcases belonging to the *CWR genetic reserve network* were assessed through a factor analysis. This involved the use of descriptive statistics and comparative tables to characterize the factors that were considered covering the creation, development, objectives and social components of the network (Table 1). Descriptive factors were selected based on previous literature (Maxted *et al.*, 1997a; Stolton *et al.*, 2006; Maxted *et al.*, 2010; Maxted *et al.*, 2015; Maxted *et al.*, 2016; Smith *et al.*, 2009; Iriondo *et al.*, 2011; Magos Brehm *et al.*, 2017) and bearing in mind the information available. When the information was unknown or not available, it was noted with 'N/A'.

Table 1. Description and parameters of all the factors analysed.

DESIGN COMPONENTS	
Factor	**Parameters and description**
Conservation approach	Monographic / Floristic
Conservation scale	Local (occurring in one official administrative level below country) / National (occurring in more than one official administrative level below country) / International (occurring in more than one country)
Year in which conservation began	Year or decade
Implementation initiated by	Local agency / National agency / Research project / Group of experts
Main purpose of the conservation	CWR / Threatened species / Threatened, rare and endemic flora / Ecosystems
Location	PA National designated area / PA Natura 2000 / Outside PA: agriculture fields / Mixed
Distinguished designation	Any official designation of the area
Land ownership	Public / Private / Common / Mixed
Reserve size	Size of the area in hectares
Reserve configuration	Single large (>20 ha) / Several large (>20 ha each) / Several small (<20 ha each)
Target CWR taxa number	Number of taxa (species and subspecies) that is actively conserved. When it relates to genera, it is specified
Target taxa main characteristics	Conservation linked to use (related to major crop) / Socio-economic use / Biological importance / Cultural importance / Genetic or ecogeographic distinction
IMPLEMENTATION COMPONENTS	
Factor	**Parameters and description**
Current status of the conservation	Active / In process
Warranted period	Short-term (<5 years) / Medium-term (5-15 years) / Long-term (>15 years)
Funds origin	Local / National / International / Research project / Private / External organisations / Own funds
Available financial and human resources	Yes / Not enough
CWR conservation institutional framework	Yes / On-going / No
Involved partners	Local government / National government / Research groups / Organisations / Local people / NGOs / Enterprise
External supporting partner (adjoining network)	Yes / No
Specific CWR management plan	Yes / On-going / No
Active conservation	Demographic monitoring / Phytosociological monitoring / Morphological and genetic characterization / Population genetic analyses / Control or removal of animals / Invasive species control / Controlled fire / Habitat conservation or

	restoration / Reintroduction / *In vivo ex situ* conservation / Actions not specified
Ex situ back-up	Yes / No / Partially
Other reserve uses	Agriculture / Livestock farming / Forestry / Education / Ecotourism Tourism / Military purposes / None
SOCIAL COMPONENTS	
Factor	**Parameters and description**
Conservationists and agro-biodiversity community working together	Yes (farmers or breeders involved) / No
Traditional-Local community involved in site management	Yes / No
Local stakeholder's recognition	Yes / No
Economic return for stakeholders	Yes / No
Public awareness and education CWR activities	Yes / No
Involved in other environmental networks	Yes / No
Civil society engaged	Yes / No

In addition to the information gathered on the factors listed in Table 1, for most showcases, we have also recorded the current threat status of the target CWR taxa that were being conserved, as well as their recognition in international legislation or any other additional distinction. This was not possible for all the showcases, like those conserving many CWR, those with incomplete information about specific CWR, or those where information was only specified at the genus level.

Once the information was organized in tables, it was used to compare the characteristics and peculiarities of the showcases. Subsequently, a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was performed for the *CWR genetic reserve networks*, compiling the information from all the showcases and then categorizing them as a whole to evaluate the situation of the studied showcases and identifying the main characteristics associated to the showcase's success, organizing them according to their impact and frequency. The exploration was complemented with a CAME (Correct the weaknesses, Adapt to the threats, Maintain the strengths and Explore the opportunities) analysis for the most frequent factors (appearing as significant at three or more studied showcases) to confront the internal and external variables of the SWOT analysis and to deploy a spectrum of possible actions to carry out to address those risks. In this manner, some of the best practice solutions that came across were highlighted to select the best strategies to follow and define and prioritize actions for the design of a European network of genetic reserves of CWR with optimal *in situ* management practice.

To validate the findings that underlie the main conclusions, the comparative tables of the selected subsection of showcases, as well as the SWOT analysis, were verified in 12 of the 17 showcases by the people involved in the conservation actions of the showcases or related professionals who delivered the information. Specific showcases and particular features found were selected to illustrate exemplary *in situ* management practices.

The whole workflow of the methods used in this study is summarized in Figure 1.

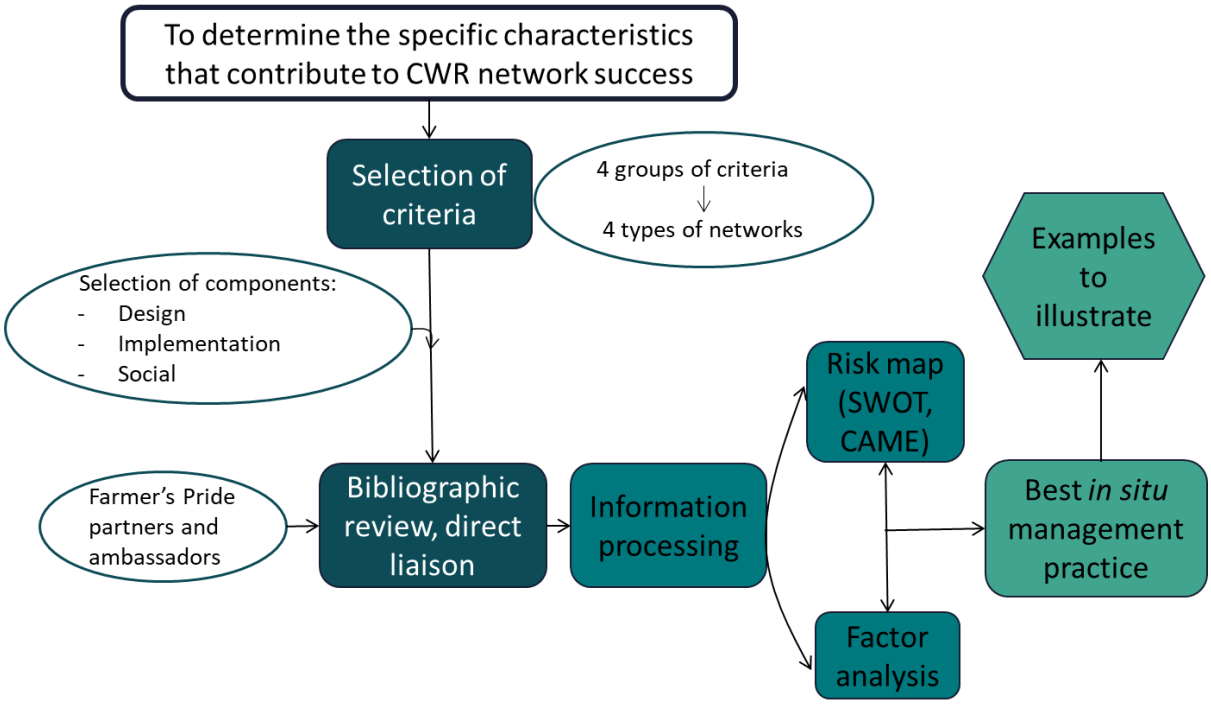

Figure 1. Workflow design to determine the specific characteristics of the networks of CWR that contributed to their success.

3. Results

3.1. Identification of *in situ* conserved CWR showcases

Networks of CWR conserved *in situ* comprised different types of experiences that address the issue from various approaches. After achieving milestone MS 5 'Crop wild relative *in situ* conservation case studies' of Farmer's Pride project (Álvarez-Muñiz *et al.*, 2020), an extensive list of showcases related to CWR *in situ* conservation served as the main body of the following information (Table 2, Table 3, Table 4 and Table 5) along with additional information obtained afterwards through personal communications.

3.1.1. CWR genetic reserve networks

A total of 29 initiatives that actively *in situ* conserve CWR were identified (Table 2). These conservation actions do not necessarily imply in all cases that the conservation actions took place just for the sake of them being CWR.

Table 2. CWR genetic reserve networks, country of origin, target CWR and associated crops

Name	Country	Crop (target CWR)
Erebuni state reserve in Armenia (EcoLur Network, 2015; Ministry of Agriculture of the Republic of Armenia, 2008)	Armenia	Wheat (*Triticum boeoticum*, *T. urartu*, *T. araraticum*, *Amblyopyrum muticum* and *Aegilops* spp.), barley, rye and almond CWR

Name	Country	Crop (target CWR)
Genetic Reserve Network for Wild Celery (Frese, 2019; Herden *et al*., 2020)	Germany	Celery (*Apium graveolens* ssp. *graveolens*, *Helosciadium repens, H. inundatum* and *H. nodiflorum*)
Network of genetic reserves for *Vitis sylvestris* (Ledesma-Krist *et al*., 2013; Nick, 2014)	Germany	Grape (*Vitis sylvestris*)
Sub-regional Network for Grassland Genetic Reserves (Federal Office for Agriculture and Food (BLE), 2019)	Germany	Grassland species
Flusslandschaft Elbe Biosphere Reserve (Mulongoy & Gidda, 2008a)	Germany	Pear (*Pyrus achras* and *P. pyraster*) and apple (*Malus sylvestris*)
National *Citrus* Gene Sanctuary – Biosphere Reserve in the West Garo Hills (Malik *et al*., 2006; B. Singh, 1981)	India	*Citrus* (*Citrus indica* and *C. macroptera*)
Ammiad Reserve Israel (Singh & Upadhyaya, 2016)	Israel	Wheat (*Triticum dicoccoides*), barley (*Hordeum spontaneum*), olive (*Olea europaea)* and oat (*Avena sterilis)*
Majella National Park in Italy (Martino, L., Cecco, V., Santo, M. and Manzi, A. pers. comm.)	Italy	Rye (*Secale strictum),* celery *(Apium graveolens*), grass pea (*Lathyrus* spp.), etc.
Besh-Aral State Nature Reserve (Association for the Conservation of Biodiversity Kazakhstan *et al*., 2016)	Kyrgyzstan	Walnut (*Juglans regia*), plum (*Prunus sogdiana*) and pear (*Pyrus korshinskyi)*
In situ conservation of wild relatives of coffee (Dulloo, 1998; Dulloo *et al*., 1998)	Mauritius	Wild relatives of Coffee (*Coffea mauritiana, C. macrocarpa* and *C. myrtifolia)*
Sierra de Manantlán and maize and its wild relatives (Contreras-Toledo *et al*., 2019; UNESCO, 2012a)	Mexico	Maize (*Zea diploperennis*) and *Z. mays* subsp. *parviglumis*)
Wadi Sair Genetic Reserve (Al-Atawneh *et al*., 2008, 2013)	Palestine	Legumes (*Lens* spp., *Vicia* spp., *Lathyrus* spp.) and fruit trees (*Prunus* spp., *Pyrus* spp., *Pistacia* spp.)
Biodiversity Micro-Reserves network (Quercus, 2010)	Portugal	Ornamental and medicinal crops (seven endangered or rare relatives)
Beta patula genetic reserve (De Carvalho *et al*., 2011; Frese *et al*., 2012)	Portugal	Beet (*Beta patula*)
Plant Micro-Reserves network (Laguna *et al*., 2016)	Spain	Endemic, endangered or rare CWR
Sierra del Rincón Biosphere Reserve (Community of Madrid, 2019)	Spain	15 CWR species of the priority Spanish CWR list
In Situ Conservation of CWR in Sri Lanka (Wijeratne & Piyasiri, 2016)	Sri Lanka	Rice (*Oryza* spp.), banana (*Musa* spp.), cowpea (*Vigna* spp.), cinnamon (*Cinnamomum* spp.)
In situ conservation of forage plants genetic diversity (Federal Office for Agriculture (OFAG), 2019)	Switzerland	17 CWR national prioritized species
Sale-Rsheida Reserve (Al-Atawneh *et al*., 2008)	Syria	Wheat (*Triticum dicoccoides*) and barley (*Hordeum* spp.)
Lizard Peninsula CWR Reserve (Department for Environment Food and Rural Affairs DEFRA, 2011; Hannah Fielder *et al*., 2015)	United Kingdom	Eight CWR out of 148 UK priority CWR
Central-Southeast USA (Pavek *et al*., 2003; Rahimi & Atri, 2013)	United States of America	Grape vine (*Vitis rupestris, V. shuttleworthii* and *V. monticola)*

Name	Country	Crop (target CWR)
The Coronado National Forest (Coronado National Forest, n.d.-a; U.S. Forest Service, n.d.)	United States of America	Pepper (*Capsicum annuum* var. *glabriusculum*)
Great Basin, Washington State (Hellier, 2000; Pavek *et al*., 2003)	United States of America	Onion (*Allium columbianum, A. geyeri* and *A. fibrillum*)
Nevada (Eldredge, 2011; Khoury & Nabhan, 2019)	United States of America	Indian and red pea (*Lathyrus* spp.)
Organ Pipe Cactus National Monument (Organ Pipe National Park Service, 2016a; UNESCO, 2005)	United States of America	Pepper (*Capsicum annuum* L. var. *glabriusculum*)
Nurata Mountain Walnut State Reserve (Hunter & Heywood, 2011; UNEP, 2011)	Uzbekistan	Walnut (*Juglans regia*)
In situ Conservation of Crop Wild Relatives Uzbekistan (Hunter & Heywood, 2011; UNEP, 2011)	Uzbekistan	Onion (*Allium* spp.), apples (*Malus* spp.), pistachio *(Pistacia* spp.), almond (*Prunus* spp.) and barley (*Hordeum* spp.).
Gene Management Zone in Huu Lien Nature Reserve, Lang Son Province (Hunter & Heywood, 2011; Iriondo *et al*., 2008)	Vietnam	Taro (*Colocasia* spp.), rice (*Oryza* spp.), citrus trees (*Citrus* spp.*)* and rice bean (*Vigna umbellata*)
Ngoc Hoi (Hunter & Heywood, 2011; Iriondo *et al*., 2008)	Vietnam	Citrus trees (*Citrus* spp.) and rice (*Oryza* spp.)

3.1.2. Potential genetic reserve networks

Ten networks of sites where CWR are occurring and are subject to scientific studies or other conservation actions were identified. Although, in many cases, passive conservation takes place, no active conservation actions have been undertaken in the area for the target CWR (Table 3).

Table 3. Potential genetic reserve networks, country of origin, target CWR and associated crops.

Name	Country	Crop (target CWR)
In-situ Conservation of Crop Wild Relatives Bolivia (Gonzalez Paredes, 2011; UNEP, 2010)	Bolivia	Crop wild relatives from the genera: *Anacardium, Ananas, Annona, Arachis, Bactris, Carica, Capsicum, Chenopodium, Cyphomandra, Euterpe, Ipomea, Manihot, Phaseolus, Rubus, Solanum, Theobroma*
Corcovado National Park (Hunter & Heywood, 2011; Mulongoy & Gidda, 2008b)	Costa Rica	Avocado (*Persea spp.*)
Phaseolus CWR *in situ* conservation in Costa Rica (Barrantes *et al*., 2008; Torres-González *et al*., 2011)	Costa Rica	Bean (*Phaseolus* spp.)
Research study for *in situ* conservation of *Crocus cartwrightianus* in Cyclades and Crete islands (Ralli, 2015; Ralli & Dordas, 2013)	Greece	Saffron (*Crocus cartwrightianus*)
Research study for *in situ* conservation of *Beta nana* in alpine areas of Greece (Frese *et al*., 2009; Stavropoulos et. al, 2008)	Greece	Beta (*Beta nana*)
Protecting *Brassica macrocarpa* Guss. (a *Brassica oleracea* L. CWR) in Favignana (Egadi Island, Sicily, Italy) (Ferdinando Branca *et al*., 2011)	Italy	Brassica (*Brassica macrocarpa*)
CWR Russia (Afonin *et al*., 2008)	Russia	Burclover (*Medicago* spp.)

The wild vine. An important phytogenetic resource without legal protection in Spain (Lara *et al*., 2017; Rodriguez *et al*., 2016)	Spain	Grape (*Vitis* spp.)
The Bey Mountains Coast National Park (Anonymus, 2018; Koptu, 2019)	Turkey	Oat (*Avena barbata),* grass pea *(Lathyrus cicera),* faba bean *(Vicia cassia* and *V. eristaloides).*

3.1.3. People and institutions networks

Three networks of different groups of experts, administrations and other institutions, all working on CWR *in situ* conservation, were identified (Table 4).

Table 4. People and institutions networks, countries involved, target CWR and associated crops.

Name	Country	Crop (target CWR)
Informal Nordic Crop Wild Relative Network (Fitzgerald *et al*., 2017; Palmé, *et al*., 2019; Weibull, 2019)	Multi-country (Denmark, Finland, Iceland, Norway, Sweden)	Prioritized Nordic CWR
Irish Crop Wild Relative Database (National Biodiversity Data Centre, 2016)	Ireland	102 CWR selected from Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture.
ECPGR Wild Species Conservation in Genetic Reserves Working Group (Maxted *et al*., 2015)	Multi-country (Europe)	European CWR

3.1.4. Networks associated to projects

Seventeen current and past projects that built networks for preserving CWR in their own habitats were identified (Table 5). Networks under this tag do not necessary imply that the target CWR are being conserved because of their relation to crops.

Table 5. Networks associated to projects identified.

Name	Country	Crop (target CWR)
In-Situ Conservation of Andean Crops and their Wild Relatives in the Humahuaca Valley, the Southernmost Extension of the Central Andes (Argentina) (GEF, 2015; Watts, 2016)	Argentina	Potatoes (*Solanum* spp.), oca (*Oxalis* spp.), cañahua (*Chenopodium* spp.), ataco (*Amaranthus* spp.), and peppers (*Capsicum* spp.)
Saving our Species programme (S. L. Norton *et al*., 2017; NSW Government, 2019)	Australia	Macadamia nut (*Macadamia integrifolia*), finger lime (*Citrus australasica*), among another 11 CWR.
Conservation and Sustainable Utilization of Wild Relatives of Crops (Kell *et al*., 2015)	China	Soybean (*Glycine* spp.), wheat (*Triticum* spp.) and rice (*Oryza* spp.)
Touran protected area (Bakhtiari, 2019; Dornagasht, 2018)	Iran	Barley (*Hordeum* spp.)
Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives (CWR Diversity, 2019)	Multi-country	Wild relatives of 29 priority crops, selected based on their importance and occurrence on Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture
In situ Conservation of Crop Wild Relatives through the Enhance Information	Multi-country (Armenia, Bolivia,	521 CWR prioritized (Armenia 104, Bolivia 195, Madagascar 119, Sri Lanka 33 and Uzbekistan 70).

Name	Country	Crop (target CWR)
Management and Field Application (Brandolini, 2013; UNEP, 2010)	Madagascar, Sri Lanka and Uzbekistan)	
Safeguarding Mesoamerican CWR (Tobón *et al*., 2019)	Multi-country (El Salvador, Guatemala, Honduras, Mexico)	269 CWR taxa
SADC CWR Project "*In situ* conservation and use of crop wild relatives in three ACP countries of the SADC region" (Allen *et al*., 2019; SADC Crop Wild Relatives, 2016)	Multi-country (Mauritius, South Africa, Zambia)	SADC priority CWR and national priority CWR
SADC CWR Network–Bridging agriculture and environment: Southern African CWR regional network (SADC Crop Wild Relatives, 2019)	Multi-country (Malawi, Tanzania, Zambia)	SADC priority CWR and national priority CWR
Conservation and Use of Agricultural Biodiversity (Horticultural Crops and Wild Fruit Species) (Hunter & Heywood, 2011; UNEP, 2011)	Multi-country (India, Indonesia, Malaysia, Thailand)	Apple (*Malus* spp.), pear (*Pyrus* spp.), plum (*Prunus* spp.), almond (*Prunus* spp.), pomegranate (*Punica granatum*), grape (*Vitis* spp.), etc.
CARE MEDIFLORA project–"Conservation Actions for Threatened Mediterranean Island Flora: ex situ and in situ joint actions" (Care Mediflora, 2019; Fenu *et al*., 2017)	Multi-country (Spain, France, Italy, Greece, Cyprus)	15 threatened Mediterranean CWR plant taxa
In situ Conservation of native cultivars and their wild relatives (Angé *et al*., 2018; IPCCA, 2019)	Peru	Potato (*Solanum* spp.), sweet potato (*Ipomea spp*.), etc.
Ceylanpinar State Farm (Aslan, 2018; A Karagöz, 1998)	Turkey	Wheat (*Aegilops aucheri, Ae. ligustica, Ae. tauschii, Triticum dicoccoides, T. boeoticum*
Kaz Mountains National Park (Özel, 1999; Uysal *et al*., 2012)	Turkey	Garlic (*Allium* spp.), almond (*Prunus webbii),* asparagus (*Asparagus acutifolius),* chickpea (*Cicer montbretia),* grass pea (*Lathyrus aureus)* and other 10 CWR.
Bolkar Mountains (Eken *et al*., 2006; Tolun *et al*., 2000)	Turkey	Chestnut (*Castanea sativa)*
Kibale Forest Wild Coffee Project (Kasenene, 1998; Lilieholm & Weatherly, 2010) (Kasenene, 1998; Lilieholm, 2010)	Uganda	Coffee (*Coffea* spp.)
Chatkal Biosphere Reserve (Brandolini, 2013; Hunter & Heywood, 2011)	Uzbekistan	Almond (*Prunus bucharica*)

3.2. Documentation of *in situ* conserved CWR showcases

As the objective was to find characteristics that mainly contributed to the *in situ* conservation success of CWR, a greater effort was made to document cases where CWR were already actively protected. We prioritized having a representative sample of conservation showcases occurring in different countries and continents. Seventeen showcases of CWR genetic reserve networks are, thus, described in-depth in Annex 1, as well as five *Potential genetic reserve networks*, one *People and institutions network* and twelve *Networks associated to projects*.

In certain showcases, it was not possible to find updated in-grained information or details. For most of non-European showcases, information was scarce and hard to access.

Many attempts were made by contacting people who were involved in the various initiatives (e.g. China, USA, Russia, Costa Rica and Ecuador). However, they failed to a large degree when there was not a tight personal liaison. Thus, several interesting showcases could not be studied due to lack of response. For some other showcases it was not even possible to find a contact that was directly involved in the experience and, since the available literature found was limited and webpages were not running or were not updated (e.g. in Syria, Uzbekistan, Vietnam and Bolivia), it was not possible to find out whether the conservation had ended or it was still operational but without any reachable dissemination actions. As an example, in Sri Lanka, Wijeratne & Piyasiri (2016) reported that in several locations there were conservation committees to protect *in situ,* and sometimes *ex* situ, genetic resources, such as *Cinnamomum capparu-coronde*. However, no further evidence was found about the establishment and management of these genetic reserves in subsequent national and international reports (e.g., Puspakumara *et al*., 2016, web sites or scientific literature).

3.3. Analysis of characteristics that contributed to success

3.3.1. Genetic reserve networks

3.3.1.1. Factor analysis

The compiled comparative database contained information about 18 selected genetic reserve networks. Detailed information on data of each showcase can be found in Annex II.

a) Design

Both monographic (50%) and floristic (50%) conservation approaches were used to focus on the priority CWR or to encompass the CWR occurring in the area. The most frequent conservation scales were local (50%) and national (44%) versus the international scale (6%). However, the implementation was more commonly initiated by a national agency (50%) followed by research projects (22%). 33% of the conservation actions that are currently active, started in the last decade (2010–2019), whereas 22% started in the previous decade. Most genetic reserves (67%) were totally located within protected areas (22% at Biosphere Reserves), and in only one case it was entirely located outside them. Even so, most genetic reserve networks are located in both private and public lands (44%) and just 33% belong exclusively to the public administrations. The configuration of the reserve through several small reserves (50%) was more frequent than that of a single large (44%) or of several large ones (6%), but the total area size was usually either less than 200ha (39%), followed by more than 30,000ha (33%) (Table 13 and Figure 2).

Although not all selected showcases were initially developed to conserve the genetic diversity of CWR, most plant conservation networks studied had CWR conservation as their primary target. The reasons for actively conserving the target taxa were in most cases due to their relation to a major crop (53%), followed by their biological importance (22%), cultural importance (12%), socio-economic use (8%) and genetic or ecogeographic distinction (5%) (Table 13 and Figure 2).

Detailed information regarding their threatened status was gathered for 76 CWR species that are being conserved at the genetic reserves (more information in Annex III). The list contains 14 CWR that are known to be under an IUCN threat category —one species Critically Endangered (CR), eight Endangered (EN) and five Vulnerable (VU). Only six species were reported as country endemics and 17 species are protected under international legislation. This information is not complete since it was not possible to obtain detailed information for all the genetic reserves.

The typical genetic reserve network was interchangeably designed following a monographic or floristic approach. It was established during the last decade at a local conservation scale, located in a protected area, and implemented by a national agency. Its main purpose was to conserve between one and ten non-threatened CWR species. The network was structured with a configuration of several small reserves, in both private and public lands, with a total area of less than 200ha.

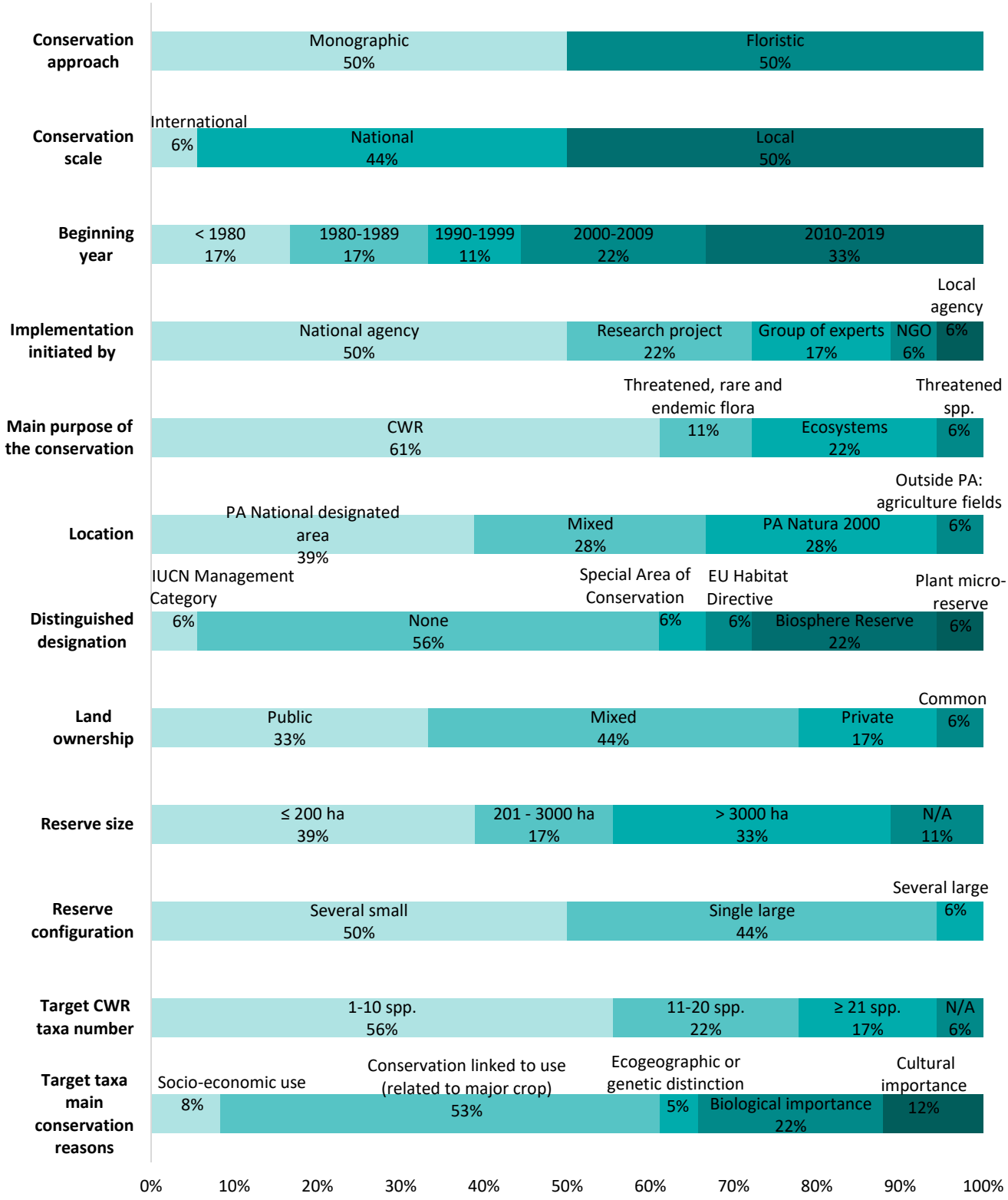

Figure 2. Percentage of analysed factors related to the network design of 17 selected showcases.

b) Implementation

On the basis that all the showcases that were analysed in depth were not abandoned, 83% of them were already active, while 17% were in the process of being established. The great majority (78%) was considered long-term (more than 15 years), only 6% were considered medium-term and another 6% short-term. There was no related information for the remaining showcases. The funds had national origin for 56% of the networks, 19% were raised from research projects, 10% proceeded from local administrations, 5% from external organizations and 5% from international funds. Only two showcases partially obtained their funds from private support and other two showcases partially used own funds. Only two showcases considered counted on enough available human and financial resources. 50% of the showcases studied were not covered by a CWR institutional framework, 33% were actually covered and 17% were in the process. Several partners were involved in most of the showcases (all except one), and national governments were the most common (34% of the cases), followed by research groups (28%), NGOs and other organisations (14%), local people (13%) and, less frequently, local governments (9%) and private enterprises (2%). To take part or build a mutual supporting relationship with an adjoining network or initiative was a widespread practice (56% of the showcases) (Table 14 and **Figure 3**).

A specific plan for the management of CWR was missing in 72% of the conservation networks, however, almost half of them were working on it. Thus, only 28% had a specific management plan for CWR in operation. Active conservation actions differed a lot among the diverse studied cases, being demographic monitoring the only one present in all cases with available information (16 showcases). After this, from highest to lowest frequency were: actions not specified, population genetic analyses, phytosociological monitoring, control or removal of animals, habitat conservation or restoration, morphological and genetic characterization, controlled fire, *in vivo ex situ* conservation (e.g. botanical garden), reintroduction and invasive species control. *Ex situ* conservation was implemented for all the CWR conserved in the genetic reserves in 78% of the showcases, and partially in 11%. In addition to conservation, only one showcase did not hold any other activities; for the remainder, these activities were (from more to less frequent): agriculture, livestock farming, ecotourism, education, military purpose, conventional tourism, forestry and other activities not specified.

The typical genetic reserve network was already being implemented with a warranted period of more than 15 years, but with limited resources. The main origin of these resources are national administration bodies; however, they are not set under a CWR institutional framework. Several partners are involved in the conservation activities, mostly national governments and research groups. In addition, the genetic reserve network participates as stakeholder in an external supporting network with adjoining initiatives. There is a lack of implementation of CWR management plans, although several actions of active conservation are carried out, like demographic monitoring and population' genetic analyses, besides the *ex situ* back-up. Aside from the conservation, the reserve is also used for other purposes, such as agriculture and livestock farming.

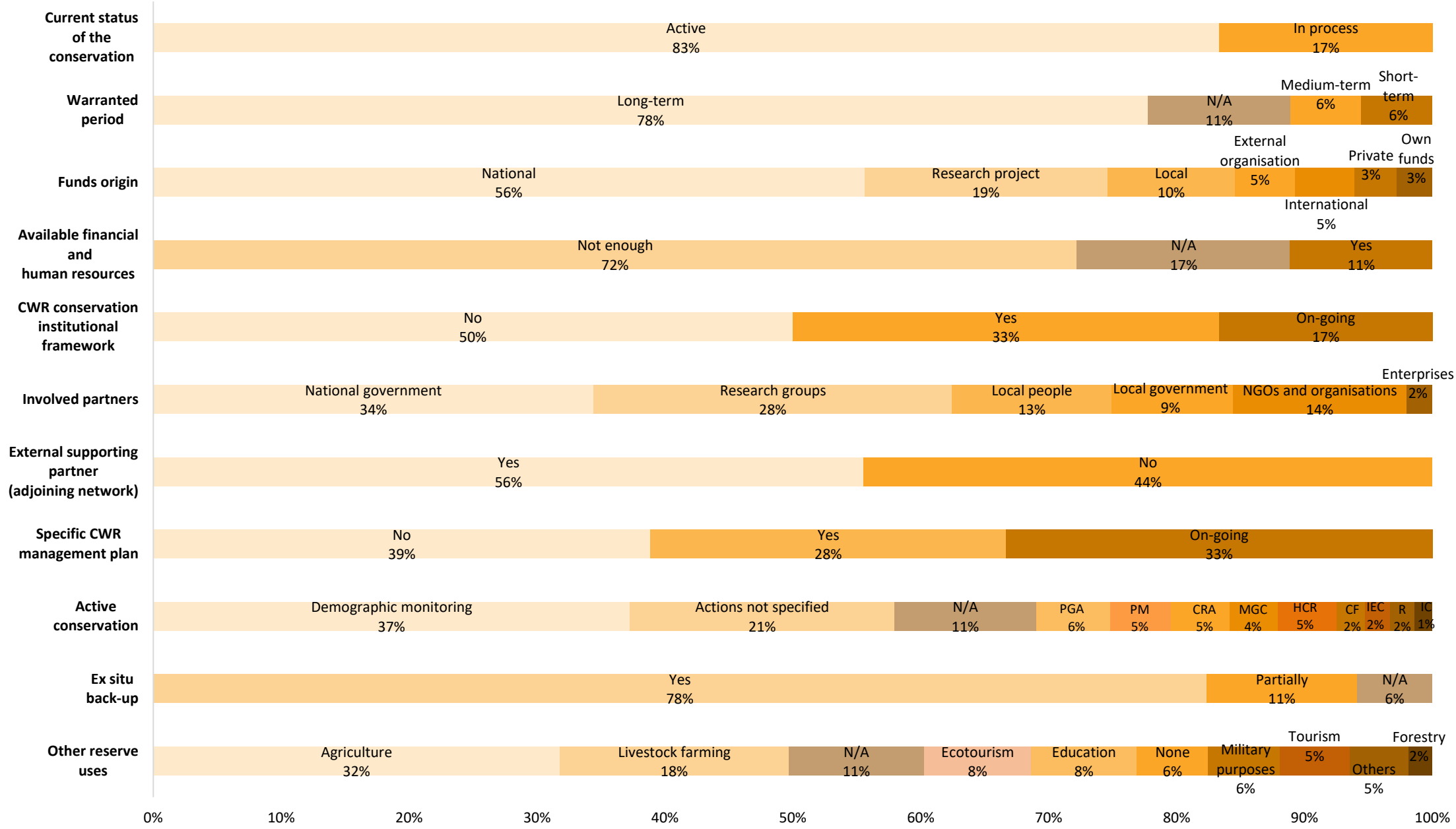

Figure 3. Percentage of analysed factors related to the implementation of the network. Abbreviations 'Active conservation': Population genetic analyses (PGA); Phytosociological monitoring (PM); Control or removal of animals (CRA); Morphological and genetic characterization (MGC); Habitat conservation or restoration (HCR); Controlled fire (CF); In vivo ex situ conservation (IEC); Reintroduction (R); Invasive spp. control (IC).

c) Social involvement

Professionals from the fields of agrobiodiversity and plant conservation worked together in 50% of the analysed networks. Local communities were involved in the management of the genetic reserves in 72% of the showcases. Their involvement was only publicly recognized in 67% of them, but only 17% contemplated an economic return for the stakeholders. Civil society was engaged in 50% of the initiatives but only 39% hold public awareness and education activities specifically related to CWR. 56% of the showcases participated in other environmental networks or different conservation programmes, and 6% were in the process of joining them (Table 15 and Figure 4).

The typical genetic reserve network has a coordination group of agrobiodiversity managers and conservationists working together. Local community is engaged, with public recognition but no economic returns. Civil society is as well involved, but there are no specific educational activities offered related to CWR. However, the genetic reserve participates in other conservation and environmental programmes.

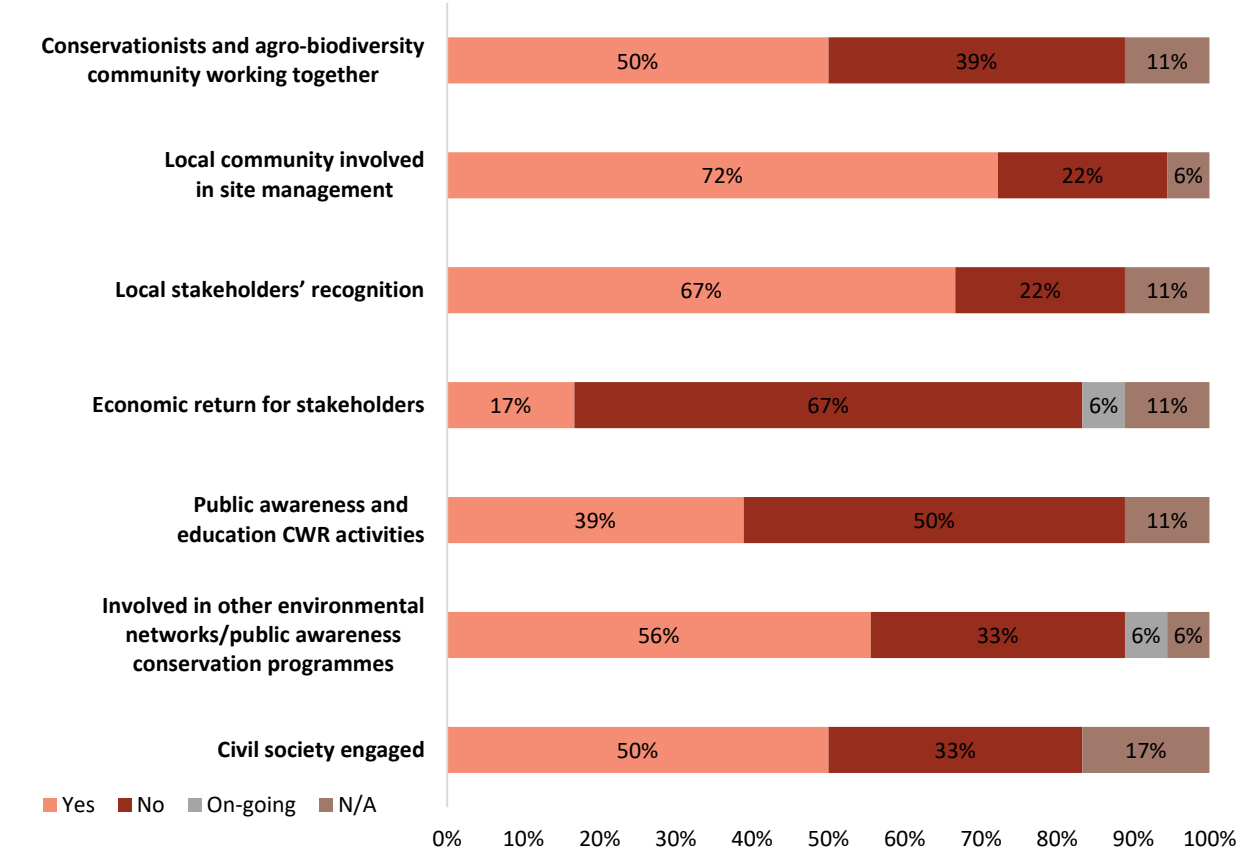

Figure 4. Percentage of analysed factors related to the social aspects of the network.

3.3.1.2. SWOT analysis

A framework for identifying and analysing the internal and external factors that (could) have an impact on the viability of the networks was studied by means of a SWOT analysis. The specific characteristics of each of the 17 *CWR genetic reserve networks* can be found in Annex IV. Figure 5, Figure 6, Figure 7 and Figure 8 graphically depict a summary of categorized features that affect the showcases and

illustrate their overall impact or significance by frequency of occurrence (more information at Annex V).

The advantageous internal characteristics (strengths) that appeared more frequently were related to the already gained experience from the previous years of running the network, a quite stable financial support, being able to build on scientific background information, safeguarded by being part of an external network with support from partners and collaborators and certain guarantees of long-term conservation. Other features that were less frequent among the showcases, were related to a) the design (strategic allocation, efficient design, improving design or holistic approach), b) the stakeholders involved (counting on local people and agriculture experts, stakeholders recognition, official agreements with locals or a not intrusive site management), c) the support at managing the network (the existence of a coordination unit, a collaborative relationship between agriculture and nature protection communities or support from related programmes), and d) damages resistance (physical protection or certain activities protection) (Figure 5).

Box 1. Glossary of terms used for *Figure 5. Identified strengths and their frequency among the analysed showcases*.

Well-planned components: Working on design, implementation and social aspects at the same time
Strong legal protection: Legal coverage of the area against destruction and deterioration
Several types of locations: Location of the areas among different types of areas protected and without protection
Other activities protection: Activities that are not conservation are limited and regulated
Not intrusive site management: The management plan does consider the social stakeholders claims
Local people agreement: Agreement about the conservation at a delimited area signed by the local people
Land assured: The land where the conservation takes place is guaranteed to remain as part of the network
Data available to the public: Web sites and other public platforms provide information updated
Criteria for designation of GR will keep improving: There is a plan to improve the criteria affecting the conservation
Conservation areas designed efficiently: The areas of intervention are reduced as much as possible
Agriculture and nature protection collaborating: Environmental and agriculture experts collaborate in the conservation
Agriculture experts: The conservation counts on the participation of agriculture experts
Certain budget self-control: Economic activities performed at the area generate a part of the economic resources needed
Stakeholders recognition: The active role that stakeholders play is acknowledged
Physical protection: Conservation taking place in safe areas because they are isolated sites from human disturbance
Coordination unit: The existence of an institution that is specific to coordinate all the areas that build the network
Monitoring plan: There is a specific CWR monitoring plan
Low costs: Conservation only needs a small financial contribution to remain active
Biosphere Reserve support: Biosphere Reserves usually facilitate support for the conservation of genetic resources
Located in protected areas: All conservation occurring in areas with certain protection
Local people involved: Civil society, farmers and/or local communities involved at the conservation and its related activities
Scientific background: Scientific studies have been carried out in the area
Long-term network guaranteed: Guaranteed availability of resources for conservation to last several years
Network support: Coordination with related projects and initiatives providing support to each other
Social support: Civil society, farmers and/or local communities engaged at the initiative and providing support
Financial support: Consolidated ensured funds
Gained experience: Conservation occurring for more than a decade

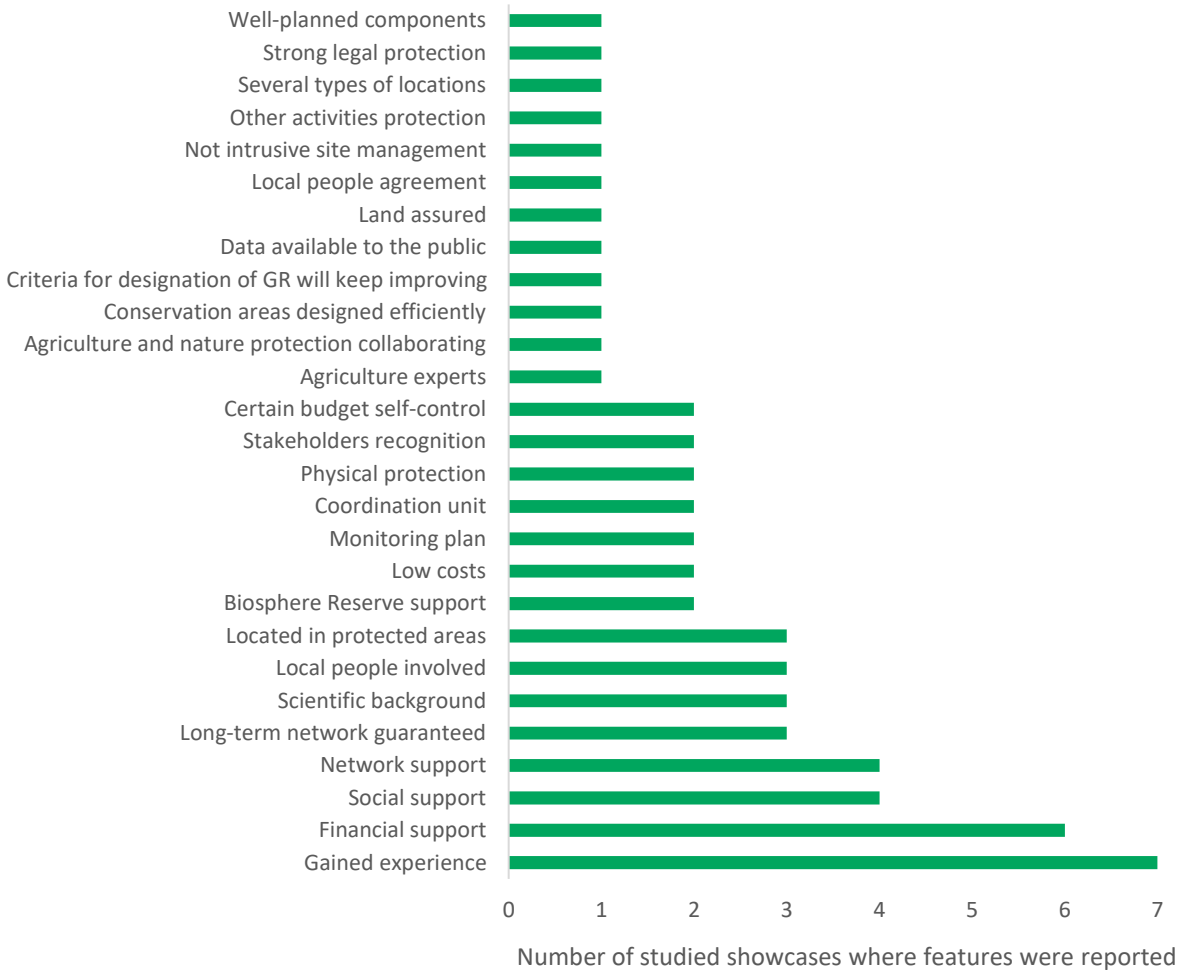

Figure 5. Identified strengths and their frequency among the analysed showcases.

The internal disadvantageous characteristics (weaknesses) studied in the *CWR genetic reserve networks* were commonly related to the lack of human and economic resources and several issues concerning the management plan (its absence, problems at its implementation or design, challenges at its approval, etc.). To a lesser extent, certain social struggles, the data not being available to the public, the need to cover more CWR taxa than what is being conserved, and the need of CWR being more known at different targeted groups, were also frequent weaknesses in the networks. There were also some weaknesses related to the involved stakeholders (side lining social claims, absence of scientific and social support, not counting with social recognition or not enough CWR relevance) (Figure 6).

Box 2. Glossary of terms used for *Figure 6. Identified weaknesses and their frequency among the analysed showcases*.

No more species in the country: No other target CWR taxa in the country
Physical damage: Conservation taking place in areas exposed to animal and/or human disturbances
Not enough social recognition: The active role that stakeholders play is not acknowledged enough
Lack of social support: Civil society, farmers and/or local communities are not engaged with the initiative and/or do not provide support

Lack of scientific research: There are not scientific studies occurring within the area
Forest plan does not capture social reclaims: The management plan does not consider the social stakeholders claims
Diverse locations imply more work: The greater the number of different areas that integrate the network, the more complex their coordination is
Lack of local communities' engagement: Local communities do not support the conservation activities or are not involved
Lack of recognition of GR: The label of 'Genetic Reserve' is not officially recognized yet, with the impediments that this entails
First stages: The conservation activities are at an early stage
Data not available to the public: Web sites and other public platforms are not working or not updated
Social struggles: Conflict between two or more actors that affect the area, the activities or the availability of resources for the conservation
Need of CWR relevance: CWR are not being recognized enough for the potential they have and there is a need to value them to continue with their conservation
Does not cover all CWR taxa: There are CWR taxa that are not being actively protected
Lack of management plan: There is not a CWR specific management plan
Lack of resources: Not enough resources disposed for the conservation

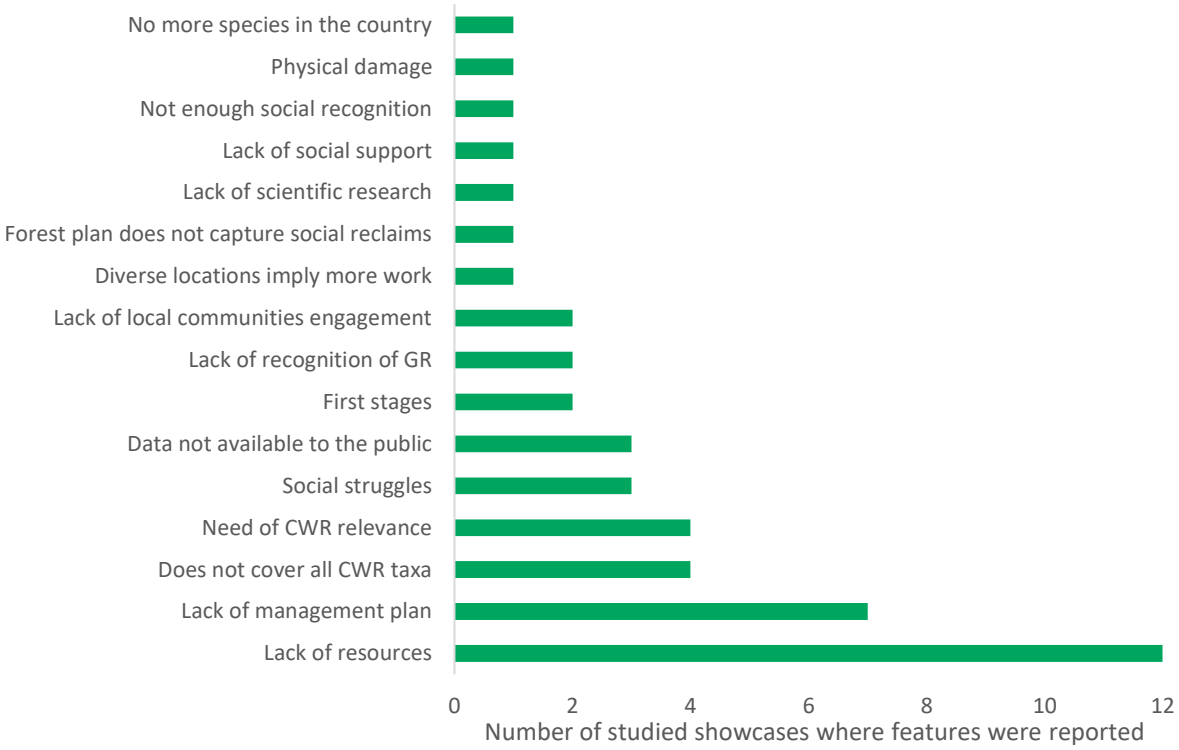

Figure 6. Identified weaknesses and their frequency among the analysed showcases.

The positive external factors (opportunities) that were most often noticed in the showcases were the location of the reserve at a CWR biodiversity hotspot and the strong social engagement. An external supporting network, potential for area growth, potential financial support, replicability of the model, and special importance of CWR potential use, were also important opportunities detected. To a lesser

degree, CWR willingness (from the government, the managers or the general public), and opening up the possibilities for linking the conservation of CWR to other conservation initiatives (Figure 7).

Box 3. Glossary of terms used for *Figure 7. Identified opportunities and their frequency among the analysed showcases*.

Special importance for spp. limited distribution: CWR with very limited distribution
National framework supporting: National CWR conservation strategy
Link with other initiatives: Collaboration and communication with related projects, initiatives and networks
Intersectoral approach: Conservation approach that facilitates the collaboration among different stakeholders
Governmental interest: Politicians and/or governmental staff with special interest on CWR conservation
Managers interest: Managers of the site with special interest on CWR conservation
Biodiversity hotspot: Site with great diversity of alive organisms
Special importance for spp. potential use: CWR with exclusively traits
Replicable model: The network can serve as example for other regions
Potential financial support: The existence of possible funds to the initiative
Area growing possibilities: New possible sites to join the network
External supporting network: Participation on an external group that provides support
Social engagement: Civil society, farmers and/or local communities involved at the conservation and its activities
CWR biodiversity hotspot: Site with great diversity of CWR

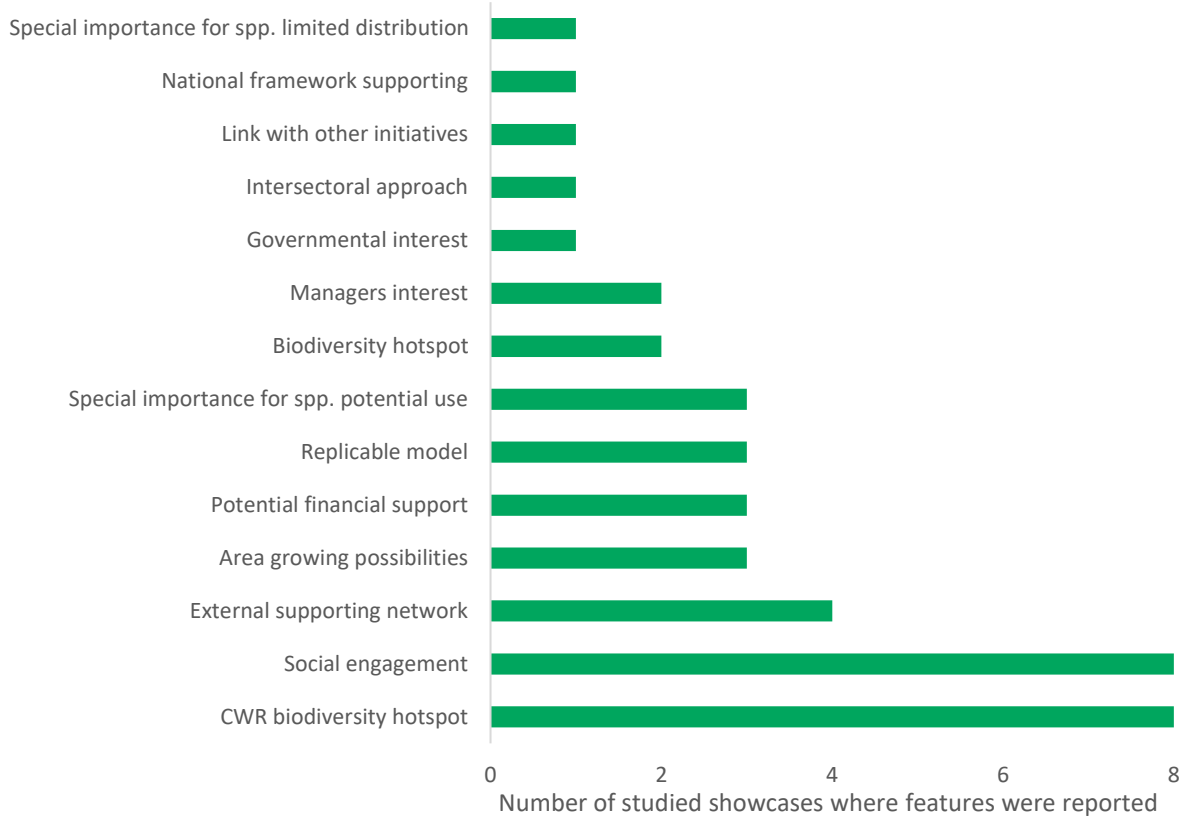

Figure 7. Identified opportunities and their frequency among the analysed showcases.

The group of harmful external factors that threaten the *CWR genetic reserve networks,* was tightly led by the uncertainty about obtaining funds. Risk of damages, the uncertainty of the owners of the lands

where the reserve is placed and the lack of CWR relevance, were also significant threats present in the showcases (Figure 8).

Box 4. Glossary of terms used for *Figure 8. Identified threats and their frequency among the analysed showcases*.

Over resource exploitation: CWR populations are being harvested too much
Social struggles: Conflict between two or more actors that affect the area, the activities or the availability of resources for the conservation
Outdated actions: Conservation actions have not been revised for a long period of time
Climate Change and pollution: Change of the temperatures, precipitation and its timing, as well as water, air and soil pollution affect CWR in situ populations
Environmental/Agriculture regulation: Changes in environmental and/or agriculture regulation generate general aversion towards nature conservation
Ex situ: CWR not conserved ex situ
General uncertainty: The conservation takes place in an area with a complex socio-political context
Need of CWR relevance: CWR are not being recognized enough for the potential they have and there is a need to value them to showcase their conservation
Land uncertainty: The land where the conservation takes place is not long-term guaranteed
Damages: Conservation taking place in areas exposed to animal and/or human disturbances
Lack of funds: Not enough economic resources to continue regular conservation actions

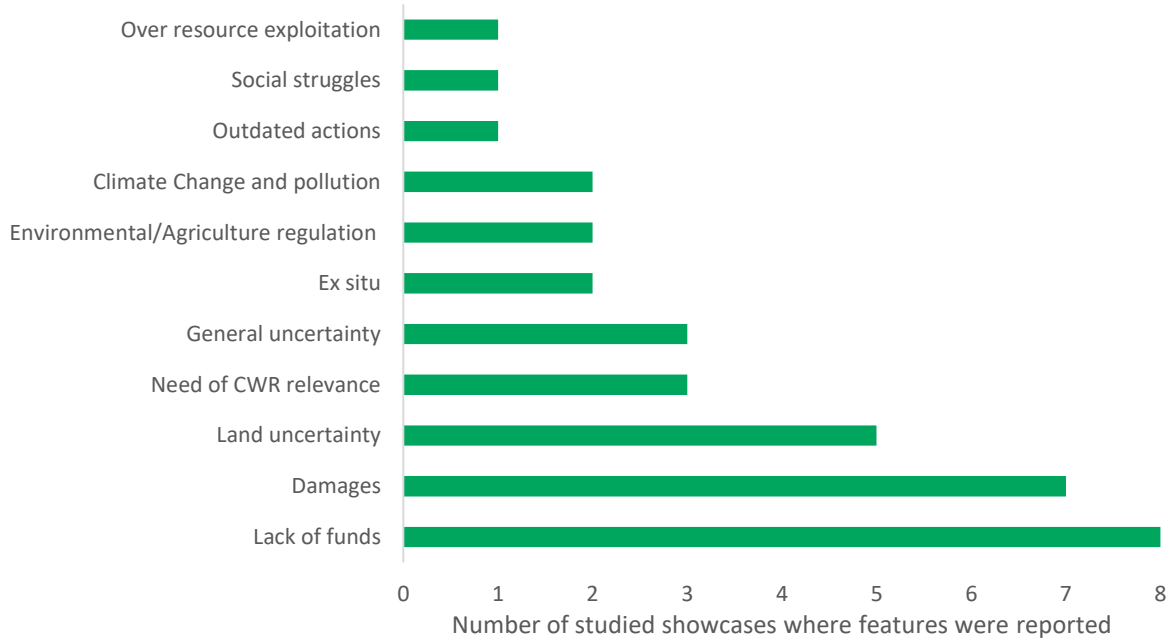

Figure 8. Identified threats and their frequency among the analysed showcases.

3.3.2. Remarkable features of Potential genetic reserve networks, People and institutions networks and Networks associated to projects

Although information related to *Potential genetic reserve networks, People and institutions networks* and *Networks associated to projects*, was scarce and harder to find to build comparative patterns, there was significant and interesting information to consider (Annex I).

Potential genetic reserve networks can possibly become initiatives where active conservation of CWR takes place. However, the time that takes to get to that point, or the actual fact of ever reaching it, is mainly determined by the following range of factors: the lack of funds is the most common impediment, leading to voluntary work (which slows down the process) and often results in a very reduced number of people involved, limiting the perspectives and relying only on their willingness, with a volatile future. Besides, the difficulty with involving different stakeholders, such as experts of agriculture or environment, farmers, local people and governmental administration, exists, and this is shown to be an obstacle in the process.

The only *People and institutions network* we got information from was the CWR Nordic Network. This initiative has shown successful results regarding cooperation and knowledge exchange among the Nordic CWR stakeholders as well as Nordic level conservation planning. The network stimulates national activities and supports national planning and implementation, which has resulted in increased knowledge and awareness of CWR and their importance. However, it is lacking stronger involvement of nature conservation stakeholders, as well as an official recognition and mandate. The network enables the national conservation to be more cost-efficient, it provides funding opportunities and the networking activities offered facilitate future cooperation. Despite this, the Nordic network lacks long-term funding, and at the present time, it has resulted in limited interest in CWR from politicians.

Many showcases under the category of *Networks associated to projects*, refer to studies developed to establish a genetic reserve, which did not have a continuation and are in standby or ended. This is often induced by the lack of funds and interest to continue, which is usually caused by not raising enough willingness, when the project was running, at different groups involved that would provide sufficient interest to support the initiative by themselves. On the other hand, some other showcases of *Networks associated to projects* refer to projects that are actually conserving CWR, although they are not being conserved for their potential use in agriculture. However, there are also showcases under this category that are making good progress on establishing the network, and soon could be consider as *CWR genetic reserve network.* This is the case of the SADC Regional CWR network, currently working under the Darwin project. Their white paper has been endorsed by SADC Secretariat and will be submitted to the next SADC Council of Ministers for approval.

4. Discussion

4.1. Identification and documentation of in situ conserved CWR showcases

The present study has identified 29 initiatives related to *CWR genetic reserve networks*, 9 showcases classified as *potential genetic reserve networks*, 3 *people and institution networks* and 17 *networks*

associated to projects. We have tried our best to gather in a single document all reported initiatives using all means available to us, but we are certain that this compilation is not exhaustive and that there must be several other initiatives that took place in the past and ended or are currently active that involve the *in situ* conservation and use of CWR. The initiatives that are most likely to have been unnoticed are those that are originated at a local scale, with no participation of international institutions and which do not have a dissemination policy associated to the initiative. Thus, they remain unnoticed and do not appear in publications or websites and are likely to remain as a sort of 'grey literature' in the folder cabinets of local or national administrations or NGOs. One of the conclusions that can be extracted from this is the need to increase the visibility of the actions through public awareness activities in any new initiatives involving the creation of CWR genetic reserve networks. A second conclusion is the relevance of obtaining information from all known experiences, including those that did not prosper. Some lessons are better learnt from failed initiatives than from successful ones.

From those showcases that were identified, it is important to highlight that it was not possible to find updated information or details on several of them. For most of the non-European showcases, information was scarce and hard to access. The difficulty associated with finding the people responsible for some of these initiatives and the lack of updates on past interventions show the weakness of some initiatives that may involve substantial economic support and international backing associated to a specific project at a particular time, but that have no continuity once the project and the associated funding ends. This situation also exposes the need to establish a strong social involvement of the local community with the initiative. A strong will and motivation of the local community is likely to be the main factor of resilience and persistence of the CWR genetic reserve conservation experiences.

4.2. Analysis of characteristics that contributed to success

Although it is not possible to precisely tell which factors lead to success, it is feasible to suggest which practices had a positive impact on CWR conservation and benefited them. There are several practices that, regardless of whether they are unusual or exclusive from one or few showcases, have shown to generate good results.

4.2.1. Design, implementation and social involvement

Bottom-up approaches seem to be more successful than top-down approaches, although a national agency is often involved in implementing the initiative. The mixed location in public and private lands within the same network appears to be the wisest design, frequently occurring inside a Biosphere Reserve, facilitating support for the conservation of genetic resources (UNESCO, 2017). The great majority of the fruitful showcases take place in a protected area. However, the Swiss CWR conservation network is based outside protected areas, a usually unexplored experience that is showing remarkable success. Networks formed by numerous small reserves have an advantage over the larger ones. This is the case of the Valencian Microreserves (Spain) with a total area smaller than 2000ha. The network is actively conserving more than 200 CWR taxa at near 300 microreserves (Laguna, 2008; Laguna *et al.*, 2010a). When land security does not depend on a single or few private landowners, external fluctuations have smaller impacts, building certain network resilience. Even if it

complicates the coordination of the networks, it also allows to include in the network a greater diversity of CWR, since the addition of new populations does not involve a considerable enlargement of the area. At the wild celery network in Germany there is a coordination unit which articulates all genetic reserves. This useful agency, coordinates the work developed in all the parts of the network, allowing an easy information exchange about the management, join works to be more efficient and the sharing of specific resources.

The origin of the funds is diverse, but national funds predominate. Partial self-control of the budget was a distinguishing characteristic to highlight from the CWR conservation at Majella National Park (Italy) and Organ Pipe (USA). In the first case, through the selling of CWR seedlings, the reserve ensures funds to continue with, at least, a minimum of conservation activity and provides resilience from external funding cuts. The American case receives additional funding through the selling of fees and passes for visitors, from donations and from bookstores located at the entrance. Another singularity of this showcase is the dual conservation of alive organisms and its environment with the preservation of the relevant human history of the area. The involvement of several partners and participation of national governments also seems to be successful. The lack of a CWR management plan is an impediment commonly found among the showcases; that is why many initiatives are currently working on it. Most of the genetic reserves are also used for other purposes, such as agriculture and livestock farming.

Strong and resilient social willingness, involving local communities, is the key to last in time for many initiatives. Targeted CWR rarely occur in an anthropogenic vacuum area, although there are cases, as with the *in situ* conservation of *Beta patula* in Portugal, where there is no human population nearby and the access to the area is restricted. Usually, target CWR occur at sites where there are nearby human populations (Jarvis *et al*., 2015). For this reason, social support becomes more important when establishing a CWR genetic reserve network (Borrini-Feyerabend *et al*., 2004). Before the establishment of the network of reserves, local people may have been exploiting the resources of the site in a sustainable manner for numerous generations (Lewis, 1996). CWR conservation experiences based in a non-intrusive planning and deep respect to locals, that involve them at different steps of design and implementation of the network, are more likely to succeed. The Wadi Sair reserve (Palestine) is a good example in this respect (Al-Atawneh *et al*., 2008). On the contrary, in this compilation of cases, several initiatives were found to not continue, possibly because the locals (including local scientific, environmental and genetic resources institutions) were not properly integrated in the project.

The initiatives that involve the scientific and/or agro-biodiversity communities tend to succeed. At the Swiss experience conserving CWR, there is a budg*et al*located to the farmers who own the land where CWR populations occur and the farmer's training to make them part of the management of these genetic resources. An economic return for the stakeholders is hard to reach but it is another way of ensuring long-term conservation. The CWR conservation at the Lizard Peninsula (UK) (Jarvis *et al*., 2015) or at *Sierra del Rincón Biosphere Reserve* (Spain) (Community of Madrid, 2019), are some of the examples where the conservation strategies are based on national inventories and prioritization of CWR (Hannah Fielder *et al*., 2015; Rubio Teso *et al*., 2018), by properly implementing the theory into practice. Even more, it is also remarkable the inestimable worth of long-standing genetic reserves, with a deep asset of scientific knowledge in the area, as in the case of the conservation of wild relatives

of wheat in Erebuni (Armenia) and in Ammi'ad (Israel). Networks conserving CWR based on rigorous scientific work attract attention to the genetic reserves and then, the political agendas start considering and covering CWR conservation. The first five official designated genetic reserves in Germany and Europe target celery wild relatives, and their recognition comes after many years of scientific research.

4.2.2.CAME analysis

Once the main advantages, weaknesses, opportunities and threats were identified, a battery of general strategies is proposed, to turn the SWOT analysis into action (Table 6).

Table 6. Proposed strategies resulting from the CAME analysis.

CORRECT THE WEAKNESSES
Funding aspects: • Increase the number of different financial sources • Ensure public funds **Design and implementation:** • Allocate efforts to develop a CWR management plan, to have it approved by the authorities and to integrate it into the general plans • Enhance the publication of data and make it accessible to the public **Social involvement**: • Strive to develop a network design and an implementation plan that is respectful and non-intrusive to local communities. Let local communities, farmers and landowners accommodate their traditional and cultural uses into the design • Promote CWR through actions targeted to different stakeholders
ADAPT TO THE THREATS
Funding aspects: • Promote some self-funding activities to be more resilient to external changes **Social involvement**: • Work on consent forms to ensure long-term conservation. Search for availability of funds for land and social support • Offer engaging CWR activities to spark interest in this group of plants

MAINTAIN THE STRENGTHS
Funding aspects: • Sustain diverse sources of financial resources **Design and implementation:** • Take full advantage of gained experience to facilitate the work • Plan for long-term conservation, even if it not ensured • Uphold contact with similar initiatives • Facilitate scientific work in the network **Social involvement**: • Promote CWR conservation activities to keep stakeholders involved • Consider socio-economic-political ethnographic factors when making changes, and raise participatory decisions to make sure that landowners, local people and farmers remain engaged
EXPLORE THE OPPORTUNITIES
Funding aspects: • Explore regularly potential sources of funding **Design and implementation**: • Renew and improve the design and implementation, paying special attention to the new opportunities that may arise • Draw on similar networks and replicate successful decisions • Profit from the external supporting networks **Social involvement:** • Update frequently the social activities offered (citizen science, workshops, volunteering, etc.) • Ensure that the benefits of CWR conservation reach as many people as possible

4.2.3. Concluding remarks

This document is meant to serve as a roadmap that each network should adapt to its particular situation and needs. It may be useful at the establishment of new networks, as well as to the already established ones, by providing alternative ideas to implement, insofar advantages of local resources and own distinguishments continue to be exploited. All the remarkable practices considered above are not a guarantee of success for CWR conservation networks, but a cluster of ideas that could be useful at different scenarios and circumstances.

Regardless of the type of network in question, CWR scientific studies and social support and willingness are crucial to claim CWR specific legislation and economic backing. There is a paramount need to share information related to the *in situ* conservation of CWR. It is important to increase the scope of dissemination of all the knowledge acquired and successful experiences, since genetic reserves networks are only at the beginning stage of what they can become, and they should draw upon other experiences.

We hope that the presented results may find an interested audience among the stakeholders that are joining the '*European network for in situ conservation and sustainable use of plant genetic resources—in cultivation and in the wild*', as well as among end-users that may not be a part of this network. To facilitate the establishment of a CWR conservation network, the Farmer's Pride Project has also generated the resource document entitled *Crop Wild Relative Population Management Guidelines* (Iriondo *et al*., 2020), which provides practical guidelines on how to manage *in situ* the populations of target CWR and the genetic reserves where they occur, through a series of standards and recommendations that are in consonance with the ones presented in this report.

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Annex I: Standardized fact sheets documenting *in situ* maintained CWR showcases and structures that facilitate their conservation

Table of contents of Annex I

All the cited bibliography of Annex I is in the previous section '5. References'.

1. Established networks containing CWR

1.1. Erebuni State Reserve

Continent	Asia
Countries	Armenia
Crop (target CWR)	Wheat (*Triticum boeoticum*, *T. Urartu*, *T. araraticum, Amblyopyrum muticum* and *Aegilops* spp.)

Creation of the Network

Between 1925 and 1930 Armenian scientists M. Tumanyan and A. Araratyan discovered wild wheats in the area currently occupied by the Erebuni Reserve. In 1934, N.I Vavilov confirmed the presence of wild wheat and rye species in this area. The reserve was established in 1981 as a State Reserve*, i.e*. the areas included in the reserve were state lands, occupying a total of 89 ha (A. Avagyan pers. comm. 2020). In 2015 the borders of the Erebuni State Reserve were revised, andon the 1st October 2015, with consent from the Voghjaberd community, the executive approved a resolution that changed the category of 24.87 ha of forest land from the Voghjaberd community and 6.6434 ha of agricultural land to specially protected areas of nature. These lands were included in the Erebuni Reserve (EcoLur Network, 2015) thereby ensuring the maximum representation of biological and landscape diversity in protected areas (A. Avagyan pers. comm. 2020). The reserve then included 118.75 ha versus the 89 ha when it was first established (EcoLur Network, 2015).

The Erebuni Reserve is located in the south-western part of Yerevan, near the villages of Mushaghbyur and Geghadir, at an altitude of 1300–1400 m above sea level on the transition between semi-desert and mountain-steppe zones (Ministry of Agriculture of the Republic of Armenia, 2008). It is considered a "Strict Nature Reserve" as according to the IUCN Management Category Ia (Ministry of Agriculture of the Republic of Armenia, 2008; Stolton *et al*., 2013), i.e. "strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphical features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values" (Dudley, 2008).

Current situation

It is presumably funded by the Armenian government as it is a State Reserve that is currently active given that it was enlarged in 2015.

This is the only conservation area in Armenia which is not a "state non-commercial organization" (SNCO) with a charter approved by the government and which does not have its own management system but remains under the jurisdiction of the "Reserve Park Complex" of the Ministry of Nature Protection of Armenia (Hunter *et al*., 2011). Since 2002, the Erebuni Reserve has been under the authority of the Bioresources Management Agency which was established within the Ministry of Nature Protection in 2002 (Government Decree No. 1236-N, August 8, 2002). Scientific research and monitoring as well as other conservation activities, including active management of CWR populations, are carried out by the staff of the Reserve Park Complex (Ministry of Agriculture of the Republic of Armenia, 2008).

Objectives and key actions to conserve CWR

Although the relatively small Erebuni Reserve has 292 different flowering species belonging to 196 different genera and 46 botanical families (Ministry of Agriculture of the Republic of Armenia, 2008), it was originally established to conserve wild cereals and their habitat (Avagyan, 2008; Ministry of Agriculture of the Republic of Armenia, 2008). It is especially dedicated to the conservation of wild wheat, including good populations of *Triticum araraticum* Jakubz (wild two-grain Ararat wheat), *T. boeoticum* Boiss. (wild one-grain wheat) and *T. urartu* Tumannian ex Gandilyan (wild Urartu wheat) (three out of four known wild wheat species), several *Aegilops* spp. (*A. tauschii* Cosson., *A. cylindrica* Host., *A. triuncialis* L., *A. columnaris* Zhuk., *A. trivialis* Zhuk.) and the extremely rare *Amblyopyrum muticum* (Boiss.) Eig (Avagyan 2008). Both *T. araraticum* and *T.urartu* were originally discovered and described in Armenia and each contain high intraspecific diversity (Ghandilyan *et al*., 1998). Additionally, wild rye (*Secale montanum* Coss., *S. vavilovii*Grossh.) and seven wild barley species (*Hordeum spontaneum* C. Koch., *H. bulbosum* L., *H. glaucum* Steud., *H. murinum* L., *H. maritimum* Huds., *H. geniculatum* All., *H. hrasdanicum* Gandil are also present in the reserve (Avagyan, 2008; Ministry of Agriculture of the Republic of Armenia, 2008). The reserve also has wild almond trees (*Amygdalus fenzliana*) which were planted before it was declared a reserve in 1981. A total of 39 CWR have been listed in the reserve (Ministry of Agriculture of the Republic of Armenia, 2008) as well as several plant species included in the Red Book of Plants of Armenia, including *A. crassa*, *S. vavilovii*, *H. spontaneum*, *T. araraticum*, *T. boeoticum*, *T. urartu*, *Gladiolus atroviolaceus*, *Iris elegantissima*, among others (Ministry of Agriculture of the Republic of Armenia, 2008).

A management plan for the reserve as well as a separate management plan for selected priority CWR were outlined within the framework of the UNEP/GEF project "*In situ* conservation of crop wild relatives through enhanced information management and field application"(Hunter *et al*., 2011). The Erebuni Reserve Management Plan included both habitat and species management actions that spanned from 2008 to 2012 (see table 7). Given the large number of CWR that occur in the reserve, the main challenge was to conserve more than one CWR without creating separate management plans for each species (Hunter *et al*., 2011). Despite initial efforts, the management plan of the reserve was never developed and finalized. The Ministry of Environment Protection plans to do so, but exact dates have not been fixed mainly due to a lack of financial resources (A. Avagyan pers. comm. 2020).

Nevertheless, a Management Plan for priority CWR (*Ae. tauschii*, *T. araraticum*, *T. boeoticum*, and *T. urartu*) was prepared. All the main institutions involved in conservation activities in Armenia were contacted to nominate experts who could be engaged in the development process, and it was finally prepared with the participation of the Ministry of Nature Protection (GEF and CBD focal point agency), Ministry of Agriculture, Institute of Botany, Yerevan State University and Armenian Agrarian University (Hunter *et al*., 2011). A number of meetings were held before and during preparation of the plan, a draft was sent for comment to the aforementioned institutions, and feedback was subsequently received and discussed with the project partners; the draft plan was also presented to local communities through Aarhus Convention Centres in Armenia. An outline of the content of the "Management Plan for *In situ* Conservation of *Triticum boeoticum*, *T. araraticum*, *T. urartu* and *Aegilops tauschii* in Armenia" is shown in table 8. It must be noted that this management plan has not been approved by the Government for several reasons including non-compatibility with the required format/template for the submission of management plans (A. Avagyan pers. comm. 2020). So,

although it has not been implemented, the target CWR species are protected according to the usual principles and rules of reserve management, i.e. collecting is restricted to relevant authorities with a special permit, research observations are allowed when requested, entry on reserve area is limited, etc. (A. Avagyan pers. comm. 2020).

Furthermore, although the reserve is not fenced, this has never been a problem and no fires have occurred there (NEWS.am, 2015).

Table 7. Species management actions in the Erebuni Reserve Management Plan (from Hunter *et al*., 2011).

Action	Methodology	Timescale
Collecting biodiversity data	Field surveys to collect herbarium specimens, living material or any other data regarding plants and animals of the reserve, including information on their distribution	2008–2009
Creating updated distribution maps of CWR in the reserve	Field surveys to identify biological characteristics of the species of interest and collect data on their distribution	2008–2009
Estimating CWR resources	Field surveys to collect resource data of CWR	2008–2009
Creating maps of the flora of the reserve	Field surveys to collect specimens and distribution data with subsequent identification of collected material in the lab	2008–2012
Creating maps of the fauna of the reserve	Field surveys to collect specimens and distribution data with subsequent identification of collected material in the lab	2008–2012
Creating a database to store information about the reserve	Developing a database to store information regarding the current state, scientific, economic and social values, and qualitative and quantitative characteristics of biodiversity components	2010–2012

Table 8. Content of the Management Plan for *In situ* Conservation of *Triticum boeoticum*, *T. araraticum*, *T. urartu* and *Aegilops tauschii* in Armenia (from Hunter *et al*., 2011).

1. Introduction
2. Description
2.1. Morphological characteristics of target species
2.2. Taxonomy of the target species
2.3. Current distribution (in the country, inside and outside protected areas; distribution maps and any other relevant information)
2.4. Habitat and ecology
2.5. Biological characteristics (life cycle, life form), seed characteristics, phenology, pollination, dispersers, pest and diseases
2.6. Conservation status
3. Evaluation
3.1. Importance
3.1.1. Cultural value of the CWR for local community
3.1.2. Potential value of the CWR for research, breeding or other functions
3.2. Threats
3.2.1. For conserved populations in the Erebuni Reserve

	3.2.2. Outside protected areas
	3.2.2.1. Land privatization
	3.2.2.2. Uncontrolled grazing and hay harvesting
	3.2.2.3. Road construction
	3.2.2.4. Industrial and agricultural waste pollution
4.	Identification of stakeholders
5.	Goals/objectives
6.	Management of threats
7.	Strategic actions
8.	Actions to ensure protection in the protected area(s)
9.	Actions to ensure protection outside protected areas
10.	Improvement of *ex situ* collections
11.	Research and monitoring
12.	Public awareness and education

According to Armenian Law on "National specially protected areas", monitoring in protected areas is implemented by means of state and community budgets, meaning that monitoring activities are undertaken annually. However, monitoring is generally a weak point of the national protected areas management system and not very active. In the last few years, the monitoring results of target CWR in the Erebuni reserve have not been published or reported (A. Avagyan pers. comm. 2020). Despite that, a monitoring system was developed in 2007, tested and fine-tuned in 2008 with protected area authorities, and finally applied to the populations of the four priority target species in the reserve. Climate, soil contamination, natural and human-induced disturbances, phenology, population size and occupied area, pests and diseases and invasive species were considered and included in the plan. Protocols and field forms were developed for each of these elements, and a stand-alone software tool was developed to help record and store the captured monitoring data. The monitoring plan for cereal CWR in the reserve is available in Hunter *et al*., 2011.

Finally, CWR species growing in the Erebuni Reserve are stored *ex situ* in the seed collection of the Laboratory of Crops Gene Pool and Breeding of the Armenian State Agrarian University in the gene bank of the Scientific Center of Agrobiotechnology of the Armenian State Agrarian University and in the Institute of Botany of the National Academy of Sciences (A. Avagyan pers. comm. 2020).

Link to social initiatives

Civil society in Armenia is generally involved in conservation activities implemented in protected areas, especially through several NGOs which are very active in developing and organizing educational awareness campaigns. However, these activities are not carried out in the Erebuni reserve (A. Avagyan pers. comm. 2020).

Nevertheless, there is a clear need to engage local communities in the reserve for the successful conservation of CWR (Naire Yeritsyan in Hunter *et al*., 2011). In fact, the enlargement of the reserve in 2015 involved the Voghjaberd community, via its village heads, who had to give their consent to include their lands in the Erebuni Reserve (NEWS.am, 2015).

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The authors would like to acknowledge Alvina Avagyan, Nelli Hovhannisyan and Janna Akopian for providing all the essential information to write this section of the document.

1.2. Genetic reserve network for wild celery

Continent	Europe
Countries	Germany
Crop (target CWR)	Celery (*Apium graveolens* ssp. *graveolens*, *Helosciadium repens*, *H. inundatum* and *H. nodiflorum*)

The German Wild Celery Network is the first crop wild relative (CWR) network to have officially recognized genetic reserves in Europe. It could potentially serve as an example and a point of reference for the development of other such networks in Europe and worldwide. The network covers the conservation of the taxa *Apium graveolens* ssp. *graveolens* (wild celery) as well as *Helosciadium repens*, *H. inundatum* and *H. nodiflorum*. These *Helosciadium* species are closely related to *Apium* and were previously classified as *Apium*.

Creation of the Network

The Wild Celery Network has been under development since 2015, and in June 2019 the first five genetic reserves were officially recognized (Frese, 2019). By January 2020, a total of 14 genetic reserves had been established, covering three of the four species. The aim is to extend the network to include 45 sites and all four species.

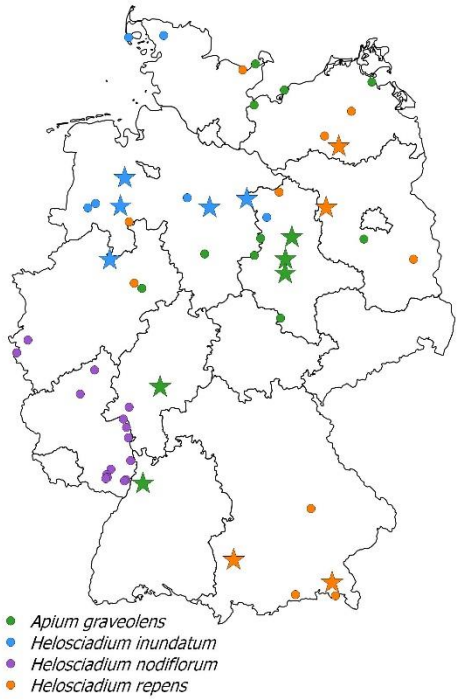

Figure 9. Occurrences of the four wild celery species in Germany for which genetic reserves have been proposed (dots) or established as of January 2020 (stars).

Since 2015, research teams from the Julius Kühn Institute, the University of Osnabrück and the Humboldt University of Berlin have been investigating the genetic diversity of wild celery occurrences in Germany in the framework of the Project "Genetic Reserves for Wild Celery Species (*Apium* and *Helosciadium*) as part of the German Network of Genetic Reserves (GE-Sell)". The aim of the project was to use different wild celery species as model taxa to demonstrate how the protection of wild plants for food and agriculture can be improved in their natural habitats by establishing an exemplary nationwide network of genetic reserves. The project was funded by the German Federal Ministry of Food and Agriculture based on a resolution of the German Bundestag via the Federal Office for Agriculture and Food (grant number 2814BM110 to -112).

The wild celery species were selected according to a combination of criteria that made them excellent model taxa for a demonstration project:

- There are four wild celery species in Germany.
- They are the wild relatives of cultivated celery, which is, for example, grown as tuber or leaf celery. Wild plants may contain heritable traits that are not present in the related cultivated plant species. They are an indispensable resource for plant breeding in order to adapt cultivated plants to changing production conditions and to secure our food supply.
- The distribution areas of the species extend throughout Germany, so that special features specific to the federal states were taken into account in the establishment of genetic reserves.
- The species are endangered or critically endangered (i.e. *Helosciadium repens*) in Germany.
- Sufficient information on the biology of the species is available for the planning and implementation of species-specific maintenance measures. In addition, initial experience has been gained from actions to reintroduce or increase the population size of *H. repens*.

During the project, experts evaluated approximately 350 sites of the wild celery species *Apium graveolens* ssp. *graveolens*, *Helosciadium repens*, *H. inundatum* and *H. nodiflorum,* and the newly obtained data was used to update floristic databases. The geographic distribution patterns of the species' genetic diversity were also analysed to identify a set of 10 – 12 occurrences that best represent the intraspecific variation of each species (Frese *et al*., 2018; Herden *et al*., 2020). The new inventory data and the genetic information are perceived as a tangible contribution of the agricultural sector to species protection programmes. Furthermore, sharing information with stakeholders has been, and will continue to be, essential in the process of designating genetic reserves and to receive local support for conservation actions.

The research teams aimed to establish and designate genetic reserve sites for approximately 45 wild celery occurrences in the framework of a formal, reproducible process. A second goal was to collect seed samples from each occurrence to store them in a genebank as a back-up and to facilitate access to the germplasm.

Current situation

The Wild Celery Network coordination unit has meanwhile been raised from project level to an organisational unit permanently established at the Julius Kühn Institute by the German Federal Ministry of Food and Agriculture, thereby demonstrating that agricultural policy takes responsibility for the conservation of CWR. The coordination unit is meant to connect permanently involved

institutions and persons to maintain and expand the network. It also collects information on wild celery occurrences in Germany and advises on their conservation.

The coordination unit of the Wild Celery Network:

- serves as a contact point for landowners and managers as well as non-governmental organizations (NGOs), nature conservation authorities and other parties interested in the Wild Celery Network
- supports the monitoring of wild celery occurrences in genetic reserves and the preparation of management plans for designated occurrences
- is responsible for maintaining and expanding the network
- collects, secures and maintains data on genetic reserves and other wild celery occurrences
- integrates the Wild Celery Network into the superordinate "German Network of Genetic Reserves" coordinated by the Information and Coordination Centre for Biological Diversity of the German Federal Office for Agriculture and Food

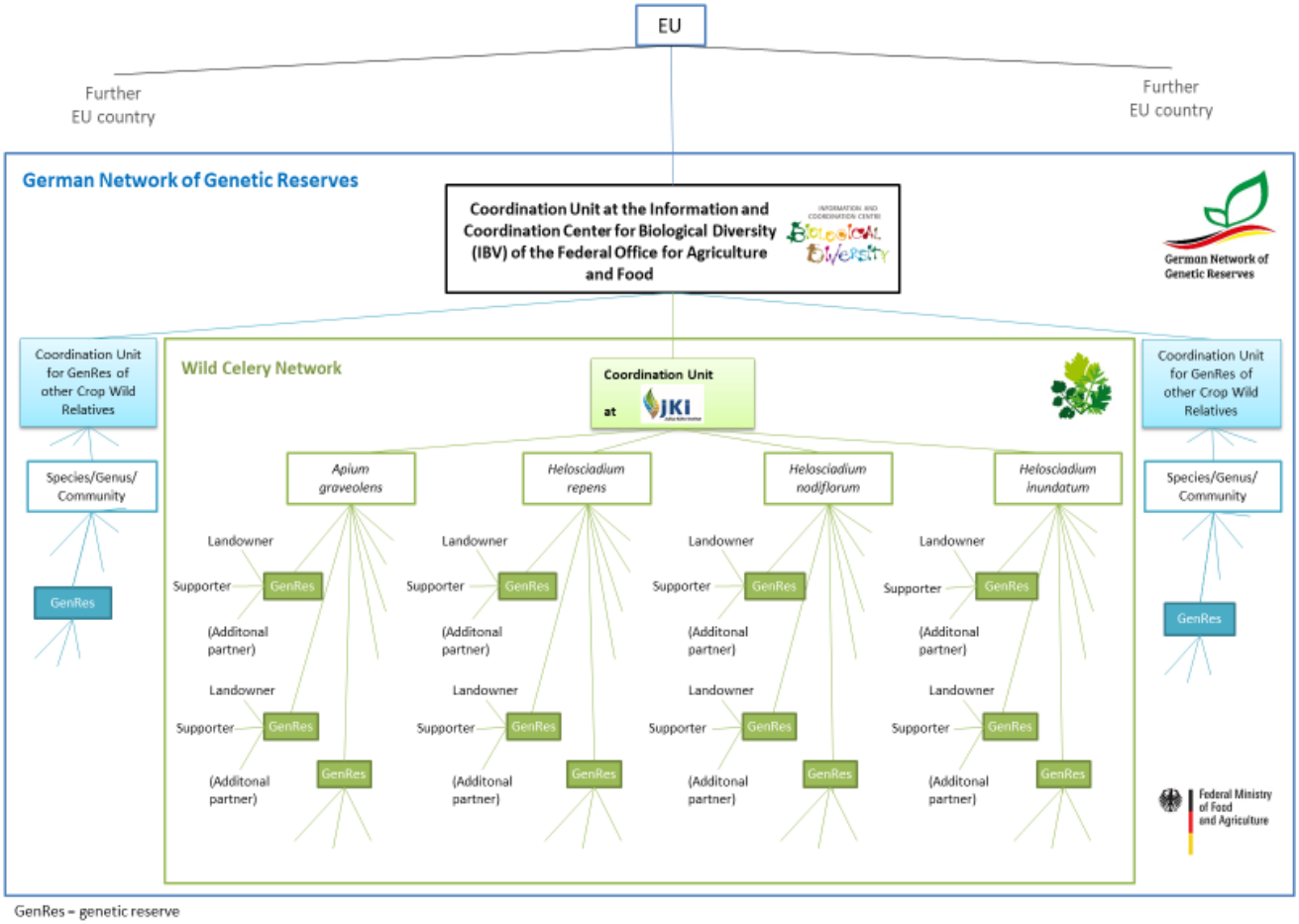

Figure 10. The coordination unit of the Wild Celery Network and its integration in the superordinate "German Network of Genetic Reserves". The genetic reserves of the wild celery species are part of the German network of genetic reserves, which will be integrated through its coordination unit into European activities.

A declaration of consent regulates cooperation between local partners and the coordination unit. For each genetic reserve, an organisation was identified (Table 9) to support the maintenance of the target occurrence to the best of its abilities (funding for maintenance is not provided by the coordination unit). This support depends on the stakeholders' profession, available resources and further individual conditions and, consequently, differs between the supporting organisations. A wide range of stakeholders take part in the management of the sites, including nature conservation agencies, landowners and countryside management associations. Supporting stakeholders receive a certificate in recognition of their commitment to conserve a wild celery occurrence.

Table 9. Wild celery genetic reserves officially recognized till January 2020.

Species	Site	Local Stakeholders
Apium graveolens* L. spp. *graveolens	nature protection area at Hecklingen, Saxony-Anhalt	• landowner and supporter: NGO
	nature protection area at Sülldorf, Saxony-Anhalt	• landowner and user: commune and farmer • supporter: commune, farmer, nature conservation agency of the district, local countryside management associations
	park near Nidda, Hessia	• landowner: commune • supporter: landowner, nature conservation agency of the district and consultation company
	natural monument at Ubstadt-Weiher, Baden-Wuerttemberg	• landowner and supporter: commune
	stream near Zielitz, Saxony-Anhalt	• landowner and supporter: local company
***Helosciadium repens* (Jacq.) W. D. J. Koch**	nature protection area at Lake Chiemsee, Bavaria	• landowner and supporter: public-law institution for state forest
	meadow at lake Hohennau, Brandenburg	• landowner: commune • supporter: local nature conservation NGO group
	nature conservation area at lake Müritz, Mecklenburg-Western Pomerania	• landowner and supporter: regional foundation for nature protection
	stream in Unterallgäu, Bavaria	• landowner: commune • supporter: local countryside management association
***Helosciadium inundatum* (L.) Koch**	nature protection area near Warendorf, North Rhine-Westphalia	• landowner: commune • supporter: local nature conservation station of an NGO
	nature protection area near Celle, Lower Saxony	• landowner: private citizen • supporter: landowner and local nature conservation NGO group
	shallow pond near Dinklage, Lower Saxony	• landowner: commune • supporter: commune and local nature conservation NGO group
	ditch near Wittingen, Lower Saxony	• landowner: commune • supporter: coordination unit of local nature conservation NGO groups
	nature conservation area near Oldenburg, Lower Saxony	• landowner and supporter: local water maintenance association

Objectives and key actions to conserve CWR

The objectives of the network are to:

- gain practical experience in managing a network of genetic reserves
- serve as an example for other such networks
- conserve 10 – 12 populations of each of the four wild celery species in Germany
- facilitate access to celery genetic resources via the *ex situ* storage of seeds for use in research and plant breeding

The occurrences in the genetic reserves chosen to be included in the network are generally not endangered, because the habitat requirements of the target species are already met. This means that in most cases, only a continuation of the current use/management is needed, in combination with the development of a monitoring programme to observe the conservation status of the target species. If management needs to be adapted, the feasibility is discussed with local stakeholders and funding options are investigated. In addition to *in situ* conservation, seeds are preserved *ex situ* in a gene bank.

Criteria for the designation of genetic reserves (J. M. Iriondo *et al*., 2011) were weighted pragmatically to ease the initiation of the network. Criteria with a strong weight were population size and indications of a fundamental willingness of local stakeholders and institutions to support a genetic reserve.

Link to social initiatives

Several links to civil society were developed during the first phase of this network. Amateur and professional botanists were informed about the network during lectures, botanic meetings and via NGO magazines / websites (e.g. Frese *et al*., 2017); www.nabu.de/tiere-und-pflanzen/pflanzen/aktivitaeten/27237.html; https://netzwerk-wildsellerie.julius-kuehn.de). The network is collaborating with nature conservation NGOs and their local (volunteer) groups, using their network to identify local supporters. There is also active cooperation with local botanic experts.

Acknowledgements

The authors would like to acknowledge Nadine Bernhardt and Maria Bönisch for providing all the essential information to write this section of the document.

1.3. Network of Genetic Reserves for Vitis sylvestris in Germany

Continent	Europe
Countries	Germany
Target CWR	Grape (*Vitis sylvestris*)

The European wild grapevine, *Vitis sylvestris* C.C. Gmel (synonym: *Vitis vinifera* L. subsp. *sylvestris* Hegi), is considered the wild progenitor of cultivated *Vitis vinifera* L. It can be found today in Eastern and Western Europe and is the only endemic taxon of the Vitaceae family in Europe. In Germany it is classified as threatened and a great decrease in population size has been observed.

Creation of the Network

The project "Survival of the wild grapevine *Vitis sylvestris* C.C. Gmelin in the Rhine floodplains through targeted *in-situ* management" was initiated in 2008 as a model and demonstration project. It was carried out by WWF-Auen-Institut, the Botanical Institute of the Karlsruhe Institute of Technology (KIT) and the Federal Institute for Grapevine Breeding Geilweilerhof, financed by the Federal Ministry of Food and Agriculture (BMEL), and ended in 2013. The most important site that was identified harbours the only naturally rejuvenating wild grapevine population in Germany (Nick, 2014). It is located on the Rhine island Ketsch, a national nature protection area as well as a Special Area of Conservation (SAC) within the EU Fauna-Flora-Habitat Directive (FFH). The population is composed of about 80 individuals. The population was conserved *ex situ* in three locations, i.e. in two botanical gardens and in the German grapevine genebank. Several other spontaneous wild grapevine individuals were identified in other sites. All wild grapevine individuals identified in the project were morphologically and genetically characterized (Ledesma-Krist *et al*., 2013), generating baseline data and management plans for future monitoring. Planting was also carried out during the project to reintroduce wild grapevine in appropriate areas and to enhance populations. Phenotypic analyses during the project showed significant resistances in the Ketsch population to downy mildew, powdery mildew, and black rot, which were further investigated in a separate project "Utilization of wild grapevine genetic resources for the breeding of mildew and rot resistant grapevine" (Tisch *et al*., 2013).

At the end of the project, the project partners and local representatives recommended that the sites be designated as genetic reserves. The designation process was not concluded at that time, mostly due to personnel changes, the need to involve other key stakeholders and the early development stage of a framework to embed the process and genetic reserves. The project highlighted the great importance of the unique population of European wild grapevine at Ketsch. Since then, follow-up research projects have been carried out on the island Ketsch to safeguard the population. Wild grapevine management guidelines for nature protection personnel have been developed, and the current phase of the project focuses on the rejuvenation of the population.

Current situation

Over the past few years, the work on CWR and their *in situ* conservation in genetic reserves has gained momentum. A national priority list of CWR has been developed as well as the German Network of Genetic Reserves as a framework. The first wild celery reserves were designated in the summer of 2019 leading to the establishment of the Wild Celery Network of Genetic Reserves, and the process of designating the Rhine island Ketsch as the first genetic reserve within a Wild Grapevine Network has been resumed. Positive feedback has been received from both regional and local authorities as well as from the institutions responsible for the management and development of the area and forest management plans. The process to establish the genetic reserve is now under way. The regional ministry and administration and the coordinators of the German Network of Genetic Reserves at the Federal Office for Food and Agriculture are the main actors involved in the processes leading to the creation of the Wild Grapevine Network and the designation of the sites as genetic reserves.

Objectives and key actions to conserve CWR

The objectives of the network are to:

- actively conserve *Vitis Sylvestris in situ* in Germany
- reduce the risk of extinction of the species in Germany
- raise awareness about the importance of the species, considering its close relationship to cultivated grapevine
- facilitate access to wild grapevine resources via the *ex situ* conservation for use in research and plant breeding

Link to social initiatives

Certificates are awarded to local stakeholders that have signed the declaration of consent to establish the genetic reserves. The certificates recognize their commitment to the conservation of CWR species as an important part of biological diversity for food and agriculture and as a contribution to the implementation of the National Programme for PGRFA. Signs including the name of the genetic reserve and the logo of the German Network of Genetic Reserves can be placed in the designated areas. Depending on the size of the signs, they might contain information directed to the general public.

Acknowledgements

The authors would like to acknowledge Imke Thormann for providing all the essential information to write this section of the document.

1.4. Sub-regional Network for Grassland Genetic Reserves

Continent	Europe
Countries	Germany
Crop (target CWR)	Grassland species

The calcareous grassland areas and wet meadows on calcareous-rich groundwater bog sites are considered to be one of the most biodiverse communities in the Central European cultural landscape (Krauss *et al*., 2004; Poschlod *et al*., 2008; Wesche *et al*., 2012). In addition to their agricultural value, they also have an immense value in terms of their ecosystem services and landscape ecological functions, from carbon storage through humus enrichment to the food habitat for pollinators. The value of ecosystem services depends on both biodiversity and the age or continuity of grassland use. Grassland communities are often rich in biodiversity, and the aim of the network is the long-term conservation of old grassland areas in two sub-regions in southern Germany, the Swabian Alb and the Southern Alpine foothills in Baden-Württemberg.

Creation of the Network

The model and demonstration project "Identification and conservation of historically old grasslands" was initiated in 2014 with the goal to develop appropriate criteria and standards for the identification and conservation of historical grasslands, using the example of two grassland-dominated natural areas in Southern Germany, i.e. Swabian Alb and the Southern Alpine foothills in Baden-Württemberg. With the help of these criteria and standards, a donor area register was created for the preservation of historical grasslands. The grassland locations, which were selected based on the results of the study,

are not only donor areas for regional seeds, but they also contain species that are relevant for plant breeding. The project therefore makes a significant contribution to the conservation and development of diversity in grasslands. It was carried out by the University of Regensburg and the Regional Council Tübingen, financed by the Federal Ministry of Food and Agriculture (BMEL), and concluded during the first few months of 2020. A subset of the areas selected for the donor area register will be designated as genetic reserves.

The regional council and the coordinators of the German Network of Genetic Reserves at the Federal Office for Food and Agriculture are the main actors involved in the processes leading to the creation of the Sub-regional Grassland Network and the designation of the sites as genetic reserves, with scientific collaboration from the University of Regensburg. Local key actors are the landowners or tenants managing or farming the areas. The regional council is likely to take over the coordination function of the Sub-regional Grassland Network, which will be part of the German Network of Genetic Reserves.

Current situation

The Sub-regional Grassland Network is in the process of being established. In total, 27 areas (9 fen meadows, 9 oat grass meadows and 9 calcareous grasslands) have been proposed as genetic reserves. These represent 95% of the genetic diversity in the below listed grassland species for which genetic analyses were carried out. These types of grassland are protected under a national regulation or under the EU Fauna-Flora-Habitat Directive (FFH), and hence no active deterioration or destruction should occur. Long-term conservation of the areas, however, will require specific measures that have to be voluntarily agreed on with the landowners or tenants and should be checked regularly (Schall, 2019).

The following species have been collected for *ex situ* storage and are conserved at the Federal Genebank at the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), at the University Regensburg and in the German CWR genebank: *Dactylis glomerata, Festuca ovina* agg., *Festuca pratensis, Festuca rubra* s.str., *Lolium multiflorum, Lolium perenne, Phleum pratense, Poa pratensis, Poa trivialis, Trifolium pratense,Trifolium repens.*

Species on which population genetic analyses were carried out: *Angelica sylvestris* L., *Asperula cynanchica* L., *Campanula rotundifolia* L. s. str., *Dactylis glomerata* L., *Filipendula ulmaria* (L.) Maxim, *Heracleum sphondylium* L., *Linum catharticum* L., *Lolium perenne* L., *Succisa pratensis* Moench, *Trifolium pratense* L.

Objectives and key actions to conserve CWR

The aim of the network is the long-term conservation of historical grasslands in two sub-regions in Germany. They should also serve as donor areas for local seed production and provide material for research, plant breeding and training.

Problems that can affect the conservation are the following:

- Increase of problematic species such as *Senecio jacobea*, *S. aquaticus* or *Colchicum autunnale*, which render the selling of the mowed grass more difficult
- Disposal of harvest that cannot be used in agriculture
- Eutrophication through nitrogen entry through the air and through the mineralization of bog soils

Link to social initiatives

Certificates will be awarded to local stakeholders that have signed the declaration of consent to establish the genetic reserves. The certificates recognize their commitment to the conservation of CWR species as an important part of biological diversity for food and agriculture and as contribution to the implementation of the National Programme for PGRFA. Signs including the name of the genetic reserve and the logo of the German Network of Genetic Reserves can be placed in the designated areas. Depending on the size of the signs, they might contain information directed to the general public.

Acknowledgements

The authors would like to acknowledge Imke Thormann for providing all the essential information to write this section of the document.

1.5. National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills

Continent	Asia
Countries	India
Crop (target CWR)	Citrus (*Citrus indica* and *C. macroptera)*

This sanctuary preserves a rich diversity in indigenous citrus varieties including Indian wild oranges (*Citrus indica* and *C. macroptera*) in a site which is large enough to be an effective conservation unit (the core area is about 10265.96 ha).

Creation of the Network

A sub-committee was constituted by the National Organizing Committee for the ICAR Golden Jubilee - Dr. B.P. Pal, F.R.S., chairman - to reconsider some aspects of the proposal. In 1980, it was approved by the Government of Meghalaya and then by the Government of India.

The forests of this area belong to 30 “Aching Nokma” (village headmen), who through an agreement, enabled these forests to be reserved as protected areas. However, not all the territory requested was granted, so the reserve consists of seven different unconnected protected areas (Bhag Singh, 1981).

Current situation

As the legal protection granted to the reserve by the Government of India was a long-time guarantee, it is still current. The Indian Council of Agricultural Research, the Departments of Environment, Science and Technology, Forest, the Government of Meghalaya and North Eastern Hill University, etc., worked together to develop and manage this reserve (Bhag Singh, 1981).

Objectives and key actions to conserve CWR

Citrus species - *Citrus indica* – is the most primitive and perhaps the oldest progenitor of citrus. This species of citrus is found most predominantly in Northwest India and therefore West Garo was the most ideally suitable site for the establishment of an *in situ* Citrus Gene Sanctuary - National Park. *C. macroptera* was also protected (Malik *et al*, 2006).

Link to social initiatives

The taskforce (Indian Council of Agricultural Research) held a series of meetings with various officials and village heads in the area to arrive at definite conclusions to prepare the blueprint for the original site. In addition, this protection also opened a wide range of new opportunities that brought more projects to the area (new research ideas throughout the protected site, education projects, training…).

Furthermore, this reserve was nominated as a mixed World Heritage Site, comprising elements of both natural and cultural significance.

1.6. Ammi'ad Reserve in Israel

Continent	Asia
Countries	Israel
Crop (target CWR)	Wheat (*Triticum dicoccoides*)

Creation of the Network

The official name of the Ammi'ad reserve is Ammi'ad Mountain-the wheat progenitor reserve; meaning that it is dedicated to the conservation of wild emmer wheat *Triticum dicoccoides*, which is one of the ancestors of cultivated wheat. The reserve is "declared", which is the highest level of protection possible for a nature reserve in Israel.

It was officially declared on 4th December 2008 and is about 191 hectares.

It all started with a scientific consortium named the Ammi'ad project, coordinated from 1984-1992 by Prof. Yehushua Anikster from the Institute for Cereal Crops Improvement, Tel Aviv University. Scientists from the University of Haifa, the Hebrew University of Jerusalem and the Weizmann Institute, Rehovot took part in the activities that were financially supported by the Ministry of Science and Development, Israel and the USDA Agricultural Research service (ARS) U.S.A. The locality for the project was a grazing area chosen by Prof. Anikster in the vicinity of a Kibbutz named Ammi'ad. Kibbutz Ammi'ad gave their permission to use the area for the establishment of the project covering about 30 hectares.

Following this successful project, a call was brought up to protect the area due to its rich and high diversity of wild emmer wheat and other important CWR like wild barley and oats.

Protected areas in Israel should be legislated under law authorized by the house of parliament and approved by the National Administration of Planning.

The Israel Nature and Parks Authority which is responsible for all of the reserves in Israel were in charge of preparing all necessary documentation.

The objections to the declaration were:

1. Kibbutz Ammi 'ad's cowboys wanted to continue herding their cattle in the area.
2. A high voltage electricity line passed through the proposed area.
3. The area is part of a military zone used for practice.
4. Some private landowners on the boundary of the planned reserve were afraid that the possibility of developing their properties would be limited.
5. Not all municipalities around were in favour of the reserve.

The objections were claimed under four different committees in the years 2002, 2004, 2005, 2007 and it was decided that the reserve would be established and located in one municipality area without restrictions (the one that was in favour of it in the first place). The military forces could continue their activities, the electricity line would stay; the cowboys would continue grazing their cattle under the restrictions and in coordination with the Israel Nature and Parks Authority, and an unpaved road would go through the reserve enabling private land owner access to their properties. In general, the borders of the reserve were mostly drawn artificially and contain different exposures, rockiness, slopes and habitats possible in that landscape.

The future plan of the reserve is to enlarge it. The main possible objections are again of bordering private landowners and the city of Safed that is located on top of the Ammi'ad Mountain.

Current situation

According to Israeli law, the Nature and Parks Authority, which is a governmental body, is the only one responsible for the maintenance of the reserve. There is no unique budget for this purpose, and the area is kept as it is with the understanding that natural conditions will protect the wild emmer wheat populations as well. It should be mentioned that the Ammi'ad reserve contains other rare species as well and, wild emmer wheat is also protected in at list 3-4 other reserves located in the north of Israel. Other activities carried out in the reserve by the Nature and Parks Authority are: a yearly survey of the rare butterflies *Melitaea arduinna*, a bird survey for species that are typical to these habitats, a yearly survey for the presence of nocturnal animals and random observations of plants species reported by inspectors of the Nature and Parks Authority.

Objectives and key actions to conserve CWR

The views of the scientific group and the Nature and Parks Authority differed from each other: the scientific group aims to study and maintain the local wild emmer wheat population, while the Nature and Parks Authority aimed to protect all species in the reserve including wild emmer wheat.

Some other crop progenitors are also included in the list of species preserved in the area, such as *Hordeum spontaneum* (barley), *Beta vulgaris* (beet), *Olea europaea* (olive) and *Avena sterilis* (oat).

Scientific group:

The main objective was the *in situ* conservation of wild emmer wheat (*Triticum dicoccoides*). The actions that were taken were:

a) An in-depth study of the site ecology: soil and plant communities.

b) A study of the spatial and temporal genetic and phenotypic variation of wild emmer collected from 250 sampling points over more than a decade. A new study is ongoing with the old samples (1984-2002), and samples from 2014, 2016 and 2018 are subjected to dense genotyping.
c) Fencing parts of the site to prevent grazing by cows.
d) Declaration of the site as a nature reserve by the Israel Nature and Parks Authority

A back up collection for selected sampling points from several collection years is stored in the Institute for Cereal Crops Improvement, Tel Aviv University.

Nature and Parks Authority:

They are aware of and approve of the scientific activity. Otherwise, as mentioned above, they take no special action to conserve CWR but rather keep the ecosystem as natural as possible. One of the actions that has been carried out was to prepare a complete file about the characteristics of the reserve. The file contains geographical and morphological aspects including maps of all vegetation forms and habitats within the reserve. Another action that took place around the year 2005 was to renew the signs of the old sampling points and to fix the damaged fences. The Nature and Parks Authority also has to deal with the prevention of potential risks to the reserve like deliberate open fires and fence breaking caused by the cowboys or heavy army vehicles during their practices.

Link to social initiatives

There are currently no links to social initiatives. In the past there was a connection with the Kibbutz Ammi'ad community, but it has faded away. The only initiative today is with the scientific group, which has ups and downs depending on the budget the scientists manage to raise.

In April 2007 there was an international congress celebrating the 100 years since the discovery of the wild emmer wheat *Triticum dicoccoides* for the first time in the world in Israel. On that occasion Dr. Kaplan from the Nature and Parks Authority announced that the Ammi'ad reserve had been officially declared a reserve, and the highlight of the congress was a trip of all participants to the reserve.

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1.7. Majella National Park

Continent	Europe
Countries	Italy
Crop (target CWR)	Rye (*Secale strictum),* celery *(Apium graveolens*), grass pea (*Lathyrus*spp.), etc.

Creation of the Network

The Majella National Park is an Italian park that includes 3 provinces (Chieti, L'Aquila, Pescara). It was established by the following measures: L 394 6/12/1991 - DD.MM. 4/12/92, 4/11/93, 22/11/94, DPR 5/6/95. It has an area of 74095 ha. Further managed Protected Areas are 4 Sites of Community Importance (SCI) (SCI Fonte di Papa, SCI Maiella,

SCI Maiella Sud Ovest and SCI Monti Pizi - Monte Secine) and one Special Protection Area (ZPS) (Parco Nazionale della Majella).

The Majella National Park is characterized by a territory dominated by mountains. As a matter of fact, 55% is over 2,000 meters. It includes wide lands with particular wilderness aspects, the rarest and most precious part of the biodiversity national heritage.

At the moment - as far as it is known - the park houses over 78% of the mammal species (except Cetaceans) living in Abruzzi, and over 45% of the Italian species. Considering the lack of data on some numerous groups like insectivorous species and chiropters, we can say that the Park is also a real "hot spot" for biodiversity conservation in these fields.

Current situation

The territory of the Majella National Park, located in the centre of the Abruzzo region, is a strategic biogeographic point for the confluence of the distribution of Euro-Siberian, Mediterranean and Balkan species, as well as a band of tension between the Mediterranean and Middle-European regions. From a climatic point of view, it contains a flora with over 2100 species and subspecies surveyed (over 65% of the Abruzzo flora, almost 30% of Italian flora), of which about 15% are endemic and / or in protected categories. In this great floristic richness, so far more than 150 taxa have been recognized as wild species of cultivated plants (Crop Wild Relatives), and there are also numerous native agricultural varieties. I In line with the FAO Treaty and the most recent Nagoya international protocol on access to genetic resources and the fair sharing of the benefits derived from their use and traditional knowledge associated with them, the Park Authority started a database to provide information on the CWR species to be protected including the size of the populations, their location, the level of risk, morphological and genetic characteristics, etc. For some particularly rare taxa, the Park Authority began an *ex situ* conservation path through its Botanical Gardens ("Michele Tenore" and "Daniela Brescia"), for the maintenance of the collections *in vivo*, and its genebank (Majella Seed Bank) for seed conservation and for studies related to reproductive biology. The Park is one of the founders of the RIBES initiative, an *ex situ* conservation network in Italy. Since 2011, “Daniela Brescia” Botanical Garden obtained the phytosanitary authorization to sell plants. With this production, the Park nursey obtains funds to support the Park and offers plantlets or seeds of local flora to farmers or visitors or for other initiatives.

Objectives and key actions to conserve CWR

A first analysis of the CWR of the Fabaceae family present in the Park territory led to the identification of 55 taxa belonging to the genera *Lathyrus, Lotus, Lupinus, Medicago, Melilotus, Pisum, Trifolium,* and *Vicia*. For the rarer and more localized species, including *Lathyrus clymenum* and *L. odoratus*, in addition to collecting information on the population found, the germplasm was characterized and conserved. For some species like *Secale strictum*, *Apium graveolens*, some *Lathyrus* etc. actions include monitoring the number of individuals and the status of the populations, seed collection, germination tests for processing germination protocols, and *ex situ* conservation in germplasm banks and in botanical gardens.

Link to social initiatives

To promote these activities, conferences were organized on the importance of the CWR, and articles and posters were also presented in popular and scientific journals.

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1.8. Besh-Aral State Nature Reserve

Continent	Asia
Countries	Kyrgyzstan
Crop (target CWR	Walnut (*Juglans regia*), plum (*Prunus sogdiana*) and pear (*Pyrus korshinskyi)*

Creation of the Network

Before becoming an established reserve, the Besh-Aral area was heavily used by local herders, leading to extensive damage to local ecosystems due to high grazing pressure. Therefore, in 1979 the Besh-Aral State Nature Reserve was established in Kyrgyzstan around the lower Chatkal river to preserve the ecosystems of the Chatkal Valley. Founded by the State Agency on Environment Protection and Forestry under the national Government, the Besh-Aral State Nature Reserve initially covered 116,700 hectares, but over the years decreased in size to 86,748 ha. After the government established the Chandalash area, the total area of the reserve increased again to the current coverage of 112,018 ha. The terrain is mountainous and predominantly covered by grassland ecosystems. Furthermore, some forest cover can be found in the reserve, such as walnut forests and a great diversity of other species such as pear and wild plum is harboured.

Current situation

The BASNR currently encompasses 112,018 ha. Since it is a State reserve, it can be assumed that funding for the maintenance of the reserve comes from the State. In the year 2011, for example, 1349800 KGS came from State budget. The reserve can also receive funding through services to visitors. In 2010 the BASNR received 122200 KGS through such services. The "Regulations of the Besh-Aral State Reserve" drawn up in 2006 mention that funding for the reserve's activities will come from the republican budget, republican and local nature protection funds and "other sources which do not contradict legislation". This document states that one of the main objectives is the preservation of genetic stocks of biological diversity. For the years 2013-2017 it mentioned that funding would come partly from the State Budget of the Republic, as well as from non-tax revenues funds of the Republican Fund for Nature Protection and Forestry Development.

The area is strictly protected, and it is therefore forbidden to conduct any activities not related to fulfilment of the main objectives, or that disrupt the natural area. Ecological tourism is allowed, but only on developed routes and in the company of a guide.

According to the Association for the Conservation of Biodiversity (Kazakhstan *et al*., 2016), the flora in the reserve has been poorly studied. 388 spp. have been recorded in the reserve, but estimates suggest that there are at least 1500 species. Furthermore, 65 species are endemic to the Western

Tien-Shan area, and some species are listed as globally threatened: *Crataegus knorringiana* (CR); *Pyrus korshinskyi* (CR); *Malus sieversii* (VU) and walnut (NT).

Objectives and key actions to conserve CWR

The management plan of the Reserve for 2013-2017 has four objectives. Only the first objective somewhat refers to CWR: "Preserve in its natural condition the most typical area of Western Tien Shan's nature, the rich gene bank of the animal and plant kingdom and the unique mountain ecosystem, first of all – the grass ecosystems of medium and high altitude mountains – habitats of rare and endemic species."

1.9. *Sierra de Manantlán* Biosphere Reserve

Continent	America
Countries	Mexico
Crop (target CWR)	Maize (*Zea diploperennis*) and *Z. mays* subsp. *parviglumis*)

This Biosphere Reserve is considered a good example of CWR conservation through the establishment of a protected area in Sierra de Manantlán in southern Jalisco, Mexico. Different types of forests are present in the reserve including mesophytic, cloud, and dry deciduous and semi-deciduous tropical forests. The Sierra de Manantlán's varied and complex plant cover shelters a great wealth of flora (over 2900 species of vascular plants belonging to 981 genuses) (UNESCO, 2012b).

Creation of the Network

It was originally established for the conservation of two wild teosintes, after the discovery of *Zea diploperennis* (endemic of Jalisco). A team of scientists from the University of Guadalajara and the University of Wisconsin, willing to protect these unique *Zea* species, began efforts to create this protection. The reserve was listed in the Man and Biosphere programme of UNESCO, and the Mexican government did the registration process to have it within the protected areas of Mexico. It was declared a protected area,covering a surface area of 139,577 ha in 1988 (UNESCO, 2012b).

Land property is a fundamental aspect for the management of the RBSM, since the declaration of the protected area contemplates the maintenance of forms of existing tenure and work with landholders and landowners. Of the 32 agrarian communities existing in the Sierra de Manantlán, most are "ejidos" (collective agricultural land), and a few are indigenous communities. Only 1% of the land is state or federal property. The problem of irregular land tenure subsists nowadays, as well as conflicts over the definition of boundaries (Graf-Montero *et al*., 2003)

Current situation

Manantlán continues active. The direction of the Sierra de Manantlán Biosphere Reserve is within the National Commission of Protected Natural Areas (CONANP), a decentralized body of the Ministry of the Environment and Natural Resources (SEMARNAT). The fiscal resources come from the budget authorized to SEMARNAT that they allocate to the CONANP. These resources are granted based on the Annual Operating Programme of the reserve. Support from the Global Environment Facility (GEF)

and the Natural Protected Areas Fund (FANP) within the Mexican Fund for the Conservation of Nature (FMCN) also contributes to the funding (UNESCO, 2012b).

Objectives and key actions to conserve CWR

Although the Management Programme is not specific for CWR, some of them are covered. Some of the main objectives of the reserve in the short, medium and long term are to ensure the *in situ* protection of *Zea diploperennis*, among others species of particular interest, endemic, rare or threatened, and to identify the means or management practices necessary for its conservation (Graf-Montero *et al*., 2003).

There are up to 47 CWR in the reserve, although not all of them are actively conserved. This list of CWR includes two teosintes: *Z. diploperennis* and *Z. mays* subsp. *parviglumis* (Contreras-Toledo *et al*., 2019). *Ex situ* backups are in several gene banks: International Center for Maize and Wheat Improvement (CIMMYT), United States Department of Agriculture Agricultural Research Service (USDA-ARS), Millennium Seed Banks of Kew (MSB-Kew) and the National Center for Genetic Resources-National Institute of Forestry, Agriculture and Livestock Research (CNRG-INIFAP).

Link to social initiatives

The reserve carries out several dissemination actions. Various universities, research institutes, government and civil society participate in different conservation, dissemination, tourism, research and educational activities in the reserve.

As agriculture, forestry and animal husbandry are the traditional activities that the rural population develops in the area, they are allowed and regulated in the reserve. Revalorizing and highlighting the importance of these activities in dissemination actions is a way of involving the local rural community (Louette *et al*., 1997).

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1.10. Wadi Sair Genetic Reserve

Continent	Asia
Countries	Palestine
Crop (target CWR)	Legumes (*Lens* spp., *Vicia* spp., *Lathyrus* spp.) and fruit trees (*Prunus* spp., *Pyrus* spp., *Pistacia* spp.)

Creation of the Network

The Wadi Sair Reserve was established in Palestine within the framework of the GEF-funded project "West Asia Dryland Agrobiodiversity (Conservation and Sustainable Use of Dryland Agro-Biodiversity of the Fertile Crescent)" (1998-2010), led by the International Centre for Agriculture Research in the Dry Areas (ICARDA) in cooperation with the International Plant Genetic Resources Institute (IPGRI) and the Arab Centre for the Study of Arid Zones and Dry Lands (ACSAD) (Al-Atawneh *et al*., 2007). The project targeted two areas in each of the four project countries (Jordan, Lebanon, Palestine and Syria). These areas were identified in an ecogeographic study and field

surveying of the distribution, frequency and density of target CWR within selected monitoring areas between 2000 and 2004. The areas rich in target CWR (see sub-section below) were then identified, and two additional areas were intentionally selected to represent different ecosystems and the maximum diversity of the target species (Al-Atawneh *et al*., 2007). Each site was then scored for various criteria (see (Al-Atawneh *et al*., 2007) for more details), each criterion was weighted, scores summed, and the sites finally ranked. Additional information about the villages and residential areas at each site was also gathered, and one site per country was finally selected to implement the genetic reserve. The final selection of the sites therefore resulted from considering the abundance of target species, the genetic diversity within the species in target populations at the sites and the socio-economic-political-ethnographic environment at the site (Al-Atawneh *et al*., 2007).

The Wadi Sair genetic reserve in Palestine has an area of 2 km^2 and is located in the North-eastern region of the Hebron area, namely east of Sair town, extending from the middle of Sair village to Al-Baqaa and Tequoe in the east (Al-Atawneh *et al*., 2007). The soil is fertile, the area is dominated by strongly dissected hills, and the main agricultural activities are the cultivation of grapes, stone fruits, field crops and grazing of natural grasslands (Al-Atawneh *et al*., 2007).

The areas that integrate the Wadi Sair genetic reserve were privately owned by more than 50 farmers which proved to be a challenge. To overcome this problem, the Ministry of Agriculture in Palestine created a committee of 10 people to represent the farmers who then followed up on all management options together with specialized staff from the Ministry. The Ministry of Agriculture took responsibility for the sustainability, management and long-term monitoring of the site. Additionally, a new governmental body was created with a clear terms of reference in order to follow up on agrobiodiversity conservation issues (Al-Atawneh *et al*., 2007). The continued contact between the Ministry of Agriculture and local farmers was vital to successfully implement the management regime of the reserve (Al-Atawneh *et al*., 2007).

Current situation

The Ministries of Agriculture in each project country were responsible for allocating the financial resources needed for managing the project sites (Al-Atawneh *et al*., 2007). However, other ministries such as those dealing with economic development, education, environment, finance, forestry, rangeland, rural development, tourism, trade, transport and water were also included in project discussions. The various responsibilities were then shared among the National Steering Committee (NSC) which was chaired by the Ministry of Agriculture. In Palestine, the leading research institution that prepared the management plan was the Extension General Department. This management plan was one of the first of this kind dealing with the management and sustainable use of a designated site to conserve CWR of global importance for food and agriculture. At the regional level, ICARDA, IPGRI and ACSAD were the leading institutions who provided technical support, network building and dissemination of project activities, and universities also helped in providing technical support for the project (Al-Atawneh *et al*., 2007). Information about how these efforts are currently reflected was not found.

Objectives and key actions to conserve CWR

The Wadi Sair reserve is dedicated to the conservation of forage legumes (*Lathyrus* spp., *Lens* spp., *Medicago* spp., *Trifolium* spp., and *Vicia* spp.), cereals (*Aegilops* spp., *Avena* spp., *Hordeum* spp., and *Triticum* spp.), fruit trees (*Amygdalus* spp., *Olea* spp., *Pistacia* spp., *Prunus* spp., and *Pyrus* spp.) and vegetable (*Allium* spp.) CWR (Al-Atawneh *et al*., 2013).

A Management Plan for the Wadi Sair genetic reserve has been prepared as an exit strategy of the "West Asia Dryland Agrobiodiversity" project (Al-Atawneh *et al*., 2007). This management plan was drafted by ICARDA and was the result of various meetings, workshops and brainstorming sessions with various relevant stakeholders within the country and at the regional level between the project countries, and the management plan was reviewed by national and international consultants (Al-Atawneh *et al*., 2007).

Link to social initiatives

Local farmers played an important role in defining and implementing the management options of the reserve together with the Ministry of Agriculture (Al-Atawneh *et al*., 2007).

1.11. Biodiversity Micro-Reserves network

Continent	Europe
Countries	Portugal
Crop (target CWR)	Ornamental and medicinal crops (seven relatives endangered or rare)

Creation of the Network

This network was created in 2005 by QUERCUS–National Association for the Conservation of Nature (Associação Nacional de Conservação da Natureza), via its Fund for the Conservation of Nature (Fundo para a Conservação da Natureza), following the concept of the Plant Microreserves network in Spain. The Fund for the Conservation of Nature is maintained by its own funds as well as by private people, private companies and other institutions (Quercus, 2010).

The process via which the micro-reserves are established follows five steps: (i) identification and cartography of potential areas that may constitute a micro-reserve, (ii) contact with the land owner to understand his/her willingness to collaborate in the conservation of the target biodiversity element, (iii) scientific validation of the target area by a scientific institution (i.e. minimum size of area needed to effectively conserve the target element, management measures, monitoring plan, etc.), and (iv) legal formalization of its protection which usually requires a land stewardship contract but, if needed, it may involve the acquisition of land. It should be noted, however, that the "figure" of micro-reserve is still not recognized by Portuguese law. Among the 13 micro-reserves already included in this network, five were purchased by QUERCUS for a total of 504,752.37 EUR, seven have a land stewardship contract with public and private entities and the remaining one is currently unknown (Quercus, 2010).

Current situation

Quercus uses its Fund for the Conservation of Nature to purchase and manage these micro-reserves. The establishment of these micro-reserves generally involves other partners, such as local parishes, NGOs as well as the national agency for the conservation of nature (ICNF, Instituto da Conservação da Natureza e das Florestas) whenever the target area occurs within an existing protected area. By 2016, there were 13 micro-reserves and at least four target plant diversity, including some CWR (see Table 10).

Objectives and actions to conserve CWR

The main objective is to actively conserve rare and susceptible habitats as well as endangered or rare species that fall outside the national network of protected areas, as only CWR that are endangered or rare are conserved within this network.

Table 10. Quercus Micro-reserves in Portugal and CWR-related conservation activities.

Name of the micro-reserve (size)	Management	Target taxa	CWR actively conserved	Activities and action plan	*Ex situ* conservation
Recovery of a forest in Serra do Caramulo	-	-	*Quercus* spp.	-	-
Peninha–Serra de Sintra (10 ha)	Protocol with national conservation agency (ICNF) as it is within an existing protected area	National endemics: *Armeria pseudoarmeria*, *Juncus valvatus*, *Phyllitis scolopendrium*, *Rynchosinapis pseudoerucastrum* subsp. *cintrana*, *Dianthus cintranus* subsp. *cintranus*, *Ulex jussiaei* subsp. *congestus*	*A. pseudoarmeria*, *D. cintranus subsp. cintranus, J. valvatus*, *U. jussiaei* subsp. *congestus* are wild relatives of ornamental crops, thrifts and carnations, rushes and gorses, respectively	• Trampling control: construction of fences and gates to decrease the entrance of cars. • Invasive species control (Acacia spp.). • Planting of native trees (*Quercus pyrenaica*) at higher elevations	Yes (*A. pseudoarmeria*, *D cintranus*, *J. valvatus*)
Sítio dos Prados (1 ha)	10-year contract with landowner	*N. pseudonarcissus* subsp. *nobilis*	*N. pseudonarcissus* subsp. *nobilis* is a wild relative of ornamental daffodils	These activities were agreed with the landowner: • No land mobilization. • Extensive grazing • No use of acro-chemicals, etc	-
Monte dos Colmeais (4 ha)	Management protocol with the company that owns the land	*Linaria ricardoi* and *Cynara tournefortii* (endemics), *Echium boissieri*, *Adonis annua* and 11 orchid species	*L. ricardoi* and *L. hirta* are wild relatives of cultivated toadflax, and wild relatives of cultivated orchids	-	-

Source: Quercus (2010)

Link to social initiatives

Civil society is involved not only because landowners (citizens and private companies) are made aware of the importance of the species being protected but also because they are directly involved in conservation, as some of the contracts require specific activities and actions to be carried out to conserve target species. The participation of local parishes and NGOs also boosts the involvement of civil society in the conservation of important biodiversity elements.

1.12. *Beta patula* genetic reserve

Continent	Europe
Countries	Portugal
Crop (target CWR)	Beet (*Beta patula)*

Creation of the Network

The need to establish a genetic reserve for *Beta patula* Aiton was identified in the *Beta* crop gene pool analysis carried out in the AEGRO project (http://aegro.julius-kuehn.de/aegro/). Field surveys to identify potential sites and collect distribution and abundance data were carried out between 2007 and 2010 in order to establish a demographic baseline. Additionally, geological, edaphic and topographic features, land uses of the distribution area and threats to the species were described, and leaf samples were collected for a genetic diversity study (see Frese *et al.*, 2012; Pinheiro de Carvalho *et al.*, 2012). The Natural Park of Madeira and the University of Madeira were involved in the identification of the genetic reserves which are expected to be located within existing protected areas, namely the Natural Park of Madeira, the Natural Reserve of Desertas Islands and sites of the Natura 2000 network.

Current situation

Both NPM and the University of Madeira prepared a document which described the need to conserve the species, where genetic reserves should be established and their management plans. This document is currently being revised by the Instituto das Florestas e Conservação da Natureza (IFCN–Madeira)[1], and the species' management plan is expected to be included in the management plan and legislation of the protected areas of Ponta de São Lourenço (in the Natural Park of Madeira) and Desertas (in the Natural Reserve of Desertas Islands), as well as in the Sites of Community Interest (SCI) of Ilhas Desertas (PTDES0001) and Ponta de São Lourenço (PTMAD0003). The management of the genetic reserves will therefore be under the umbrella of IFCN-Madeira.

Objectives and operation of key actions to conserve CWR

Beta patula, a primary wild relative of sugar beet (*B. vulgaris* L.) is the target species of this genetic reserve. Conservation measures, such as habitat restoration, removal of rodents and seagulls that were threatening *B. patula* and invasive species control, namely *Mesembryanthemum crystallinum*, were carried out by the Natural Park of Madeira and have led to an increase in the size of two *B. patula* populations by 10.8 and 2.6 times. The species has a 5-year monitoring plan ending in 2019 in the context of the project PROJETO LIFE12 NAT/PT/000195. Within this project the number of individuals

[1] The governmental body that is responsible for the nature and forest policies in Madeira archipelago, including the management of its protected areas.

of the two populations was counted, their minimum viable population size was determined, and their spatial distribution of genetic variability was assessed (two publications are being prepared). The Most Appropriate Wild Population (MAWP) was identified in the Ilhéu do Desembarcadouro but the smaller population of Ilhéu Chão is also genetically distinct and important to conserve. In addition, seed accessions have been collected for long-term *ex situ* conservation in the ISOPlexis Germobanco.

Link to social initiatives

There is no link to social initiatives as the localities where the genetic reserves will be implemented are of restricted access. As mentioned above, the genetic reserves will be implemented within existing conservation areas, namely the national network of protected areas and the Natura 2000 network.

1.13. The Valencian Plant Micro-Reserves network

Continent	Europe
Countries	Spain
Target CWR	Endemic, endangered or rare flora

The main objective of this 1918.2 ha network is to complement the existing protected areas, ensuring the protection of endemic, endangered or rare plants of the Valencian Community in Spain.

Creation of the Network

The network began in 1994, when the Regional Wildlife Service of the Valencian Government (Servicio de Vida Silvestre, Generalitat Valenciana, Spain) developed a programme to create a network of numerous small areas, which recognized for the first time the figure of protection of wild species called "microrreserva vegetal" in the Decree 218/1994, October 17th, of the Valencian Govern. In 1998, the first micro-reserves were officially declared.

These numerous small-protected areas were acquired differently depending on the owner of the land where the micro-reserve occurred:

1. Located on land owned by the Generalitat Valenciana
2. Located on "Public Utility" land owned by thec city council
3. Located on land owned by individuals/ONGs

In case 1, the land was automatically acquired, since they were the promoters of the initiative. In cases 2 and 3, any landowner or city hall could ask for the declaration of a micro-reserve in their property as a voluntary option, joining the public calls for grants to set up a pre-micro-reserve (Laguna, 2001).

Current situation

Until 2008, the number of protected areas kept growing reaching a total of 273 different micro-reserves. At the moment, efforts are more focused on the active conservation of flora in these areas rather than increasing the number of reserves (Laguna *et al*., 2010b).

Financial support for this network came from EU funds, including two LIFE-Natura projects and the EAFRD as well as from public funds from the Valencian Government.

Two kinds of grants were established for landowners (each year grants from the Conservation and Biodiversity Management Service of the Valencian Government reach a total sum between 80.000 and 90.000 EUR):

1) To join the MR programme to set up a pre-established MR, in a temporary status prior to being officially declared.
2) To develop conservation activities.

Although their creators manage this conservation initiative, the micro-reserves group keeps in close contact with other botanical and conservation organizations and institutes in Valencia, most of them under the aegis of the Generalitat Valenciana. In addition, private landowners (individual people or NGOs) play a role in establishing and maintaining the protected areas.

Objectives and key actions to conserve CWR

Only the CWR in the micro-reserves that are rare, endemic or threatened are being conserved. This means that a total of 232 CWR taxa are being conserved in these areas —around 25% of CWR in Spain. Of these conserved CWR, 142 have been identified as a conservation priority (Rubio Teso *et al*., 2018).

Although the number of CWR species being actively protected is quite high, there is no specific action plan for CWR, since the objective of the micro-reserves is to protect endangered flora.

In the case of the CWR that meet the requirements, they are also conserved *ex situ* at the Gene Bank of CIEF (Forest Research and Experimental Centre).

Link to social initiatives

Believing that local people feel the area is a part of themselves and they will take special care of it, several initiatives were successfully implemented to involve people at different stages. In the establishment stage, any landowner or city hall could ask for the declaration of a MR on their property, joining the public calls for grants and thus acquiring the commitment of following the basic rules (no disturbance of the future MR on their lands and to keep it against any external aggression). In addition, numerous groups of people participate in monitoring activities of the MRs.

This network has some specific objectives in common with other initiatives, such as educational uses and the possibility of including these areas in territorial networks for responsible ecotourism (Laguna, 2001).

Acknowledgements

The authors would like to thank Emilio Laguna for providing the essential information to write this section of the document.

1.14. *Sierra del Rincón* Biosphere Reserve

Continent	Europe
Countries	Spain
Target CWR	15 CWR species of the priority Spanish CWR list

The Sierra del Rincón Biosphere Reserve (SRBR) was selected to establish the first genetic reserves of crop wild relatives (CWR) in Spain. As protecting genetic resources is one of the main functions of biosphere reserves, it makes them an interesting scenario for developing pilot projects to conserve CWR. The SRBR turned out to be the perfect set for designating the first three genetic reserves as it concentrates a high diversity of CWR and a few genebanks can be easily reached.

Creation of the Network

The initiative to carry out a pilot project, a pioneer project in Spain, for the *in situ* and *ex situ* conservation of CWR in the *Sierra del Rincón* Biosphere Reserve arose within the framework of the European Project Farmer's Pride, one of whose objectives is to establish a network of genetic reserves of CWR in Europe. The implementation of the project was possible thanks to coordination with the 'César Gómez Campo' genebank (Technical University of Madrid), the Madrid Environmental Education Area and the Biodiversity and Conservation Area of the King Juan Carlos University, along with support from the Madrid Agriculture and Livestock Department and the local councils of *La Hiruela* and *Prádena del Rincón* (Community of Madrid, 2019).

Current situation

During 2019, this pilot experience was achieved with success, and the proposal for objectives for 2020 gave continuity to it. The number of CWR conserved *in situ* and *ex situ* will increase, more workshops will be held, educational and informative materials will be developed, and citizen participation will be promoted.

Objectives and operation of key actions to conserve CWR

Within the limits of the Reserve, 173 CWR species related to the main crops of the country were identified. According to the National Inventory (Rubio Teso *et al.*, 2018), 108 belong to the prioritized group.

In 2019, the first year of this project, 15 CWR species were selected and three areas (genetic reserves) were chosen to begin the *in situ* conservation process. One population in good condition was located for each CWR and georeferenced (Table 11). Once the population was georeferenced, a total census or an estimate of its size was carried out. The associated biotic community was also characterized, and the main threats to the populations were evaluated (Organismo Autónomo Parques Nacionales, 2019).

Table 11. Species of CWR in each of the three genetic reserves of *Sierra del Rincón*.

Genetic Reserve	CWR
Huerta Catalina	*Vicia sativa*

Vía Pecuaria Cordel del Salmoral	*Aegilops geniculata, Lathyrus aphaca, Lupinus angustifolius, Lupinus hispanicus, Ornithopus compressus, Trifolium angustifolium, Trifolium campestre, Trifolium pratense, Trifolium strictum, Daucus carota, Linum bienne, Salvia verbenaca*
Escuela Herbolaria "Rincón Silvestre"	*Hypericum perforatum, Papaver rhoeas*

Seed samples of the 15 prioritized species were collected and deposited as an *ex situ* backup in the 'César Gómez Campo' genebank. First, each sample or accession was recorded in the genebank's database and the passport data was documented. Then seeds were processed following the genebank´s protocol and conserved under conditions of low humidity (5%) and temperature (-15 ° C).

Link to social initiatives

Two training workshops were held for a wide range of professionals in the fields of the environment and conservation. The objectives were to build capacity in CWR conservation, exchange opinions and suggestions about the initiative, engage different stakeholders in the establishment of the genetic reserves, and to encourage trainees to participate in all phases of the project.

In addition, a project in the international citizen platform iNaturalist was created to promote citizen participation, as well as to contribute to a better understanding of the distribution and diversity of CWR in the Sierra del Rincón Biosphere Reserve.

Acknowledgements

The authors would like to thank Ada Molina for providing the essential information to write this section of the document.

1.15. *In situ* conservation of forage plants genetic diversity

Continent	Europe
Countries	Switzerland
Target CWR	17 CWR national prioritized species

A network of small areas of 0.5 – 2 hectares in size (2750 hectares in total) is being established in Switzerland. At the moment, the network is being started by certain states, with the purpose of implementing it in all of the country.

Creation of the Network

The bases for the conservation was developed in work group from the national plan of action for the conservation of PGRFA —members are fodder crop experts, e.g. representatives of Federal Office for Agriculture, agricultural departments of some states (cantons), breeders, researchers, environmental agencies and NGOs which are active in the field of (genetic) biodiversity. The guidelines for implementation were developed by the Federal Office for Agriculture (FOAG).

In situ conservation should be implemented in all states of Switzerland by 2022. It began in the state of Graubünden in 2019 (selection of the sites in 2018), followed by Lucerne in 2020 (selection of the sites in 2019).

To choose the sites, the agricultural office of the state informed all farmers who were eligible to get direct payments that they could register sites that fulfill the requirements for *in situ* conservation. Then, the agricultural office mandated an environmental agency or an agricultural school to evaluate the sites and make vegetation surveys. The data of the suitable sites was sent to the FOAG. The FOAG selected the sites based on distribution, plant associations, presence of target crops, management parameters and quality. The farmers were informed about the selection of their sites by the agricultural office.

Current situation

Conservation started recently and is still ongoing. The following parties are involved in the conservation process:

- Farmers: the most important people for conservation and preserving the knowledge of the management of the sites.
- An agricultural school or other experts for vegetation surveys.
- The agricultural office of the state(s) for collecting information, contact with farmers, distribution of payments, etc.
- The FOAG for selection of the sites, ensuring access under the MLS of the IT-PGRFA, etc.

Objectives and key actions to conserve CWR

At the moment, 704 populations belonging to 17 different species (*Agrostis gigantea, Alopecurus pratensis, Arrhenatherum elatius, Dactylis glomerate, Festuca rubra, Lolium multiflorumam, Lolium perenne, Lotus corniculatus, Medicago sativa, Onobrychis viciifolia, Phleum pretense, Poa pratensis. Schedonorus arundinaceus, Schedonorus pratensis, Trifolium pretense, Trifolium repens* and *Trisetum flavescens*) are being conserved. Regarding the activities implemented, as the farmers have the best knowledge as to how to manage the sites to preserve the genetic diversity, they decide which activities are undertaken. All sites underlay the following conditions:

- Access under the MLS has to be granted.
- The areas must not be oversown with commercial seed mixtures.

If the plant association or the relative presence of the species change in the area, the site could be excluded.

Link to social initiatives

Farmers are the main actors in this network, but there are currently no additional social links.

Acknowledgements

The authors would like to thank Christina Kägi for providing the essential information to write this section of the document.

1.16. Lizard Peninsula CWR Reserve

Continent	Europe
Countries	United Kingdom
Target CWR	Eight CWR out of 148 priority CWR present

Lizard Peninsula, southwest of England, is the site where practical genetic reserves are established and in the process of being recognized by the national authority in the United Kingdom. Further sites are being identified to form a network.

Creation of the Network

The beginning of the genetic reserve initiative was to develop a long-term conservation strategy. The Biodiversity Strategy for 2020 (Department for Environment, Food and Rural Affairs DEFRA, 2011) of the Department of Environment, Food and Rural Affairs (DEFRA), with the cooperation of researchers from the University of Birmingham and the national agency organization Natural England. Extensive scientific work related to CWR was conducted by the researchers to make a national CWR inventory, as well as a prioritized checklist (Fielder *et al*., 2012; Fielder *et al*., 2015), through FP7 (European Union's Research and Innovation funding programme for 2007-2013) and the PGR Secure Project. Further complementary analyses identified 17 areas with a great CWR diversity, which included two-thirds of the prioritized taxa.

In Lizard peninsula, 148 taxa of priority CWR occur (out of 223 priority CWR in the UK). In addition, genetic analyses revealed that some traits were exclusively present at this site. Consequently, this area was chosen to hold the first genetic reserve in the UK. Further studies showed that CWR were mostly located in protected areas (Natural England and Natural Trust properties), and a few were distributed among the properties of ten farmers. Natural England and Natural Trust lands are within the boundaries of Lizard Natural Nature Reserve. The ten private lands that were selected are managed by their landowners, after they received specific advice. In the areas managed by Natural England, active CWR conservation started in 2015.

Current situation

At the moment, there is still no official recognition of the conservation as a genetic reserve, although active conservation of selected crops is already taking place on Natural England lands. DEFRA provides financial support to the on-the-ground agencies (Natural Trust and Natural England), as well as binds CWR conservation to the politician's sphere. Both agencies are in charge of designing and implementing the management of the Lizard Natural Nature Reserve. Individual landowners which have selected populations of CWR occurring within their properties play an important role, with the assistance from the other actors involved. The University of Birmingham and its specialized CWR team provide input to all stakeholders at any step of the process.

Objectives and key actions to conserve CWR

According to Fielder *et al*. (2015), 148 priority CWR are distributed in Lizard Reserve. The active conservation of CWR was formally included in the site management plan of Natural England. The activities undertaken are the appropriate management and monitoring of CWR taxa.

Through discussion with stakeholders, it was decided to prioritize the conservation of: *Allium schoenoprasum*, *Allium ursinum, Asparagus officinalis* subsp. *prostratus*, *Beta vulgaris* subsp. *maritima*, *Daucus carota* subsp. *gummifer*, *Raphanus raphanistrum* subsp. *maritimus*, *Trifolium occidentale* and *Trifolium repens*.

The Kew gene back has kept *ex situ* samples of some of the CWR present at Lizard, but due to financial issues it was not possible to conserve all the taxa occurring in the peninsula.

Link to social initiatives

Natural England and the University of Birmingham work with the farmers and landowners on Lizard peninsula to raise concern about the importance of CWR and their conservation. A workshop was held to raise awareness and point out how their practices have a direct impact on CWR. Natural England agents offered to provide personalized advice to anyone who wishes to participate.

Acknowledgements

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1.17. The Coronado National Forest

Continent	America
Countries	United States
Crop (target CWR)	Pepper (*Capsicum annuum* var. *glabriusculum*

The Coronado National Forest is a United States National Forest with the objective to sustain the unique biodiversity of the ecosystems found within the area managed by the organization and provide a variety of high-quality visitor opportunities and services within the capabilities of these ecosystems. It also promotes the use of prescribed fire as an important tool in maintaining healthy ecosystems. An important CWR found in Coronado is the chiltepin (*Capsicum annuum* var. *glabriusculum*). A wild relative of the modern cultivated peppers, chiltepin has great historical and cultural significance for the Indigenous People (Khoury *et al*., 2019).

Creation of the Network

The forest was named for Francisco Vasquez de Coronado, who journeyed in 1540 to the Zuni and Hopi villages through part of what is today the Coronado National Forest. The beginning of its conservation started in 1902, when it was established. In 1953 the Coronado National Forest attained its current form (U.S. Forest Service, U.S.D.A., and Forest Service Conservation Corps). Today, the Coronado National Forest attracts visitors in numbers that have grown to the point that they threaten to overcrowd some of the very attractions that drew them (Coronado National Forest, n.d.-a).

Current situation

Today, the Coronado National Forest includes an area of 720,000 ha spreading throughout southeastern Arizona and southwestern New Mexico National Forests in the USA. It is administered and its management is funded by the United States Forest Service (U.S.F.S.), an agency of U.S.D.A.

U.S.F.S. provides leadership in the protection, management, and use of forest, rangeland, and aquatic ecosystems (U.S. Forest Service, 2019).

The Coronado National forest has a recently revised Forest Plan (2018), which substituted the previous plan of 1986 and provides forest-specific guidance and information on project and activity decision making over the next fifteen years (U.S. Forest Service, 2019).

The Coronado National Forest works in close contact with the tribes whose aboriginal territories are within its boundaries. Tribal consultation mandated by the National Historic Preservation Act, the National Environmental Policy Act, other laws, Treaties, and Executive Orders is conducted at early stages of planning and project design, so that tribal perspectives and information can be incorporated into decisions. Collaboration between tribes, Forest Service, state agencies, private foundations and landowners help create partnerships and facilitate management by landscape rather than jurisdiction (Coronado National Forest, n.d.-d). In addition, the Coronado National Forest collaborates with several federal and non-federal agencies such as universities, schools, volunteer organizations, conservation organizations, the U.S.F.S. and the U.S.D.A. in order to accomplish educational, volunteering and conservation programmes (Coronado National Forest, n.d.-e).

An important partner regarding plant diversity conservation, especially for the chiltepin pepper (*Capsicum annuum* var. *glabriusculum*), is the Native Seeds/SEARCH (NS/S). NS/S is a non-profit seed conservation organization based in Tucson, Arizona, aiming to conserve and promote the arid-adapted crop diversity of the Southwest U.S.A. and Mexico in support of sustainable farming and food security. NS/S utilizes both *in situ* and *ex situ* (Seed Bank, Conservation Farm) approaches for the conservation of these important plant species, promotes the use of these ancient crops and their wild relatives by gathering, safeguarding, and distributing their seeds to farmers and gardening communities and documents the role these seeds play in cultures of the American Southwest and Northwest Mexico.

Objectives and key actions to conserve CWR

Recognized CWR species in the Coronado National Forest include the chiltepin pepper (*Capsicum annuum* var. *glabriusculum*), wild cotton, tepary beans, and two species of wild gourds (Coronado National Forest, n.d.-a). However, the main conservation efforts are focused on the chiltepin, a small, hot, round pepper native to Mexico and wild relative of modern *C. annuum* cultivars. The plant is a perennial shrub that without hard frost in winter can live 35–50 years (Richardson, 1995). Chiltepin has a great economic value in the United States. Therefore, there is a great demand for these peppers, which can have a negative impact on wild populations (Coronado National Forest, n.d.-c).

In 1999, Native Seeds/SEARCH and the United States Forest Service established the Wild Chile Botanical Area in the Coronado National Forest (Vander Lee *et al*., 2008). This preserve located in the Rock Corral Canyon subwatershed near Tumacacori, Arizona (Horst, 2001) was designated to provide additional notoriety, protection, and research opportunities for the chiltepin and other plants of economic importance or conservation concern. The over 2500 ha preserve provides habitat for the largest population of chiltepin peppers north of Mexico, also representing the northernmost distribution of the species available for study and as a genetic reserve (Horst, 2001). Chiltepines have been harvested in the area of Coronado National Forest for decades, if not centuries, and are an important food crop with cultural significance. In the Tumacacori Ecosystem Management Area,

chiltepins and other plants that are traditionally important to the indigenous O'odham people are available for sustainable, traditional and cultural uses (Coronado National Forest, n.d.-c).

Multiple use management of the Wild Chile Botanical Area perpetuates the existence of chiltepins, while their traditional uses do not threaten existing populations. Activities related to the international border minimally impact natural resources and species. The issue of complex land ownership within the ecosystem management area was addressed by consolidation through land ownership adjustments resulting in easily identifiable ownership boundaries (Coronado National Forest, n.d.-d). The management approaches targeting on the chiltepins mainly include the support of continued research and the monitoring of wild chilles by Native Seeds/SEARCH (Horst, 2001) and other non-profit or educational organizations.

Specific guidelines for the protection of chiltepin peppers dictate that within the Wild Chile Botanical Area: a) Planned and unplanned ignitions (wildland fire treatments to create resiliency to disturbances) should be used seasonally prior to chiltepin flowering and fruiting; b) Livestock grazing should be deferred during the growing season of chiltepin; c) Chiltepin plants should be protected when high severity fire threatens the population; d) A special use permit should be issued for any plant or animal collection (excluding traditional uses); e) A special use permit should be issued for scientific research that would involve placing anything on National Forest System lands. In addition, management activities involving ground disturbance and/or vegetation management should incorporate site specific design features to benefit habitat for, or mitigate impacts to, rare or unique vertebrate, invertebrate and plant populations (U.S. Forest Service, 2019).

Link to social initiatives

In recent years, the Forest Service has placed increasing priority on the relationships between national forests and surrounding communities, as well as communities of interest. It is recognized that all agencies and non-governmental organizations that manage wildlife, fish, rare plants, and their habitats need to work together as complete partners, rather than relying on an individual group or agency to bear the burdens of management and conservation (Coronado National Forest, n.d.-b).

The Coronado National Forest maintains a governmental relationship with 12 federally recognized American Indian Tribes that have aboriginal territories and traditional ties to the land within its boundaries. Coronado National Forest managers consult with Tribes when proposed policies or management actions may affect their interests. Many Tribal members regularly visit these lands to gather traditional resources and to visit traditional cultural properties and sacred sites. Therefore, Tribes share an interest in protecting important natural and cultural resources. Native American Tribes have expressed desires for more accommodation of traditional uses and cultural uses in decision-making and planning. Since the current forest plan does not provide guidance for the type of collaborative conservation efforts, plan improvements and additions will be needed in the future (Coronado National Forest, n.d.-d).

With respect to Tribal Relations, there are several well-defined Management Approaches for achieving and maintaining the desired conditions. These conditions dictate that the traditional lands on the Coronado provide a setting for education in culture, history, and land stewardship. Interpretive and educational exhibits, events, and other media that focus on the history of the lands provide the public

with a greater understanding and appreciation of native history, culture, and traditions. In addition, traditional Tribal uses, such as the collection of medicinal plants, wild plant foods, basketry materials, and fuelwood take place on the Coronado National Forest. Tribal members have access to sacred sites for traditional ceremonies and rituals, and the integrity of sacred sites is maintained or improved whenever feasible. When available, Forest Service administrative sites can be used by Tribal families and organizations through government-to-government agreements (Coronado National Forest, n.d.-d). The Coronado National Forest and its partners are responsible for the 'Sky Island Children's Forest', an educational programme aiming to promote youth to experience and understand the Sky Islands ecosystem by organizing indoor and outdoor educational activities. This is accomplished by the collaboration with more than eight partners including universities, schools, volunteer organizations and the U.S.F.S. (Coronado National Forest, n.d.-b). The Forest Service also supervises the Forest Service Youth Conservation Corps (YCC), a summer youth employment programme designed to develop an ethic of environmental stewardship and civil responsibility (Coronado National Forest, n.d.-e). In the Coronado National Forest, YCC crews are working on various projects including removing invasive plant and animal species, as well as installing food lockers and water troughs (Coronado National Forest, n.d.-a). In addition, the Coronado National Forest accepts volunteers to take part in the daily operations of the Forest Service. Volunteer efforts are much needed and appreciated because the Forest Service, like other federal land management agencies, has a declining budget. Furthermore, the Coronado National Forest is collaborating with a network of 35 Partner Volunteer Organizations that are active in its area (Coronado National Forest, n.d.-e).

1.18. Organ Pipe Cactus National Monument

Continent	America
Countries	United States
Crop (target CWR)	Pepper (*Capsicum annuum* var. *glabriusculum*

Organ Pipe Cactus National Monument (O.P.C.N.M.) is a U.S. National Monument and UNESCO biosphere reserve located in extreme southern Arizona that shares a border with the Mexican state of Sonora and covering an area of 133,925 ha (UNESCO, 2005). Its purpose is to preserve and provide for public enjoyment and scientific understanding of diverse Sonoran Desert natural resources, including the organ pipe cactus; multicultural connections and resources; and an expansive designated wilderness area. Historical and cultural resources, documenting 15,000 years of human presence in the managed area, are also of great significance (Organ Pipe National Park Service, 2016a).

Creation of the Network

The area where the O.P.C.N.M. is situated was important for the Hohokam and the subsequent Tohono O'odham and Hia Ced O'odham cultures at least from the 15th century. The U.S. government purchased the area from the Mexican government in 1853. Mining, ranching, as well as, legal and illegal border related activities played a very important role in the area before its establishment as a park (Organ Pipe National Park Service, 2018b). The area of 517 square miles was established in 1937, by Presidential proclamation, to preserve a pristine example of Sonoran Desert Habitat and was strongly opposed by local farmers and miners at the time (Organ Pipe National Park Service, 1996). In

1976, a year after the end of the ranching era of the park, O.P.C.N.M. was designated as a Biosphere Reserve by UNESCO and joined in a reserve programme (Organ Pipe National Park Service, 2016b). The following year, USA congress declared 95% of the monument as Wilderness.

Current situation

Today, O.P.C.N.M. offers a variety of recreational and educational activities and more than 200,000 visitors are attracted by its protected areas each year (Meierotto, 2019). The Biosphere Reserve designation has helped to attract scientists from around the world to O.P.C.N.M. to conduct a variety of studies for a better understanding of the Sonoran Desert and the impact of humans on the landscape (Organ Pipe National Park Service, 2016b). The planning and management efforts of the park are focused around five Fundamental Resources and Values (FRVs) in order to determine what is truly significant for the park (Organ Pipe National Park Service, 2016a):

- The Columnar Cacti, including the Organ Pipe Cactus.
- The areas designated as Wilderness.
- The historically and culturally significant Quitobaquito oasis.
- The Continuum of Human History in the area.
- The Science and Research value, concerning various scientific domains.

The O.P.C.N.M. remains under the management and authority of the United States National Park Service (N.P.S.), an agency of United States Department of the Interior, and receives funding by the Congress (Organ Pipe National Park Service, 1996). However, numerous federal, state and local environmental agencies (N.P.S., U.S. Fish and Wildlife Service, the Bureau of Land Management (B.L.M.) and the State of Arizona) manage many different tracts of protected land in the region (Meierotto, 2019). In addition, the N.P.S., the U.S. Customs and Border Protection and the U.S. Army Corps of Engineers have worked together to cooperatively manage environmental resources and border security (U.S. Customs and Border protection, 2019). O.P.C.N.M. intends to work closely with the surrounding land agencies and stakeholders, including the Tohono O'odham Nation, the B.L.M., Cabeza Prieta National Wildlife Refuge and local communities to further the ideas of the biosphere programme by promoting expanded research, education, tourism and recreational facilities (Organ Pipe National Park Service, 2016b).

O.P.C.N.M. is part of the International Sonoran Desert Alliance (ISDA) which includes citizens, native Americans, business leaders and organizations of the United States and Mexico (including the Alto Golfo de California Biosphere Reserve) which are concerned with the western Sonoran Desert. ISDA has developed several culturally and environmentally focused community based activities (UNESCO, 2005).

Additional funding for the accomplishment of O.P.C.N.M. projects is generated by fees and passes for visitors and donations, while stores operated by the Western National Parks Association (W.N.P.A.) sell books and gifts. W.N.P.A. is a non-profit cooperating association of the National Park Service, founded in 1938 to support the interpretive activities of the National Park Service. In addition to developing publications for parks, W.N.P.A. supports park research and helps fund programmes (Organ Pipe National Park Service, 2015). In addition, efforts to restore lands, adversely affected by

cross-border activities, are funded by the Department of Homeland Security (Organ Pipe National Park Service, 2018a).

Due to its geographical position, there are many geopolitical issues in this area. Illegal border crossings and activities, including drug smuggling, occur daily (Organ Pipe National Park Service, 2020b). In addition, the borders of U.S.A.–Mexico and the immigration topic are matters of controversy. The intention for border wall construction arises human and environmental themes (Greenwald *et al*., 2017; Provenzano *et al*., 2019). Researchers express the concern of threat for the conservation of flora and fauna, underlying the risk of destroying the habitat of threatened or endangered species (Greenwald *et al*., 2017). It was also shown that vehicle passes may cause significant disruption of vulnerable soils in the park (Webb *et al*., 2013).

Objectives and key actions to conserve CWR

The O.P.C.N.M. provides habitat for a highly diverse flora, containing approximately 90% of the Organ Pipe Cactus in the U.S., many other plant species and CWR (Organ Pipe National Park Service, 2008) . Besides the cacti, all trees and shrubs in the area are protected (Organ Pipe National Park Service, 2018c). There are also references of the native wild chilli peppers (*Capsicum annuum* L. var. *glabriusculum* (Dunal) (Felger *et al*., 2012; Heiser *et al*., 1975) and the protection of small populations of this species (Mulongoy & Gidda, 2008). However, while the wild chilli pepper is considered a CWR of modern *Capsicum annuum* L. cultivars and is culturally important to the Native People, no special activities for its preservation are mentioned in the Management Plan or the official web site of the O.P.C.N.M.

Therefore, general conservation actions are applied to all flora, regardless their status as CWR. These actions include: 1) Interagency Restoration of lands adversely affected by cross-border activities (Organ Pipe National Park Service, 2018a); 2) Ecological Monitoring of the Natural Resources of the O.P.C.N.M. (Ecological Monitoring Report, 1997 - 2005, 2006); 3) Applications of the laws and policies that guide the O.P.C.N.M management (Organ Pipe Cactus National Monument. Final General Management Plan, 1996). Park superintendents make park-specific regulations in order to protect environmental values, natural and cultural resources (Organ Pipe National Park Service, 2020a). In addition, permits are required for recreational or scientific activities that may disturb the natural environment in the park (F. B. Mathew *et al*., 2016; Organ Pipe National Park Service, 2020a)

Link to social initiatives

O.P.C.N.M. has strong ties with the people that live within its boundaries and takes into consideration the potential impacts its decisions may have on them. Therefore, during the preparation of the O.P.C.N.M. General Management Plan, neighbouring agencies and groups, including representatives from the Tohono O'odham and Hia-Ced O'odham attended consultations held in the park. Ethnographic interviews were held or site visits were made to the park to selected communities of the Tohono O'odham Nation. N.P.S. planning staff met with various O'odham individuals familiar with traditional land uses and other cultural practices pertinent to the management of cultural and natural resources in the monument (Organ Pipe National Park Service, 1996). Native Americans concerns focused on four topical areas: (1) The need for local hiring of qualified O'odham persons; (2) The mutual need to share information about cultural and natural resources; (3) The need for access to the

park for traditional purposes, including plant gathering, meditation, and religious worship, without an entry fee; (4) The desire for the N.P.S. to consult with the relevant Hia-Ced O'odham and Tohono O'odham groups about finds of archaeological sites or human remains, management plans, and future interpretive exhibits. These concerns were either addressed in the General Management Plan or in on-going park programmes. As far as future planning is concerned, alternative scenarios were developed considering possible changes in operation of the park and their potential environmental and socioeconomic impacts (Organ Pipe National Park Service, 1996).

In addition, O.P.C.N.M. offers volunteering opportunities, and every year over 100 volunteers contribute thousands of hours of service in various tasks and positions. Groups from organizations and companies volunteer for a few days, while individuals and couples may stay for months. The N.P.S. needs volunteers throughout the year to assist with all aspects of park management, while, the greater need for volunteer assistance is during late fall through early spring. Many of the volunteers work through the Student Conservation Association, a non-profit organization that provides more than three thousand volunteers per year for conservation projects (Organ Pipe National Park Service, 2018d).

2. Potential genetic reserve network

2.1. *Phaseolus* CWR *in situ* conservation in Costa Rica

Continent	America
Countries	Costa Rica
Crop (target CWR)	Bean (*Phaseolus* spp.)

Creation of the Network

The beginning of the collection of CWR of *Phaseolus* was in 1987 through the discovery of 5 species of wild beans. These actions were carried out by the Unit of Plant Genetic Resources of the International Center of Tropical Agriculture (CIAT) and the University of Costa Rica (UCR).

Since the 1990's, several external projects have worked on this topic: FAO, CROP TRUST, "Fitomejoramiento Participativo" or the Norwegian Development Fund.

Some of the populations of the CWR occur outside protected areas, in paths and roads, where human activity makes the risk of damaging these populations very high. These areas do not have any special protection that covers these populations (Villalobos *et al*., 2001).

Current situation

At the moment, no legal protection exists for this CWR. When populations occur inside a protected area, passive conservation is preserving them, while when they are located outside, they are totally unprotected. Any planning action consistent with sovereign rights on plant genetic resources should be aware of what exists and where these plant resources are located. However, the target groups for

this information is beyond the small circle of scientists and conservation agencies (Villalobos *et al*., 2001).

Two protected areas have been extensively studied for their CWR: "La Carpintera" and National Park "Chirripó", finding 6 out of the 14 populations currently known for one species and, for another species, 2 out of the 46 populations known (records supported by herbarium specimens in CR and USJ).

Objectives and key actions to conserve CWR

The location of some populations of the CWR are currently known: *P vulgaris, P. dumosus, P. coccineus, P. lunatus, P. acutifolius, P. hygrophilus, P talamancensis, P. costarricensis, P. albicarminus, P. angucianae, P. microcarpus, P leptostachyus, P oligospermus, P. tuerckhemii, and P. xanthotrichus.* There is not a specific plan to conserve them, however, they are conserved as an *ex situ* backup at gene bank of CIAT.

Link to social initiatives

Besides the work that is being done with the *Phaseolus* CWR, extensive work is being carried out in parallel with landraces (González-Torres *et al*., 2003).

To increase the general knowledge of these two conservation actions, they are presented together at different stages of education. Workshops are given to children in the area, highlighting the importance of biodiversity for humans. In addition, many efforts are made to involve local farmers in this conservation and offer them different types of training to conserve this biodiversity (Baudoin *et al*., 2009).

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2.2. *In situ* conservation of *Crocus cartwrightianus* in Cyclades and Crete islands

Continent	Europe
Countries	Greece
Target CWR	*Crocus cartwrightianus*

The main objective of this case/potential network is to ensure the protection of the endemic, rare plant *Crocus cartwrightianus* Herbert, a wild relative of the cultivated *Crocus sativus* L. (Heywood *et al*., 1995) found in southern Greece since ancient times.

Creation of the Network

The effort to establish the network began in early 2000's with the first contacts and discussions between researchers and local communities about the significance of *C. cartwrightianus* and the threat of decreasing populations. Subsequently, during the implementation of various research programmes regarding the conservation of *C. cartwrightianus*, several collaborations were

established. From 2003-2008, in the framework of the Operational Programme for the Agricultural Development and Reform of the Countryside, a project was implemented by the Greek Genebank of the Hellenic Agricultural Organization-DEMETER (former NAGREF) for the collection, evaluation and conservation of plant genetic resources, and a pilot study was conducted for the *in situ* conservation of *C. cartwrightianus* on Thera island (Stavropoulos *et al*., 2008). Later, during 2009-2015, the Hellenic Agricultural Organization-DEMETER (Institute of Plant Breeding and Genetic Resources) in collaboration with the Aristotle University of Thessaloniki (School of Agriculture), the Region of Southern Aegean (former Cyclades Prefecture) and the Union of Santorini Cooperatives-Santo Wines developed a national programme. The aim of the programme was the enhancement of the agronomic value , the on farm or *in situ* conservation, and the evaluation and utilization of a number of landraces and CWR of Santorini (Thera island) (Traka-Mavrona *et al*., 2015), including *C. cartwrightianus*. During the aforementioned projects field surveys were carried out in the complex of the Cyclades islands (particularly Thera, Anafi and the uninhabited Christiana) and Crete to support the *in situ* conservation actions of *C. cartwrightianus*.

Current situation

At the moment, the only efforts made are focused on the passive conservation of flora, especially on Christiana island, and no additional *in situ* conservation actions take place in the other areas. However, during the years 2003-2015 several conservation actions aiming to conserve *C. cartwrightianus* were taken. From 2003-2008 the conservation actions were co-funded by the EU and the Hellenic Ministry of Rural Development and Food *via* the project for the collection, evaluation and conservation of plant genetic resources (Stavropoulos *et al*., 2008). From 2009-2015 public funding was received by the Region of Southern Aegean (former Cyclades Prefecture) *via* the project for the enhancement of the agronomic value of Santorini's landraces and CWR (Traka-Mavrona *et al*., 2015).

The partners that implemented the research activities were the School of Agriculture of the Aristotle University of Thessaloniki (one of the main Agriculture Schools in Greece, https://www.auth.gr/en/agro) and the Institute of Plant Breeding and Genetic Resources (IPGRB) of the Hellenic Agricultural Organization-DEMETER (an organization which consists of four different directorates, involved in various agricultural sector activities, https://www.elgo.gr/). The research activities of IPGRB are mainly focused on conservation, characterization, evaluation, exploitation and utilization of plant genetic resources and on improvement and promotion of new varieties advanced in yield, quality and effectiveness to cultivation. Moreover, research is carried out aiming at the development of modern crop protection systems and sustainable agriculture.

These partners developed the conservation plan, conducted the field surveys, collected the genetic material, analyzed the phylogenetic and molecular data and are responsible for *ex situ* conservation. The other partner was the Union of Santorini Cooperatives-Santo Wines (https://santowines.gr/en/) which was founded on Thera island in 1947. The Union is the largest organization of the island, representing all the local farmers with 1,200 active members. Santo Wines is committed to safeguarding traditional local cultivation, producing highest quality Protected Designation of Origin (PDO) Santorini wines and products, as well as promoting sustainable agricultural development. The Union contributed to the recommendation of areas with *Crocus* populations, the field surveys and the collection of genetic material.

Objectives and key actions to conserve CWR

C. cartwrightianus is a rare endemic species and a wild relative of cultivated *C. sativus* L. (Heywood *et al*., 1995) found in southern Greece. Asia Minor or the south-western Greek Aegean islands were suggested as probable areas of origin of the genus *Crocus* (Tammaro, 1990), while *C. sativus* was probably selected and domesticated in Crete during the Late Bronze Age (Negbi, 1999). The dried stigmas of *Crocus* have been used in the making of perfume, paint and medicine since prehistoric times as demonstrated by wall paintings found on the island of Thera (Sarpaki, 2000), and Cretan angiography and scripts. Flowering, morphological similarities and scientific studies suggest that *C. cartwrightianus* is an ancestor of *C. sativus* (Caiola *et al*., 2004; B. Mathew, 1999). *C. cartwrightianus* shares many common characteristics with the cultivated species and has similar uses, as a wild type of saffron (Ralli, 2015; Traka-Mavrona *et al*., 2015). The area of distribution of *C. cartwrightianus* is relatively small, centered in the Cyclades islands and reaching south Euboea, Attica, and western Crete (B. Mathew, 1999). Therefore, it has a great scientific interest and represents a valuable genetic resource.

C. cartwrightianus is threatened with extinction in its natural environments due to habitat destruction, agricultural intensification, over-exploitation, urban development, climate change and lack of conservation attention. The decrease of populations and subsequent loss of genetic diversity are mainly attributed to human activities and to a lesser degree to climatic and environmental changes. Therefore, the application of *in situ* conservation actions in the natural ecosystems of *C. cartwrightianus* is considered necessary (Ralli *et al*., 2012).

The main objective of the actions taken for the *in situ* conservation of *C. cartwrightianus* was the protection, management and monitoring of the selected populations in the Cyclades and Crete islands in their natural habitats, so that natural evolutionary processes can be maintained. This allows for new variation to be generated in the gene pool, so the species can adapt to gradual changes in environmental conditions (Heywood *et al*., 2005). Field surveys involved the location, designation and study of the distribution of *C. cartwrightianus* in particular regions and ecosystems, and the estimation of the demographic parameters of the studied populations. Moreover, the actions included the collection of field observations (associated flora, topographic and climatic data), morphological and phenotypic characterization and the management and monitoring of the target species, in order to estimate the species' threat status and help maintain the initial levels of genetic diversity in the target populations. *C. cartwrightianusis* propagates vegetatively with corms, which is the main reproductive system, although capsules with seeds are produced in autumn (Ralli, 2015). So, corms and seeds of *C. cartwrightianus* were collected for complementary *ex situ* conservation and plant tissues were also collected for molecular analysis.

During the exploratory expeditions, five populations of *C. cartwrightianus* were found and studied in the Taksiarchis and Gavrilos areas (Thera island), Anafi island, Christiana island and the Akrotiri area (Chania, Crete island). Most of the sites were recommended by the local people and selected because they have *C. cartwrightianus* populations that were deemed to merit protection before substantial losses occurred, as proposed for the conservation of CWR (Meilleur *et al*., 2004). The *C. cartwrightianus* populations found in Taksiarchis, Gavrilos and Akrotiri have experienced a rapid decrease in size in recent years, according to inhabitants, whereas the population found in Anafi has

suffered a slower reduction. The studied populations on Thera and Anafi are particularly threatened by over-exploitation, as some careless saffron collectors take the whole plants instead of only the stigmas. On the other hand, the population on Crete suffers from habitat destruction due to urban development and extensive building construction, especially in the touristic areas of Crete.

Among the studied areas Christiana is the only site located within the Natura 2000 Network of protected areas. Because all the other sites where the target species populations were found are not protected by any special nature protection system, significant new local initiatives should be undertaken to protect a sufficient amount of the area in which they occur, so as to allow the representation of viable populations that cover a sufficient sample of the genetic variation. Otherwise, alternative means of protection should be considered, including community participation, easements or habitat conservation planning (Heywood, 2005) or a representative number of legally defined, smaller areas for micro-reserves. As almost all areas where *C. cartwrightianus* populations were found are private properties, it is important to find ways to collaborate with landowners to promote *in situ* conservation to ensure the viability of these populations and protect them from the dangers of competitive development.

The proposed plan for the monitoring and management of *C. cartwrightianus* populations that were found in the Greek islands involves: i) The detailed mapping of *C. cartwrightianus* populations in the studied areas, as well as in other areas of Greece. ii) The regular monitoring and recording of demographic parameters of the populationsand periodical observations and measurements of the ecological environment. iii) Conservation actions in populations that are at risk in specific habitats (funding landowners to protect the populations, creation of an information Centre to promote public awareness of the importance of *C. cartwrightianus* and other CWR, environmental education, etc.). iv) Complementing *in situ* conservation with *ex situ* measures by the sampling and safe maintenance of corms in field gene banks. This genetic material could be used for additional planting to support the populations that are at risk in the specific areas or in nearby publicly or privately owned lands. v) Phenotypic characterization, agronomic evaluation and genetic study of identified populations. vi) Development of a database with all the relevant information.

Corms and seeds of *C. cartwrightianus* accessions are also conserved *ex situ* in a field and in a seed collection, respectively, at the Greek Gene Bank of the IPBGR of the Hellenic Agricultural Organization-DEMETER in Thermi-Thessaloniki to complement *in situ* conservation.

Link to social initiatives

Local people feel that the landraces and the autochthonous species of the area are part of their cultural heritage. Most of them are aware of the on farm and *in situ* conservation issues and keep cultivating and taking special care of the local landraces and CWR. Moreover, the willingness of the local communities (authorities, researchers, farmers) to help implement the above-mentioned projects was significant. However, local and foreign people collect *C. cartwrightianus* as a wild type of saffron either for their own consumption as food or medicine or for its commercialization as local product, ignoring the threat for the loss of the population (Ralli, 2015; Traka-Mavrona *et al*., 2015). Therefore, the public needs to be informed about the dangers of over-exploitation and habitat destruction and made aware of the importance of the species and CWR conservation in general. Local people could also be trained to help with the monitoring and the management of the areas. In

previous years, in the framework of AGRI2012 and Saffronomics Conferences, presentations were given to raise awareness in the public and in scientific society of the importance of *C. cartwrightianus* (Ralli *et al*., 2012; Ralli *et al*., 2013).

In this sense, collaboration with local authorities and organizations will help. Apart from local interest, it is important to ensure: 1) The development of specific legislation for CWR conservation. 2) The establishment of agencies to manage and fund CWR conservation at the national level. 3) The establishment of genetic reserves. Direct measures should be taken to promote *in situ* conservation, aiming to protect, manage and maintain the selected populations of *C. cartwrightianus* in their natural habitats.

2.3. Protecting *Brassica macrocarpa* Guss. (a *Brassica oleracea* L. WR) in Favignana (Egadi Island, Sicily, Italy)

Continent	Europe
Countries	Italy
Crop (target CWR)	Brassica (*Brassica macrocarpa*)

Creation of the network

Within the NATURA 2000 framework, the SCI 'ISOLA DI FAVIGNANA' was proposed in 1995, and subsequently designated as SAC (Special Area of Conservation) in 2015, in order to protect many habitats and animal and plant species (often endemic). Among the latter, *Allium aethusanum* Garbari, *Crocus longiflorus* Raf., *Daucus siculus* Tineo and *Brassica macrocarpa* Guss. are wild relatives of important crops. In particular, *B. macrocarpa* is an important wild relative of *Brassica oleracea* L. (e.g. broccoli, cauliflower, etc.) which could provide genetic traits for the agronomical and technological improvement of their production. In addition, it is considered a WR of other species belonging to the Brassica genus, such as *B. rapa* L. and *B. napus L.*, both widely used worldwide as crops. According to the IUCN Red List, *B. macrocarpa*is classified as "CR" (critically endangered), especially for the noteworthy geographical isolation of its subpopulations. The genus Brassica has also been recognized in Annex I of The International Treaty on Plant Genetic Resources for Food and Agriculture, and *B. macrocarpa* is listed as priority species in Annex II of the EU Directive 92/43 (F. Branca *et al*., 2012).

As a SAC, the above-mentioned SAC area is covered by 'passive conservation', but several human activities endanger *B. macrocarpa*. On Favignana island the species is endangered by a) recent reforestation with alloctone pine which has substituted the maquies association to which *B. macrocarpa* belongs (changing the soil characteristics and shadowing the association), b) animal grazing which contributes to reducing the number of plants and new recruitments to the populations each year, c) an increase in disturbance activities connected with summer tourism.

Current situation of the *in situ* network

Conservation activities are still going on under the aegis of the Natura 2000 network, under the control and support of Regione Siciliana (Assessorato Territorio e Ambiente Servizio 4°) that, for the Italian legislative frame, is the Authority in charge. Although an actual management plan exists for the entire area of the Egadi (Piano di Gestione Isole Egadi decreto n. 434 del 08/08/2012), its prescriptions are

quite generic and do not include any 'active' protection of *B. macrocarpa* (and other protected species), not even population census monitoring.

Two 'LIFE' projects were submitted to the EC with the specific aims of constituting a genetic reserve and supporting local associations in nature conservation and restoration, promoting consciousness of agro-biodiversity value and ecotourism in the area. However, these projects were unfortunately not funded.

Objectives and key actions to conserve CWR

Propagation material of *B. macrocarpa* is stored at the genebank of University of Catania (It), Department of Agricoltura, Alimentazione e Ambiente, which can be used as an *ex situ* backup.

2.4. The Bey Mountains Coast National Park

Continent	Asia
Countries	Turkey
Crop (target CWR)	Oat (*Avena barbata),* grass pea *(Lathyrus cicero),* faba bean *(Vicia cassia*and *Vicia eristaloides)*

While the average annual temperature is 18.2 ^{o}C in Antalya, the highest temperature was recorded as 45^{0}C and the lowest temperature was recorded as -4.0 ^{0}C. Total annual precipitation is quite high with 1132.9 mm and it is located in the "sub-humid" climatic zone. "Mediterranean climate" prevails in the region and also "Mediterranean High-Mountain Climate" is observed in high areas. This climate is distinguished from the other high mountain climates with its apparent summer drought and from the Mediterranean Climate with its 4-5 months of snow cover. 9.2 % of the National Park is forest. Tahtalı Mountain, one of the unique mountain ranges in the western Taurus, is the highest mountain rising from the coast in the Mediterranean with 2366 m. Tahtalı Mountain is an exceptional area not only for its floristic diversity but also for its geomorphological and hydrogeological properties. Numerous dolines (karstic pits) on the mountain slopes provide drinking water for many settlement areas in the region.

The current area of the national park is 31165.88 hectares. A total of 24 grade I, II and III Archeological and Natural Sites as well as some historic sites are found within the boundaries of the park.

The Bey Mountains Coast National Park is intensively used for touristic and recreational activities, and areas far from human influence are very limited. 1.2 % of the National Park area can be used for tourism purposes and 0.2% for excursions. The tourism and recreational activities in the National Park are intertwined and therefore, it is very difficult to determine the number of visitors**.** It is estimated that about 8,800,000 people benefit from the area per year (Koptu, 2019).

Creation of the Network

Bey Mountains Coast National Park was declared a National Park in 1972 by the Council of Ministers on account of its natural, historical and cultural significance. The area of the national park is 31165.9 hectares.

Current situation

Bey Mountains national park has been preserved as a national park since 1972. The protection and management of protected areas are completely under the responsibility of the state. Basically, the Ministry of Environment and Urbanization and the Ministry of Agriculture and Forestry are responsible for the conservation of protected areas (Anonymus, 2018). Some of these tasks are the maintenance, conservation and proper development of our natural resources and their transfer to future generations. The funding required for the management of the national park is provided from public sources by the state. In addition, there are sustainable sources of finance. In accordance with planning and management conditions, an entrance fee is obtained from the fields, facilities and similar places operated by the administration, and fees are collected from benefiting from rental, accommodation, infrastructure or other facilities.

Objectives and key actions to conserve CWR

The plant genetic resources in Turkey are managed by the Ministry of Agriculture and Forestry. The General Directorate for Natural Assets Protection within the Ministry of Agriculture and Forestry is responsible for establishing and managing the majority of Turkey's various categories of protected areas and has a nationwide network of field-based staff. The Bey Mountains Coast National Park lands is under public management.

The management plan for *in situ* conservation in the Bey Mountains Coast National Park aims to reduce pressures and threats on biodiversity and ecosystems, develop species specific and ecosystem-based conservation approaches and maintain healthy ecosystems. The Bey Mountains Coast National Park presents a high degree of naturalness, legally protected to ensure the conservation of rare, endemic or threatened plant species. However, an in-depth analysis of their effectiveness regarding plant conservation is lacking. All CWR species are passively protected.

CWR species such as *Avena barbata*, *Lathyrus cicero* or *Vicia cassia* are found in forest ecosystems at high altitudes. The Bey Mountains Coast National Park contains the rare endemic relative of the landraces (Mulongoy & Gidda, 2008). One of these examples is *Vicia eristaloides*. CWR species are poorly represented in Turkish genebanks and some CWR species still need to be collected.

Link to social initiatives

The priority species of Bey Mountain National Park are used by forest villagers, rural people. Damage to nature caused by human activities is a worldwide problem that has steadily increased in Turkey in recent years. Therefore, Turkey had to take preventive measures for protecting the diversity of natural habitats, as well as against the loss of biodiversity in their regions.

In Turkey, civil society organizations are key actors in encouraging and expressing the demands of local people. The studies of non-governmental organizations do not directly deal with the conservation of plant genetic diversity. However, many national or local organizations are involved in the conservation and restoration of the environment. These organizations make a significant contribution to public awareness of the protection of biological diversity and the natural environment.

3. People and institutions network

3.1 The Nordic Crop Wild Relative network

Continent	Europe
Countries	Denmark, Finland, Iceland, Norway, Sweden
Target CWR	Prioritized Nordic CWR

The goals of the Nordic CWR network are to facilitate cooperation among the Nordic countries within the field of CWR conservation, facilitate the national conservation processes as well as knowledge exchange, communication and scientific studies relevant to conduct on a Nordic rather than national level. In many ways, the work on CWR conservation will be more efficient by cooperation, although *in situ* conservation will always be implemented at the national level. The network has been aided by the existence of a structure for Nordic cooperation, Nordic funding sources and a long-standing cooperation regarding *ex situ* conservation of plant genetic resources. The network has a broad focus regarding species and has developed a CWR priority list with 115 taxa, which were selected based on their socio-economic value and use potential.

Creation of the Network

The process to establish a Nordic CWR network was started in 2014 by NordGen, the Nordic Genetic Resource Centre, by initiating a project application on CWR conservation. Funding from the Nordic Council of Ministers was received for a project implemented from 2015-2016, and a second project implemented from 2017-2019 (Palmé *et al*., 2019b). These projects represent the first joint action at the Nordic level regarding *in situ* conservation of CWR. The goals of the projects included not only the establishment of a Nordic CWR network but also Nordic level conservation planning, the development of policy recommendations, the exchange of knowledge and communication. The network was established through cooperation on joint tasks, stakeholder workshops, meetings and communicating via websites and e-mails.

During the course of the project, a core network was created including partners from all Nordic countries, representing PGR conservation, relevant agricultural governmental agencies, research institutions and botanical gardens. Additional stakeholders were invited to take part in meetings and workshops and targeted in different communication activities, most importantly nature conservation stakeholders involved in policy, research and implementation.

Current situation

During the two Nordic CWR projects, substantial progress was made regarding CWR conservation planning, including the development of a Nordic CWR checklist, a priority list and identification of suitable sites for CWR conservation. The checklist includes more than 2,700 wild taxa related to medicinal, ornamental, forestry, food or forage crops (Fitzgerald *et al*., 2017) and can be used as an input for creating national checklists. Only food and forage CWR were included in the priority list and, among these, prioritization was based on the socioeconomic value of the crop the CWR is related to and its potential utilization value for plant breeding. This resulted in a priority list with 115 taxa (Figure 11, Fitzgerald *et al.* 2017). A gap analysis was conducted based on the priority list, and conservation

areas suitable for genetic reserves were identified in all Nordic countries. The next step will be to further investigate which of the identified sites are suitable for *in situ* CWR conservation, but this work has so far not been initiated.

As part of the Nordic CWR projects, a policy brief was developed (Palmé, *et al*., 2019a) with feedback from a wide range of stakeholders. The brief contains eight recommendations considered to be the most urgent steps towards assuring the conservation of the Nordic CWR, and efforts were made to inform the relevant Nordic stakeholders about these. Policymakers were not the only group targeted and other communication took place via a Nordic CWR website established during the project (www.nordgen.org/CWR), monthly plant portraits published at the Nordic CWR pages, social media, national publications, scientific publications and presentations at conferences.

The Nordic Network lacked funding from the middle of 2019, when the project supported by the Nordic Council of Ministers ended, until February 2020. Despite this, an informal network remained, and activities to acquire funding for future activities continued. New funding from the Nordic Joint Committee for Agricultural and Food Research (NKJ) has now been obtained and a new project was initiated in March 2020. Focus will be on networking activities, communication and acquiring funding for additional tasks.

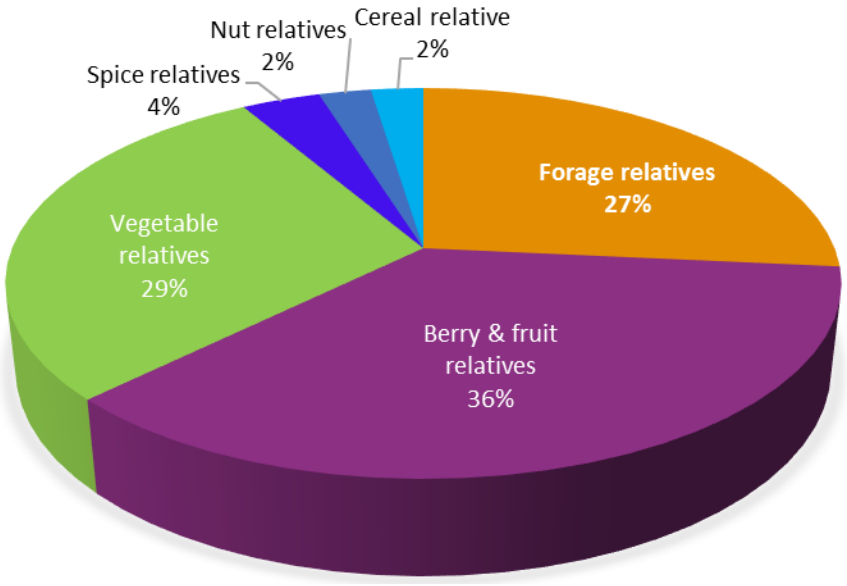

Figure 11. The proportion of crop wild relatives in the Nordic priority list that are associated with each crop group.

Figure reproduced from TemaNord 2019:533, Palmé *et al.* 2019b.

Objectives and key actions to conserve CWR

The long-term aim of the network is to assure the conservation of Nordic CWR and to facilitate the sustainable use of these resources. The specific goals have so far been:

- Cooperation and the exchange of knowledge within the field of CWR
- Joint Nordic conservation planning to make the conservation in the region more efficient
- Communication to increase knowledge about CWR and their importance for food security and climate change adaptation, including policy recommendations

Currently, there are no officially recognized genetic reserves in the Nordic countries. In Faerder National Park in Norway a process has been initiated to establish a genetic reserve and populations of 52 CWR species have been included in the management plan. However, the process has been halted due to uncertainties regarding funding for monitoring and conservation activities and disagreement on how access should be provided. In Finland and Sweden national projects on *in situ* CWR conservation have been carried out in parallel with the Nordic projects, including for example national planning and stakeholder discussions. In Finland, a pilot genetic reserve site, Nuuksio National Park, was inventoried in 2019. Suitability of the site for CWR conservation was investigated during the national project.

CWR are specifically mentioned in Nordic national strategies governing the work on genetic resources. For example, the Danish PGRFA strategy for 2017 – 2020 has a chapter on CWR and includes goals on monitoring and *in situ* conservation of threatened CWR, and the strategy of the Swedish national programme for 2021–2025 includes active *in situ* conservation as one of the goals, aiming for at least three genetic reserves by the end of the time period (Weibull, 2019). The Norwegian PGRFA strategy also mentions CWR and aims to inventory and conserve CWRs. In Finland, the CWR strategy report from 2014 defined the basis for CWR conservation needs, and the recently renewed Finnish National Genetic Resources Programme for Agriculture, Forestry and Fishery addresses and includes organization of conservation of CWR species (Pehu *et al*., 2020).

Even if there is no active *in situ* conservation of CWR in the Nordic countries yet, some CWR are conserved *ex situ*. NordGen is responsible for the conservation of seed propagated PGRFA (Plant Genetic Resources for Food and Agriculture) for all the Nordic countries, and the conservation of CWR is included in NordGen's mandate. About 21% of the seed collection is classified as wild or semi-wild, and of these, over 6000 accessions are accepted for long-term conservation and about 960 for short-term conservation. In addition to NordGen, there are gene banks for threatened species in Finland and Norway. As some CWR are threatened, they can also be conserved in these genebanks. However, the majority of the 115 priority CWR are not well represented in *ex situ* collections. A few species have large *ex situ* collections with more than 50 accessions, and they are generally of the same species as the commercially important cultivated crop. In this group the majority is forage CWR, but also a few vegetable CWR are included. Additional seed collection is needed if the *ex situ* collection is to include a representative sample of all the priority species. However, it is important to coordinate *in situ* and *ex situ* conservation, and if *in situ* conservation is adequately implemented, *ex situ* conservation would only be needed as a back-up and to facilitate use.

Link to social initiatives

Some of the communication within the Nordic project was aimed at the interested general public, for example the Nordic CWR website, plant portraits and social media communication. Attempts to engage the public interested in botany was also made via iNaturalist, a citizen science initiative for the collection of occurrence data. The aim was both to increase awareness of CWR and to improve the information on the geographical distribution of the CWR.

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4. Networks associated to projects

4.1. *In situ* conservation of Andean crops and their wild relatives in Humahuaca Valley

Continent	America
Countries	Argentina
Crop (target CWR)	Potatoes (*Solanum* spp.), oca (*Oxalis* spp.), cañahua (*Chenopodium* spp.), ataco (*Amaranthus* spp.), and peppers (*Capsicum* spp.)

Creation of the network

The project began in the Humahuaca Valley of Argentina in November 2005. The implementing agency of the project was the UNDP, the NGO FUCEMA was the executing agency and the private sector (local producers) was involved as project partner. While the expected finish date of the project was 2010, the actual date of completion was December 2009 (Watts, 2016).

Current situation

The project is currently abandoned. It ended in the year 2009, 4 years after implementation. However, the Municipal Government of Jujuy is continuing parts of the project through supporting three Andean crop programmes, the continuation of seed exchange fairs and the designation of two sites for conserving agro-biodiversity. Mixed municipalities and community forums were established in the three areas Volcan, Humahuaca and Saspala. Furthermore, a schoolbook of Andean crops was made to support the use of local crops in meals and was delivered to 25 schools. All of these activities can ensure the continuation of part of the project. The Terminal Evaluation Review of the project, published a couple of years after the finish date, rated the sustainability of the project as highly likely to likely since no major threats to the project outcomes were observed and since some of the activities had been institutionalized in the project areas. With regard to funding, permanent funding should still be pursued, but some financial resources have already been mobilized for certain project activities, and a willingness exists among local actors to support activities, as shown by their co-funding contribution to the project. Furthermore, participating farmers showed increased profits, since the price of yacon and potatoes increased by 75% and 76%, respectively (Watts, 2016).

The project received financial support mainly by the GEF project grant. Co-financing endorsements came from the government, other multi-/bi-laterals and NGOs/CSOs. Eventually, upon completion of the project, 0.95 million dollars came from GEF funding (this includes the project preparation grant) and 1.06 million dollars from co-financing for a total of 2.01 million dollars.

As mentioned earlier, the implementing agency was the UNDP and the executing agency the NGO FUCEMA. Project activities were carried out in cooperation with a multitude of actors such as farmers and schools.

Objectives and key actions to conserve CWR

The main objective of the project was “the long-term *in situ* conservation and continued evolution of globally significant agrobiodiversity in the productive landscape of the southernmost extension of the Central Andes.” This was done by adopting an on-farm approach in which indigenous farmers, through

measures based on traditional practices, would adopt improved on-farm conservation practices and management. The project aimed to work with 5 intervention areas which included 15 rural communities and 1030 families and thereby "target the conservation of 21 species and 164 varieties of tubers, pseudocereals, cereals, legumes and fruits, and at least 21 wild relative species".

Twenty-one species and 164 varieties from 13 genera and 21 wild relatives are found in the valleys. Among these are fruits and vegetables such as cayote, squash, pumpkin (*Cucurbita spp*) and peppers (*Capsicum spp*), legumes such as beans (*Phaseolus spp*), cereals such as corn (*Zea spp*), pseudocereals such as quinoa (*Chenopodium sp.*) and tubers such as potatoes *(Solanum spp*), Oca (*Oxalis spp*). In the project document, 36 species are mentioned as target species, among which are 16 wild relatives - 2 different types of peppers, 2 pseudocereals species, one variety of oca and 11 potato species (GEF, 2015).

The activities mainly considered combined action for crop varieties and crop wild relatives. With regard to CWR specifically, the project mainly seemed to aim to strengthen the enabling environment for the conservation of the wild relatives. This was done by providing better information on native crops and their CWR through, for example, inventories and surveys then disseminating this knowledge within farmer communities, through raising awareness on the importance of CWR, mainstreaming conservation of agrobiodiversity and through strengthening the protection of these species.

During the preparation of the project, stakeholder consultations were held to identify the most prominent threats to agro-biodiversity. The change in agricultural production systems with new and non-traditional crops was identified as the most significant. This goes hand-in-hand with the declining consumption of traditional crop varieties. Furthermore, the loss of traditional knowledge is also a critical factor in threatening agrobiodiversity (GEF, 2015).

In terms of development, the objective was to mainstream the conservation of agrobiodiversity into the practices of small-scale indigenous farmers in the Humahuaca valley (covering 170,000 ha) and to improve the conservation and sustainable management of the varieties of traditional crops on 1300 ha.

Three outcomes of the project were expected (Watts, 2016):

1) "Communities, indigenous farmers and local authorities have increased information on native crop varieties and wild relatives and on traditional knowledge and practices relevant to their cultivation, processing and improvement."

   Output 1: inventories of native varieties, landraces and the CWR of the target crops are completed for the core areas of the project, and conservation- oriented farmers and priority agrobiodiversity conservation zones for native species and CWR are identified.

   Output 2: documentation and dissemination of traditional knowledge and practices around the target crop varieties within local farmer communities.

2) "Indigenous farmers are motivated to participate in production of traditional crop varieties through improved production factors and supportive market structures."

   Output 1: production of targeted native crop varieties and their wild relatives on farms is enhanced in the core areas.

Output 2: processing, distribution and marketing of the target crop's native varieties and landraces is strengthened for indigenous farmers and local communities.

3) "A strengthened enabling environment exists for the conservation of traditional crop varieties and their wild relatives in the Humahuaca Valley."

Output 1: the creation of a programme to raise awareness in certain sectors of the Argentine public of the potential use and importance of traditional varieties of Andean crops.

Output 2: the mainstreaming of the conservation and sustainable use of these crops and their CWR into local policy, legal and regulatory frameworks, and sharing experience at the national level.

Regarding objective 1, by the end of the project at least 30% of the farmers in the project area received formal training through workshops. Also, 450 women participated in a programme of cooking fairs, and years later the programme had over 3000 participants.

Regarding objective 2, the following results were achieved: 70% of conservation-oriented farmers participated, prices of products are rising (yacon by 75 %, local potato varieties by 76%). The number of farmers working in the project area cultivating local varieties has increased by 10%. Furthermore, the seed exchange fairs organized by the project were attended by a large number of farmers and continued after the project finished.

The strengthened enabling environment aimed for under objective 3 was reached through a communication strategy that included local radio stations, tv channels and the newspaper. 50% of farmers from the targeted communities participated in awareness raising programmes on the importance of CWR.

Objective 3 also mentioned that the project will aim to establish priority agrobiodiversity conservation zones to strengthen the *in situ* protection of wild relatives. Furthermore, formal recognition under the State Law of Protected Landscapes will lead to stricter protection. The project will work with local municipalities to strictly apply the laws and thereby support this stronger protection.

The project focuses on *in situ* conservation. There seems to be no mention of an *ex situ* back-up through the project. However, the National Institute for Agronomic Research (INTA) conducted surveys in the area to collect cultivated crops and wild relatives for their network of gene banks.

Link to social initiatives

The project focused on 15 rural communities, in which 1030 families lived. Indigenous farmers and local communities were mainly involved in the project and represented the main stakeholders. Several events took place to further involve civil society. For example, in the preparation phase, workshops were held to identify the current issues, threats and the target crops and several consultations were organized. In the implementation of the project, local farmers played a role in the field-activities such as the recovery and dissemination of traditional knowledge, seed production, and developing micro-businesses to sell traditional crops and their products. Women were also important and actively involved in most of the activities.

Teachers were mentioned as important stakeholders in the implementation of school-related activities. By growing traditional crops in gardens and preparing meals with them, they provide a model for children's feeding habitats and promote the future of traditional crops in agriculture.

Other stakeholders are small businesses that trade Andean crops and their products, grassroots associations, NGOs, scientific institutions, schools, churches, media, local, provincial and national governmental agencies, and private sector enterprises in the field of Andean crop trade and use.

4.2. *In situ* Conservation of Crop Wild Relatives through the Enhance Information Management and Field Application

Continent	Asia
Countries	Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan
Crop (target CWR)	521 CWR prioritized

The project was implemented in Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan to conserve CWR under *in situ* conditions. Eco-geographic survey of crop wild relatives was conducted in protected and non-protected areas and eco- geographic descriptors were prepared. There were many activities involved during project period. The main activities were geographic surveys, list of important morphological characteristics and herbarium specimen of important taxa which have difficulties in identification, collected ethno-botanical notes about priority crop wild relatives, prediction maps and distribution maps using data of latitude and longitudes and geographic, ecological, taxonomic and conservation note for eco-geographic description (UNEP, 2010).

Creation of the Network

Bioversity International was the organization responsible of the project, which began in March 2004 and ended in April 2010 (UNEP, 2010).

Current situation

UNEP/GEF funded the six-year length project. It involved the Ministry of Nature Protection, Yerevan, Armenia; General Directorate on Biodiversity, Vice Ministry of Environment, Natural Resources and Biodiversity, La Paz, Bolivia; Ministry of Scientific Research, Antananarivo, Madagascar; Ministry of Agriculture, Colombo, Sri Lanka; State Committee on Science and Technology, Tashkent, Uzbekistan. These organizations would be the organisms on charge of its continuation. Since the project ended, there is no information available about it (Brandolini, 2013).

Objectives and operation of key actions to conserve CWR

A total of 521 CWR were prioritized across the five countries with Armenia (104), Bolivia (195), Madagascar (119), Sri Lanka (33) and Uzbekistan (70). CWR conservation, monitoring and use activities were undertaken at a pilot scale in the project countries with positive results. The project was very active in CWR exploration and research. *In situ* conservation and use received comparatively attention (UNEP, 2010).

The activities led to the enhancement of the local professional skills for CWR *in situ* conservation and study and the establishment of a significant global body of knowledge on CWR conservation which did not exist at project outset. Furthermore, the project did develop multidisciplinary approaches promoting the integration of CWR in development strategies, environmental tourism and agricultural research. Partner countries realized the potential and enhanced their capacities of *in situ* conservation of CWR in protected areas. Some local partners used the information generated by the project in pre-breeding and breeding programmes. The project adopted a global multi-country approach, in alternative to a regional one, consistent with the geographical dimension of crops domestication centres. Knowledge generated by the project is expected to catalyse regional approaches. The Project developed a hard copy CWR Manual and e-learning modules, through the collaboration of its partners, available in English, French and Spanish as well as in the Russian. This information constitutes a valuable asset for linking conservation, study and use of CWR and serving as a guide to other countries and CWR projects.

Linking with social initiatives

The project positively enhanced, networked and tested local collaborations in conservation and study of CWR. It filled knowledge and skills gaps in professional and local organizations and assisted them in addressing such shortages in a multidisciplinary way. The benefits of project outputs are ongoing. Lessons learnt triggered new studies on CWR and agro-biodiversity that have become a part of the national conservation and research strategy for food security in the partner countries.

The five countries were able to improve the conservation and sustainable utilization of crop wild relatives, maximising the use of existing information and conservation resources to protect CWR species occurring within their borders. This was achieved by establishing effective partnerships among relevant national agencies and individuals, as well as adding to the information base by carrying out original research on the distribution and uses of and threats to CWR populations. The project also delivered improved *in situ* conservation of agricultural biodiversity through innovative and improved policies and practice, as well as awareness programmes undertaken to increase the involvement of country decision-makers and the public in actively conserving crop wild relatives. Internationally, an information platform was created, the CWR Global Portal, bringing together previously fragmented information on CWR held by different institutions, along with a "Manual for *in situ* CWR conservation" based on the project's experiences and lessons learned. It is expected that the manual and the portal will both be instrumental in sustaining and scaling-up *in situ* conservation activities worldwide.

Assessments and conservation actions on the distribution of native crop wild relative species were carried out by all countries, and the uses and threats they face documented. As a result, species management and monitoring plans have been developed in all countries for priority crop wild relatives. Countries have also engaged in raising awareness on benefit-sharing related to CWR with all levels of stakeholders, contributing to a greater appreciation and understanding of the direct importance of wild relatives to local and national productive sectors and economy.

4.3. Saving our Species programme

Continent	Oceania
Countries	Australia
Crop (target CWR)	Macadamia nut (*Macadamia integrifolia*), finger lime (*Citrus australasica*), among other 11 CWR.

Creation of the Network

A few CWRs are conserved under the *Saving our Species* (SoS) programme in Australia. This is a statewide programme created by the Office of Environment and Heritage of the New South Wales (NSW) Government in March 2015 that officially commenced on the 1st July 2016. It is the largest Australia conservation programme (*NSW Government. Saving our Species programme*, 2019a). The programme's current legislative basis is the NSW Biodiversity Conservation Act 2016 (*NSW Government. Saving our Species programme*, 2019a).

Current situation

In March 2015 the NSW Government pledged $100 million over 5 years to protect the State's threatened species, commencing on the 1st July 2016 and ending in 2021 (*NSW Government. Saving our Species programme*, 2019a). It is not clear how much of this will be allocated to plant conservation (Broadhurst *et al*., 2017), l*et al*one to CWR.

The way the programme operates as follows:

- Consults with experts and applies independent peer reviewed science to species, populations of a species and ecological communities projects.
- Takes a rigorous and transparent approach to prioritising investment in projects that ensure benefit to the maximum number of species.
- Provides targeted conservation projects that set out the actions required to save specific plants and animals on mapped management sites.
- Regularly monitors the effectiveness of projects so they can be improved over time.
- Provides annual report cards on threatened species where actions are underway.
- Encourages partnerships with community, corporate and government in threatened species conservation by providing a website and a database with information on project sites, volunteering and research opportunities" (*NSW Government. Saving our Species programme*, 2019a).

A Conservation Co-funding Scheme was created to allow the NSW Government to co-fund conservation projects with existing conservation groups. In addition, the NSW Government together with the Environmental Trust[2] make available SoS Partnership Grants and Contestable Grants (*NSW Government. Saving our Species programme*, 2019a).

The programme recognizes the importance of involving various institutions from various backgrounds in order to make a greater impact and achieve the best outcomes for threatened species (*NSW Government. Saving our Species programme*, 2019b). Businesses, governmental, non-governmental organizations, as well as educational institutions and the wider community are all involved (*NSW*

[2] "An independent statutory body established by the NSW government to fund a broad range of organisations to undertake projects that enhance the environment of NSW".

Government. Saving our Species programme, 2019b). Partnerships through investment, funding, research, citizen science, and with contributing skills and expertise are all encouraged (*NSW Government. Saving our Species programme*, 2019b). Partnerships with 10 universities, non-governmental organizations and local councils across NSW are already underway. Existing projects are open to investors (see some projects open to investment in *NSW Government. Saving our Species parnership opportunities*, 2019). Volunteering is also stimulated through partnerships with conservation groups (*NSW Government. Saving our Species programme*, 2019b).

All conservation projects and actions of the programme are monitored using the following indicators: (i) total annual investment and the return on the investment; (ii) tangible outputs that can be totaled across the programme; (iii) threats under control or on track to be under control; (iv) management sites with populations that are secure or on track to be secure; and (v) species on track to be secure in the wild in NSW for 100 years (*NSW Government. Saving our Species programme*, 2019a).

Report cards and species profiles are produced for each threatened species where actions are underway (*NSW Government. Saving our Species programme*, 2019c) and are then made available online (see https://www.environment.nsw.gov.au/savingourspeciesapp/default.aspx).

Objectives and key actions to conserve CWR

The aim of the SoS programme is to secure as many of the 1000 threatened plants and animals in the wild in NSW as possible (*NSW Government. Saving our Species programme*, 2019b). All threatened species are allocated to one of nine management streams within which, information and management actions for each species are collated and identified (*NSW Government. Saving our Species programme*, 2019a). These streams are:

(i) Site-managed species: species that require site-based management to be secure from extinction in NSW for 100 years.
(ii) Landscape-managed species: species that are generally distributed across relatively large areas and are subject to threatening events that generally act at the landscape scale (e.g. habitat loss or degradation) rather than at distinct, definable locations; management actions aim at ensuring that they are secure in the wild in NSW and that their NSW geographic range is extended or maintained.
(iii) Iconic species: are socially, culturally and economically important species, and the community expects them to be effectively managed and protected.
(iv) Threatened ecological communities: naturally occurring groups of native plants, animals and other organisms living in a unique habitat and a healthy ecological community that is vital for their survival; they are either range-restricted or widespread.
(v) Data-deficient species: species that lack specific information on distribution, general ecology and management techniques required to secure them in the wild, or threats and appropriate actions to manage these threats; it is therefore essential to address key knowledge gaps for these species, which once resolved, can inform on their effective management.
(vi) Threatened populations of a species: this refers to threatened populations of a particular species that should be secured in the long-term.
(vii) Key threatening processes: they include climate change, weeds, fire, diseases, etc. and have specific abatement plans.

(viii) Partnership species: these are species that have less than 10% of the species' total population within the NSW, so their management aim is to secure their critical populations in NSW in the long-term; they are either range-restricted or widespread.

(ix) Keep watch species: these are threatened species that are predicted to be secure in NSW for 100 years without targeted management at particular sites; any change (e.g. decline in abundance or a significant new threat) will trigger a shift to the site-managed stream and the development of a conservation project, which will be then prioritized for implementation.

In NSW at least 13 CWR that are threatened and hence covered by the SoS programme were identified[3] (see Table 12) (Norton *et al*., 2017). For each of these species, a species profile is created with information about its threatened status in NSW and in the commonwealth, taxonomic description, distribution (with a map), habitat and ecology, threats, recovery strategies and activities to assist the species, which is then complemented by a species SoS strategy where the management objectives are stated as well as specific management actions.

Table 12. CWR covered by the SoS programme in NSW, Australia.

Taxon	Type	Threatened status in NSW	Management stream	SoS strategy	Management sites and actions
Cucumis althaeoides	Herbs and Forbs	Critically Endangered	Site-managed species	Under development	Key management sites are yet to be identified but conservation/management actions have already been identified.
Digitaria porrecta	Herbs and Forbs	Endangered	Site-managed species	Developed	Six management sites have been identified, where two are already active (Goolhi Road, Mullaley, Bald Hills, Leard, Boggabri, Goolhi Road, Mullaley, Pine Ridge); there are several management actions proposed at the sites.
Glycine clandestina	Epiphytes and climbers	Endangered population	Endangered population	Developed	Key management sites are yet to be identified but conservation/management actions have already been identified.
Glycine latrobeana	Herbs and Forbs	Critically Endangered	Partnership (range-restricted)	Under development	Key management sites are yet to be identified but conservation/management actions have already been identified.
Ipomoea diamantinensis	Herbs and Forbs	Endangered	Partnership (widespread)	Developed	Key management sites are yet to be identified but conservation/management actions have already been identified.
Ipomoea polymorpha	Herbs and Forbs	Endangered	Partnership (widespread)	-	Key management sites are yet to be identified but conservation/management actions have already been identified.
Macadamia tetraphylla	Tree	Vulnerable	Site-managed species	Developed	One management site (Wollumbin National Park) has been identified to conserve this species; there are several management actions proposed at this site.
Solanum celatum	Shrubs	Endangered	Site-managed species	Developed	Five management sites have been identified (Mount Brown area, Macquarie Pass national Park, Stockyard Mountain area, Bungonia national Park, Kangaroo

[3] These were identified by matching the CWR checklist with the SoS programme checklist available at https://www.environment.nsw.gov.au/savingourspeciesapp/default.aspx.

					Valley); there are several management actions proposed at the sites.
Solanum karsense	Herbs and Forbs	Vulnerable	Keep-watch species	Developed	Key management sites are yet to be identified but conservation/management actions have already been identified.
Solanum bauerianum	Shrubs	Presumed Extinct	Data-deficient species	Developed	-
Solanum amourense	Shrubs	Endangered	Site-managed species	Developed	Three management sites have been identified (Mount Armour, Joorilands Loop, W4 Track); there are several management actions proposed at the sites.
Solanum sulphureum	Shrubs	Endangered	Site-managed species	Developed	Five management sites have been identified (Survey Site, Sassafras, Marlee, Killawarra, Kiwarrak); there are several management actions proposed at the sites.
Solanum limitare	Shrubs	Endangered	Data-deficient species	Under development	Key management sites are yet to be identified but conservation/management actions have already been identified.

Link to social initiatives

As described above, civil society is involved through citizen science and volunteering in existing conservation groups (*NSW Government. Saving our Species programme*, 2019b).

4.4. Conservation and use of Agricultural Biodiversity (Horticultural Crops and Wild Fruit Species)

Continent	Asia
Countries	Indonesia, India, Malaysia and Thailand
Crop (target CWR)	Apple (*Malus* spp.), pear (*Pyrus* spp.), plum (*Prunus* spp.), almond (*Amygdalus* spp.), pomegranate (*Punica granatum*), grape (*Vitis* spp.), etc.

Creation of the Network

Bioversity International was responsible for the creation of this network in January 2009.

Current situation

The project, funded by UNEP/GEF, was completed in December 2015. The organizations involved were: Indian Council of Agricultural Research (ICAR), India; Indonesian Centre for Horticulture Research and Development (ICHORD), Indonesia; Malaysian Agriculture Research and Development Institute (MARDI); and the Department of Agriculture (DOA), Thailand. In addition to the above lead partners, the project worked closely together with 19 national implementation organizations at the national and site level. The project reached out to 37 project partners, comprised of 15 research organizations, 5 universities, 12 district or sub-district level offices of the agricultural or forestry department and 5 NGOs. These five NGOs in turn reached out to 7 cooperatives and over 180 self-

help groups across all four countries. These institutions became familiar with concepts and tools such as Traditional Knowledge, Prior Informed Consent, Community Biodiversity Management, Fruit Catalogue, Four Cell Analysis, Farmers' Elite materials, Diversity Fairs and Custodian Farmers.

Objectives and key actions to conserve CWR

The National Park Department in Thailand has completed a study on the distribution of wild relatives in protected forests.

Over 43 distinct species of the genera *Citrus, Garcinia, Mangifera* and *Nephelium* have been identified in 36 communities in 22 sites across the four countries.

A protocol for a Forest genebank concept was produced for wild relatives of each of the four target groups of species, increasing the value of sustainable management of forest species.

Link to social initiatives

The Project involved civil society reaching out to 14,345 households through a wide range of development activities and training workshops across the four countries and worked intensively with 1,900 households across the 36 project communities. The project assisted 7 cooperatives or farmer associations and established or strengthened 180 self-help groups, mainly in India through a collaboration with a local NGO (Dhan Foundation) targeting in particular women and poorer households involved in growing or collecting fruits.

A total of 61 diversity fairs were organized over a period of 5 years from small village fairs to the participation of farmer groups in trade events or fairs in major cities such as the famous 'mango mela' in New Delhi or the Malaysian Agriculture, Horticulture and Agrotourism Show (MAHA) in Kuala Lumpur.

In total 83 custodian farmers and their families have been identified, documented with their fruit tree diversity in a profile, and were targeted and involved in key activities of the project such as developing fruit catalogues, identifying elite materials, participating in diversity fairs and 140 training workshops, and playing a key role in the identification, implementation and mainstreaming of 23 documented good practices and establishment of fruit tree diversity gardens in 30 sites. In all countries, custodian farmers have been invited and decorated at high-level meetings and conferences where other farmers, policymakers and researchers participated to learn about their practices and the wide range of diversity of fruit trees they maintain on their farms. These activities involving local custodian farmers demonstrated to policy makers the need to support the *in situ* conservation of agrobiodiversity. These concepts, methods and tools have been mainstreamed and partners have linked up with NGOs, private sector companies, government agencies and universities in the region. This has resulted in strong *in situ* and on-farm conservation agendas in India and Malaysia, where ICAR and MARDI have funds and the mandate to mainstream findings from the project into new programmes and projects.

4.5. Touran Protected Area network

Continent	Asia
Countries	Iran
Crop (target CWR)	Barley (*Hordeum* sp.)

The Touran Protected area is a designated Biosphere Reserve accommodating three areas of Wildlife Refuge, National Park and Protected area; the second largest Biosphere Reserve in the world. It is a special habitat of steppe grasslands in Central Asia and Desert-Saharas peculiar to West Asia (Kermani *et al*., 2018). A wide range of valuable genetic resources of flora and fauna are seen in the area (Bakhtiari, 2019). It is located south of Shahrud, Semnan province, with a smaller section situated to the southeast of Khorasan province and occupies an area of 1,459,506.2 ha. It comprises a variety of salt, gypsum, stone and sandy habitats. It also covers clay lowlands and mountains and reaches altitudes more than 2,200 m above sea level (UNESCO, 2019).

Creation of the Network

Iran's High Council on Environmental Protection (HCPE) categorized Touran as a Protected Area in 1972, while in 1976, the same council divided Touran into two zones - a Wildlife Refuge and a Protected Area. It was the same year that the "Man and the Biosphere Programme" (MAB) of the United Nation Development Plan (UNESCO) identified Touran as a Biosphere Reserve, attracting the attention of international organizations. In 2002, HCPE designated part of the Wildlife Refuge, which is the central kernel and the safest part of the habitat, as a National Park (Dornagasht, 2018).

Current situation

Touran is known internationally as a Biosphere Reserve and an Important Bird Area (IBA) which increases its preservation significance (Dornagasht, 2018). The administrative authority is considered the Department of Environment, Touran National Park Authority (UNESCO, 2019). In addition, due to its conservation status the area belongs to the World Network of Biosphere Reserves, which are considered World Heritage sites. The management of the Touran protected area is facing great challenges that need practical approaches, especially when it comes to livestock grazing. A study confirmed significant habitat degradation due to human activities (livestock grazing, road development, military activities, mining and vegetation cutting) in the Touran Protected Area; the most important cause of habitat degradation is livestock grazing (Laghai *et al*., 2012). That was confirmed in a recent study, which also identified overgrazing as a major threat for the Biosphere Reserve (Kermani *et al*., 2018). These threats combined with a trend for reduced funding or occasional lack of funding for conservation (Esmaeili *et al*., 2019) put the Touran Protected Area biodiversity in danger.

Objectives and key actions to conserve CWR

The existence of a 'Master plan for the Touran protected area' that could help identify the park's objectives, planning and conservation strategies is mentioned in at least one published study (Laghai *et al*., 2012).

Since the Touran National Park belongs to the IUCN II management category, its primary objective is to protect natural biodiversity along with its underlying ecological structure, through the support of

environmental processes and the promotion of education and creation (Protected Planet, 2020). Furthermore, efforts are made to maintain the natural state of the area and to keep the native populations and species viable, so as to conserve the integrity of the ecosystem. Besides all these, the needs of local communities and the management of visitors are taken into account, so as not to cause any bio-ecological degradation. One of the primary objectives of Touran as a Biodiversity Reserve is to achieve a sustainable balance between the goals of conserving biological diversity, promoting economic development, and maintaining associated cultural values (Danub, 2019).

A study on plant biodiversity of the Touran Biosphere Reserve identified 600 angiosperms, 46 of which are endemics of Iran, while two are endemics of the Reserve (Asri *et al*., 2000). However, despite the wealth of biodiversity occurring inthe Touran Protected Area, including CWRs (Rechinger, 1977), no specific activities are being undertaken for active conservation. Mulongoy & Gidda (2008) reported that wild relatives of barley (*Hordeum* sp.), more specifically the species *Hordeum glaucum* Steud can be found in Touran (Rechinger, 1977). However, no CWR prioritization is reported for this area. Scientific support for local biodiversity by identification of the flora, detection of endemisms, vulnerability and chorology of species, and the identification of medicinal and pasture plants may improve the current situation and provide a good basis for biodiversity conservation programmes. Analyzing species richness, extinction level and distribution, drivers are important preliminary steps to set conservation priorities and to test environmental policies (Rahimi *et al*., 2013).

The Iranian government recognizes that while the assessment of biodiversity trends is difficult due to underdeveloped national biodiversity indicators, biodiversity (in Iran) in different ecosystems and at different levels is degrading. As of 2010, Iran was in the process of implementing its National Biodiversity Strategy and Action Plan (NBSAP). Priority actions towards biodiversity protection and sustainable use included: 1) Revise and update the first NBSAP of Iran for incorporating biodiversity indicators, targets and specific strategies for implementing priority elements of the CBD; 2) Complete national biodiversity indicators and develop a systematic approach for their measurement; 3) Improve public awareness on conservation and sustainable use of biodiversity resources; 4) Field studies on selected species and ecosystems to better understand biodiversity status and trends, and implementation of conservation and rehabilitation measures for threatened endemic species; 5) Implement and support further conservation projects encouraging a community-based approach to natural resource management, sustainable use and biodiversity conservation; 6) Further increase of protected areas, including the establishment of new protected areas, the extension of existing ones, completion of all the management plans for protected areas, the improvement of management effectiveness and the facilitation of financial sustainability; 7) Establishment of a national biosafety system; and completion and implementation of the national biosafety regulation; 8) Improvement in law enforcement including the strengthening of controls on illegal resources use (Natural Environment Deputy Islamic Republic of Iran, 2010).

The adopted government policies seem to be beneficial for biodiversity since the Protected Areas were increased by 35% between 2010-2014. There is also an effort for Iran to meet the 20 Aichi Targets for Biodiversity Protection. Under target 2, the government estimated the economic valuation of environmental costs of industrial development, assessed ecological values (goods) and worked out the services and ecosystem service evaluation for the Touran region (Natural Environment Deputy Islamic Republic of Iran, 2015).

Link to social initiatives

As previously mentioned, a MAB network identified Touran as a Biosphere Reserve. Such systems mainly provide programmes about the harmonious relationship between man and the biosphere. On the other hand, a biosphere reserve deals with innovative approaches of living and working in accordance with nature. So, social initiatives should focus on goals of conserving biodiversity, promoting economic development and maintaining cultural values (Dornagasht, 2018). Communities in the area depend mostly on agriculture, animal husbandry, horticulture and carpet sewing. Major human impacts on the ecosystem arise from overgrazing, especially by camels, illegal hunting and fuel wood harvesting. The villages of the Touran Biosphere Reserve are generally thinly populated due to limited water supplies; they depend on agriculture and ranching; and they have poor resources. Presently, 85% of the villages have small populations of between 21 and 200 people (UNESCO, 2019). Involvement and organization of local people in various management actions in the Touran Protected Area, especially in livestock grazing management, could minimize the environmental impact and seems to be a necessary condition in Iran (Laghai *et al*., 2012).

The main historical-archaeological attractions of the region are Abbasi caravanserais, located on the main Tehran–Mashhad route, which have been the focus of efforts by the Department of Cultural Heritage and Tourism of the Semnan Province aimed at renovating and developing surrounding tourism infrastructure. Other historic-archaeological sites of the region include forts and castles, although many are in a state of deterioration due to abandonment (UNESCO, 2019).

Furthermore, areas with such a great value of flora and fauna diversity and historical attractions could contribute to educational and scientific programmes and activities. These initiatives could attract tourists and funds for the preservation and protection of the Touran area.

4.6. *In situ* conservation of native cultivars and their wild relatives

Continent	America
Countries	Peru
Crop (target CWR)	Potato (*Solanum* spp.), sweet potato (*Ipomea spp*.), etc.

Creation of the Network

The network was created under a Global Environment Facility grant. The project started in 2000 and finished in 2005 (extended from the initial expected ending date - 2003) (UNDP, 2015).

Current situation

The sustainability of the created network was not guaranteed beyond the duration of the project. As no further incentives were offered to the farmers, maintenance is highly dependent on the farmer's will. No information reporting current activity has been found and the network seems to be abandoned. However, this does not necessarily mean that native cultivars and wild relatives are no longer conserved on farm. We do not know if native cultivars and wild relatives are still conserved, and connections in the network have been lost.

Objectives and key actions to conserve CWR

The project was highly focused on the on-farm conservation of native cultivars related to 11 important crops for Perú: 1) Camú-camú (*Myrciaria dubia* (Kunth) McVaugh); 2) Sweet Granadilla (*Passiflora ligulabis* Juss.); 3) Cañhiua (*Chenopodium pallidicaule* Aellen); 4) Maize (*Zea mays* L.); 5) Quinoa (*Chenopodium quinoa* Willd.); 6) Common bean (*Phaseolus vulgaris* L.); 7) Arracacha (*Arracacia xanthorriza* Bancr.); 8) Maca (*Lepidium meyenil* Walpers); 9) Cassava (*Manihot esculenta* Crantz); 10) Sweet Potato (*Ipomoea batatas* (L.) Lam.); 11) Potato (*Solanum* spp.). The main aim of the project was to raise attention to the importance of these 11 native crops of Peru, including their wild relatives. This objective was reached through the involvement of farmers in the project. Training courses and economic incentives were among the actions performed (UNDP, 2015).

Regarding CWR conservation, the project identified 79 species of wild relatives of the target crops. However, the list of the species is not available. No active conservation actions having these 79 species as targets were reported. Yet a gap analysis overlapping protected areas and distribution data of these species was carried out, and there may be some degree of passive protection. As the populations of these 79 species were not visited, it is highly improbable that *ex situ* backup copies are preserved (CCTA, 2006).

Link to social initiatives

During the project farmers were visited and trained to recognize the value of their native cultivars. This training was performed through developing educational campaigns, workshops and seminars. In addition, youth population was involved (increase of 78%) mainly through the creation of school gardens. The urban population was approached through publications (calendars, bulletins) or radio shows (IPCCA, 2019).

4.7. Bolkar Mountains Turkey Genetic Reserve Network

Continent	Asia
Countries	Turkey
Crop (target CWR)	Chestnut (*Castanea sativa*)

Bolkar Mountains are located in the south of Nigde province, the north side of the central Taurus Mountains. The Bolkar mountains, which form the Turkish extension of the Alps, begin in Resadiye in the southwest and run along the southern coast of Turkey until they connect to the Zaganos Mountains in Iran. There are many peaks over 3000 metres in this range. Medeksiz (3524 metres) is the highest peak in the range (Tolun *et al*., 2000).

The mountains divide the Mediterranean coast from the interior, and the climates of the south and north facing slopes are quite different, with the result that the vegetation is extremely varied. To the south, damp warm winds of the Mediterranean result in thick forests up to 2000 metres with evergreens like toros cedar; black pine, fir, and juniper, as well as a diverse range of herbaceous plants. To the north, on the other hand, the plant cover is adapted to the cooler climate with its greater seasonal extremes of temperature.

Creation of the Network

In Turkey, the protected area categories identified by legal regulations (Laws no. 2873 and 6831, etc.) and their protection values are under the authority of the Ministry of Agriculture and Forestry and the Ministry of Environment and Urbanization. The conditions for the definition and utilization of the "the Fırst, Second and Third Degree Nature SITs" are regulated by the High Commission of Conservation of Culture and Nature Resources with the authority of related regulations Code 24 accepted in 1988 and Code 101 in 1989. The Bolkar Mountain is partly protected. Located at the top of the Bolkar mountains, the Karagöl lake, Çiniligöl lake and Meydan plateau were designated first-class Natural Heritage Area in 1994. Two monumental tree individuals, the Ana Ardıç and the Koca Katran have been designated as Natural Monuments. Although the rest of the mountain block does not receive official protection, the territory of the Bolkar Mountains is under public administration.

Current situation

Management of protected areas and forest areas are completely under the responsibility of the state in Turkey. Basically, the Ministry of Environment and Urbanization and the Ministry of Agriculture and Forestry are responsible for the conservation of protected areas. Necessary funding related to management and protection is covered by the state.

The area also has the title of Plant Diversity Center (SWA No 15), Important Plant Areas (No: 74), Important Natural Areas (INA) (AKD049) and Important Bird Areas (IBAs), (TR076) (Eken *et al*., 2006).

Due to urbanization and touristic developments in recent years, there is increasing pressure on forest, pasture and even agricultural lands in this region. The most important consequences of these activities are the reduction and fragmentation of natural habitats. Without strict land-use regulations, it is very difficult keep those habitats very long. The main threat to the mountain massif stems from excessive levels of grazing, which have largely destroyed the vegetation structure particularly over the high plateau areas of the mountain. There is an urgent need to regulate grazing within the site, particularly in areas rich in endemics. Forest cover in more accessible areas of the site has been severely reduced. There is an urgent need to regulate both fuelwood collection and grazing within destroyed areas to encourage the natural regeneration of the forest cover. Conversely, afforestation activities are taking place at up to 2900 m. In time, the dense growth of trees will in their own right lead to a loss of diversity, and the possible extinction of endemic taxa. Another development affecting the limited but valuable parts of the region is the increase in the number of secondary houses, especially in relation to the plateau settlements along the southern wings of the mountain massif.

Objectives and key actions to conserve CWR

Some parts of the Bolkar Mountains are a first-class Natural Heritage SIT Area. Any action disturbing the vegetation, topography or silhouette is not allowed in First Degree Natural SIT Areas. As the forest ecosystem of the Bolkar Mountains is managed within a certain plan, it can be said that the CWR species are partly passively protected in the Bolkar Mountain Natural SIT Area and the Bolkar Mountain forest ecosystems (it includes wild *Castanea* sativa).

With the "*In situ* Conservation of Plant Genetic Diversity in Turkey" project, studies concerning the *in situ* gene conservation of important plant species have been started initially in selected sites such as

Kazdağ, Bolkar mountains and Ceylanpınar State Farm in 1993. Its objective was the *in situ* conservation of the wild relatives of plant and forest genetic resources. However, today there is no responsible institution or management system for these Gene Management Zones. CWR species are poorly represented in Turkish genebanks.

Link to social initiatives

Damage to nature caused by human activities is a problem that has steadily increased in the region in recent years. Therefore, the activities of voluntary non-governmental organizations have increased recently in the region. However, their contribution is not at the desired level due to their inadequate budgets. But still, these organizations have made a significant contribution to public awareness on the protection of biological diversity and the natural environment. However, public support is needed for the effectiveness and continuity of the conservation programme. For this reason, rural development projects are being implemented to improve the socio-economic structure of forest-dependent communities to lower the constant pressure on forests and prevent continued illegal and intensive use.

4.8. Ceylanpınar State Farm Turkey Genetic Reserve Network

Continent	Asia
Countries	Turkey
Crop (target CWR)	Wheat (*Aegilops aucheri, Aegilops ligustica, Aegilops tauschii, Triticum dicoccoides, Triticum boeoticum*

Ceylanpınar State Farm is on the borders of Ceylanpınar district of Şanlıurfa Province in Southern Anatolian Region, and it shares the border with Syria for 50 km. Ceylanpınar State Farm is located in Şanlıurfa province in South-East Anatolia between 39°00'-40°10' East longitude. It covers a total surface of 175,650 hectares, 71,230 of which are clear agricultural areas (Adigüzel and Aytac, 2005). The farm is generally flat except for the three mainstream valleys named Tufan, Şeyh Nasır, Büyük Çırçır and several other small streams. During summer, these streams are dry. Besides the cultivated lands, there are pastures, rocky, stony, and marginal lands. Altitude ranges between 370-560 m above sea level. The climate of the farm is characterized as arid Mediterranean (Karagöz, 1998).

Creation of the Network

Wild relatives of wheat are widespread in southeast Turkey. Due to the global importance of the area for wheat genetic resources, "*In situ* Conservation of Plant Genetic Diversity" pilot project was initiated at Ceylanpınar State Farm in 1993. Its objective was the *in situ* conservation of the wild relatives of plant and forest genetic resources. Through this national project, six Gene Management Zones (GMZs) were selected to conserve five target wild wheat species which contributed to the evolution of modern wheat (Karagöz, 1998). Although such areas are weak in plant cover, they give refuge to some of the target species to form good stands. All of the GMZ's were set up in marginal areas with shallow soils and no agricultural potential (Karagöz *et al*., 2009).

The farm accommodates several habitat types such as cultivation areas, arid pastures, rocky stream valleys, and stony waste areas. The area is generally flat. Wild areas, which comprise about 41 %

(71.238 ha), provide a suitable environment for many plant species including wild wheat relatives. It was reported that 217 plant genera, 407 species, 46 sub-species and 42 varieties belonging to 51 families inhabit the farm (Adigüzel and Aytac, 2005). The marginal areas are grazed yearlong by small ruminants. Due to the importance of the area for plant genetic diversity, the steppes of Ceylanpınar State Farm were later identified as one of the Important Plant Areas of Turkey by the Turkish World Wide Fund for Nature (Adigüzel and Aytac, 2005). The Ceylanpınar Steppes accommodate 6 endangered species according to the European scale and 49 rare species on the national scale. A total of 13 endemic species was reported on the farm.

Ceylanpınar State Agricultural Farms ranks first among Turkey's state agricultural enterprises in terms of its land assets. This area constitutes 48% of the General Directorate of Agricultural Enterprises (TİGEM) land and accounts for 4.5% of agricultural fields to be irrigated via the Southeast Anatolia Project (Aslan, 2018).

Current situation

Today there is no responsible institution or management system for these Gene Management Zones. Grazing has been controlled by the farm administration for over 60 years; therefore, the plant cover of Ceylanpınar State Farm has not been subject to intense changes caused by human activities. However, in recent years pastures are overgrazed regardless of their carrying capacity by the small ruminants of the farm and nomadic grazers. Among the main factors that affect the presence of the target species on the farm are loss of habitats, clearing of the natural vegetation for cultivation, overgrazing, and the opening of new soils to irrigation. Some target species and natural vegetation cover will not become fully extinct on the Ceylanpınar State Farm because of the conversion of land to fields. However, their restricted life areas will become more restricted and some aquatic species will spread to new occurring habitats in the area (Aslan, 2018).

As a result of overgrazing and disorganized grazing, the step vegetation ecosystems have become half-desert and desert types. This change may gradually cause important floristic changes especially at the irrigation canal banks due to the changing of environmental conditions when excessive irrigating is completed (Aslan, 2018).

Objectives and key actions to conserve CWR

Ceylanpinar Farm was transformed into a State Production Farm in 1950 and has been operating under the General Directorate of Agricultural Enterprises since 1984. The General Directorate of Agricultural Enterprises is an Economic State Organization, which is free in its activities and limited by its capital, established in order to produce all kinds of goods and services needed by agriculture and the agriculture industry. The state farmland has been chosen because it is a protected area and target wild wheat species are widely available. With "*In situ* Conservation of Plant Genetic Diversity" project, six Gene Management Zones were selected to conserve five target wild wheat species (*Aegilops aucheri*, *Aegilops ligustica*, *Aegilops tauschii, Triticum dicoccoides, Triticum. Boeoticum*), and these selected species are passively protected. Today there is no responsible institution or management system for these Gene Management Zones. These CWR species are represented in Turkish genebanks.

Link to social initiatives

The area where the CWR species are located is the state farm, and non-governmental organizations do not carry on activities. The CWR species in Ceylanpınar State Farm have been monitored by universities and research institutes in recent years, and scientific publications and research on selected CWR species continue.

4.9. The Kaz Mountains National Park

Continent	Asia
Countries	Turkey
Crop (target CWR)	Garlic (*Allium* spp.), almond (*Amygdalus webbii),* asparagus (*Asparagus acutifolius),* chickpea (*Cicer montbretia),* grass pea (*Lathyrus aureus)* and other 10 CWR.

The Kaz Mountains (Ida Mountains) National Park was declared a National Park in 1994 on account of its natural, historical and cultural significance. The boundaries of Kaz Mountain National Park cover an area of 21.463 ha, out of which 19.781 ha are forest and 1681.5 ha are open space. Kaz Mountain forms a natural border between the Marmara and Aegean regions of Turkey, which are phytogeographically located at the transition area of the Euro-Siberian and Mediterranean regions. There are about 800 natural plant taxa in Kaz Mountain National Park and 79 of them are endemic to Turkey (Uysal *et al*., 2012). About 32 of the endemic taxa only grow in this park (Satıl *et al*., 2006), which is why the area was classified as a European "Important Plant Area" (www.plantlife-ipa.org). Among the endemic taxa, many are of commercial value. Some are important for their secondary metabolites and others are important for their food value, whereas others are valued for their aromatic and horticultural importance, as well as other purposes.

Creation of the Network

Kazdağı National Park was declared a National Park by the Council of Ministers in 1994 on account of its natural, historical and cultural significance.

Current situation

The protection and management of protected areas are completely under the responsibility of the state. Basically, the Ministry of Environment and Urbanization and the Ministry of Agriculture and Forestry are responsible for the conservation of protected areas (Anonymus, 2018). Some of these tasks are the maintenance, conservation and proper development of natural resources and their transfer to future generations. Additionally, the General Directorate of Forestry within the Ministry of Agriculture and Forestry is responsible for managing the forests of Turkey according to the principle of sustainability.

The funding required for the management of Kaz Mountain national park is provided by the state from public sources. There are also sustainable sources of finance. In accordance with planning and management conditions, an entrance fee is obtained from the fields, facilities and similar places operated by the administration, and fees are collected from benefiting from rental, accommodation, infrastructure or other facilities.

Objectives and key actions to conserve CWR

The General Directorate for Natural Assets Protection within the Ministry of Agriculture and Forestry is responsible for establishing and managing the majority of Turkey's various categories of protected areas and has a nationwide network of field-based staff. The Kazdağı National Park lands is under public management.

The management plan for *in situ* conservation in Kazdağı National Park aims to reduce pressures and threats on biodiversity and ecosystems, to develop species specific and ecosystem-based conservation approaches and to maintain healthy ecosystems. The management of the area continues with the same first plan until today.

The protected areas located in centres of crop diversity are especially valuable for conserving plant diversity. Kaz Mountain Forest National Park is an important source of plant diversity in terms of agriculture and forestry. Out of the 335 vascular plant species in Kaz Mountain, 13% (46 taxa) are endemic. The CWR species distributed on Kaz Mountain are: *Allium guttatum, Allium paniculatum, Allium kurtzianum, Allium phrygium, Allium sibthorpianum, Amygdalus webbii, Asparagus acutifolius, Cicer montbretii, Lathyrus aureus, Agrostis capillaris, Arrhenatherum elatius, Festuca gigantean, Festuca heterophylla, Fragaria vesca, Olea europaea, Poa alpina, Pistacia terebinthus* var*. terebinthus, , Prunus spinosa and Prunus divaricata* (Özel, 1999; Uysal, 2010). All CWR species are passively protected in the management plan. CWR species are poorly represented in Turkish genebanks.

The area has also been chosen as a pilot gene management zone as part of the "*in situ* conservation of plant genetic diversity project" due to its rich plant diversity. Its objective was the *in situ* conservation of the wild relatives of plant and forest genetic resources. However, today there is no responsible institution or management system for these Gene Management Zones. All of the above-mentioned species are included in the management plan. However, an in-depth analysis of their effectiveness regarding plant conservation is lacking.

Link to social initiatives

In recent years, broadcasting educational programmes related to environmental problems in the media has considerably improved the "environmental consciousness" of the public in Turkey. However, public support is needed for the effectiveness and continuity of the conservation programme. Furthermore, an effective *in situ* conservation programme in Turkey requires the active participation of local communities.

4.10. Kibale Forest Wild Coffee Project

This project assisted Uganda's implementation of its national biodiversity strategy and action plan by helping maintain biodiversity in the landscape mosaics beyond the boundaries of protected areas of global importance.

Continent	Africa
Countries	Uganda
Crop (target CWR)	Coffee *(Coffea* spp.)

Creation of the Network

The Uganda Coffee Trade Federation, succeeded by the Kibale Forest Foundation, was responsible for its implementation, beginning in 1999. They were able to count on a National Park previously managed as a logged forest reserve to develop the project.

Current situation

This project is currently abandoned, since in 2002 the funds ended, and it was not as economically self-sufficient as expected. Until 2002, it received support from the U.S. Agency for International Development, the World Bank and the Ford Foundation.

The Kibale Forest Foundation was responsible of its implementation, trying to call up several stakeholders (farmers, land managers, consumers…).

Due to the abandonment of the project as a result of its failure to bring an economic/market advantage to the coffee growers in Kibaleit, it is uncertain how the management of wild coffee continues to this day. Most of the growers, however, did not leave the project due to the wild status of the coffee, but because the certification was not giving them a higher price for their beans. They most likely continued growing coffee in the same manner but no longer wished to pay for certification that did not increase the value of the product (Lilieholm *et al*., 2010).

Objectives and key actions to conserve CWR

The project was designed to conserve globally significant biodiversity in Kibale National Park and in the agricultural landscape of Uganda by creating a system to use income from sale of Kibale Forest Wild Coffee to improve the management of KNP. It was also intended to provide an income to pay small farmers a premium to grow their coffee in small farmer agricultural systems that are certified as organic and "shade" grown ("Shade Grown" certification requires that coffee is grown in biologically diverse agro-ecosystems that provide habitat for a richer diversity of fauna than large-scale coffee farms). The project created a system to certify coffee origin and quality to back the validity of "eco" claims for wild coffee. Income from the coffee will help conserve Uganda's biological diversity in two areas (Lilieholm *et al*., 2010).

Two species of coffee grow wild in many parts of the park - **Coffea eugenioides** and **C. canephora.** The latter, also known as robusta coffee, is very abundant in specific areas of the park where it grows, while the former is widespread but not abundant (J. Kasenene, 1998).

Link to social initiatives

The money raised to fund the project was intended to support the farmers in the area, to run the National park and to provide support or make social and economic investments in the villages around KNP. Local communities and the National Park were key to the project. The group of small independent coffee growers were also the main implementers of the scheme.

4.11. Chatkal Biosphere Reserve

Continent	Asia
Countries	Uzbekistan
Crop (target CWR)	Almond (*Amygdalus bucharica)*

Creation of the network

After a history of being used for hunting, grazing and mineral prospecting, the Chatkal State Biosphere Reserve was established in 1947 to conserve the ecosystems and the flora and fauna of the Chatkal mountain range. In 1978 it was recognized as a UNESCO Biosphere Reserve. The reserve's core area covers 45160 hectares and is part of the larger Ugam-Chatkal State Nature National Park (5746 km2). The reserve is a strictly protected area. The vegetation mainly consists of Juniper and tugai forests, steppe and meadows (Hunter *et al*., 2011).

Current situation

Conservation should still be ongoing, as the reserve still exists as a strictly protected area. In the reserve area, 1136 species and subspecies of plants have been found among which 25 are endemic species to the Western Chatkal ridge. Three species are globally threatened according to IUCN: *Betula tianschanica* (EN); Siever's apple (VU) and walnut (NT). It is managed by the State Forest Fund/State committee for Forestry of Uzbekistan.

Several organisations are involved in the conservation of *Amygdalus bucharica*. Conservation efforts are undertaken by the Ugam-Chatkal National Park and Chatkal Reserve authorities, as well as authorities of the Nurata Reserve, the main Management Department of Forestry and the State Committee on Nature Protection. Furthermore, some of the activities of the management plan for *Amygdalus bucharica* are carried out by forestry authorities, local authorities, plant production and research institutes and national project partners (Hunter *et al*., 2011).

Objectives and key actions to conserve CWR

Uzbekistan has developed a management plan for the conservation of *Amygdalus bucharica* in the Chatkal Biosphere State Reserve under the project "*In situ* Conservation of Crop Wild Relatives through Enhanced Information Management and Field Application" (Brandolini, 2013). The target of the plan is to conserve current almond populations both in and outside of protected areas, as well as to restore populations in areas that the species previously inhabited. While the plan is aimed at the Chatkal Biosphere State Reserve, it seems to concern other reserves as well. The management plan mentions other areas such as Nurata reserve and contains both direct and indirect measures to conserve the almonds of Chatkal Biosphere State Reserve and other areas. The core elements of the plan focus on the following efforts: strengthening the legal system for CWR conservation and fulfilling all measures according to existing laws, cattle grazing and CWR fruit harvesting restrictions, rental agreements with almond conservation restrictions, facultative programmes for schools, research on the selection of almond species for *ex situ* collections, the collection of genetic material for further breeding efforts and raising awareness in the region and nearby almond communities. Different parties were responsible for different activities. Several different plant-related institutes or centres, for example, were responsible for awareness raising and research programmes (Hunter *et al*., 2011).

Link to social initiatives

Support is also being provided for the conservation of CWR in the form of capacity building, community awareness and education.

4.12. Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives

Continent	Worldwide
Countries	Worldwide
Target CWR	29 CWR based on Annex 1 of ITPGRFA

Creation of the network

The project "Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives" was launched in 2011. Funding for the project, $50 million, came from the Government of Norway. It was implemented in partnership with national and international gene banks and plant breeding programmes from around the world.

Current situation

The project started in 2011 as a 10-year project and is currently still active but will draw to an end in 2020. Whereas the Global Crop Diversity Trust (Crop Trust) and the Royal Botanic Gardens, Kew, manage the project, several other organisations are involved as well, such as 24 collecting partners in 24 countries, and 52 national and international pre-breeding partners spread out over 32 countries (Castañeda-Álvarez *et al*., 2016).

Objectives and key actions to conserve CWR

The objective of the project is to "collect important species of crop wild relatives, ensure their long-term conservation, and facilitate their use in breeding new, improved crops."

The project focuses on 29 CWR based on their importance and occurrence in Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture. These 29 crops are: Alfalfa, apple, Asian/African rice, bambara groundnut, banana/plantain, barley, bean, carrot, chickpea, cowpea, durum wheat/bread wheat, eggplant, faba bean, finger millet, grasspea, lentil, oat, pea, pearl millet, pigeon pea, potato, rye, sorghum, sunflower, sweet potato and vetch.

Four main activities take place within the project; a gap analysis to decide which CWR to prioritize, field collection of CWR, the conservation of these CWR in gene banks, and using the CWR in pre-breeding efforts to prepare them for further use in crop breeding.

In the first stage of the project, research on the degree of gene bank conservation of 1081 wild relatives of 81 agricultural crops was conducted. The occurrence of CWRs was assessed, resulting in the creation of the first global atlas on these CWRs, and a gap analysis was carried out, showing where CWR had not been collected. These activities formed the basis for prioritization for further collection. This prioritization was based on both the overall number of samples present in the genebanks and the representation of geographic and ecological variation (Castañeda-Álvarez *et al*., 2016).

National partners mainly carried out the collecting part of the project. They organized the collection of priority CWR in their country, for which the locations of these CWR needed to be identified and permits obtained. Furthermore, the populations sometimes had to be checked several times to ensure that the seeds were of high enough quality for collection.

In the next step, the CWR that were collected had to be conserved properly in *ex situ* collections. The collected CWR are conserved in several different banks; “the national collections of the country of origin, the Millennium Seed Bank, the appropriate CGIAR international collection and the Svalbard Global Seed Vault”.

Pre-breeding is a first step when wanting to use CWR for crop improvement. As an essential part of the project, desired genetic trades were isolated and introduced to breeding lines. Furthermore, to support the active use of CWR and pre-breeding materials, the project is building information systems to support the global management and search of crop collections.

Annex II: Comparative tables recording selected CWR genetic reserve networks.

Table 13. Design information of genetic reserve network showcases.

Showcase	Conservation approach	Conservation scale	Beginning year	Implementation initiated by	Main purpose of the conservation	Location	Distinguished designation	Land ownership	Reserve size	Reserve configuration	Target CWR taxa number	Target taxa main conservation reasons
Erebuni State Reserve	Monographic	Local	1981	National agency	CWR	PA National designated area	IUCN Management Category "Strict Nature Reserve"	Public	118.75 ha	Single large	19	Socio-economic use; Conservation linked to use (related to major crop); Genetic or ecogeographic distinction
Genetic reserve network for wild celery	Monographic	National	2019	Research project	CWR	Mixed	None	Mixed	33	Several small	4	Conservation linked to use (related to major crop)
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Monographic	Local	2008	Research project	CWR	PA Natura 2000	Special Area of Conservation (SAC)	Public	< 200 ha	Several small	1	Conservation linked to use (related to major crop); Genetic or ecogeographic distinction
Sub-regional Network for Grassland Genetic Reserves	Floristic	Local	2019	Research project	Ecosystems	Mixed	EU Fauna-Flora-Habitat Directive (FFH)	Private	< 200 ha	Several small	11	Biological importance; Cultural importance
National Citrus Gene Sanctuary - West Garo Hills	Monographic	National	1980	National agency	CWR	PA National designated area	Biosphere Reserve	Common	10265.96 ha	Several large	2	Conservation linked to use (related to major crop)
Ammi'ad Reserve in Israel	Monographic	Local	2008	National agency	CWR	PA National designated area	None	Mixed	191 ha	Single large	4	Conservation linked to use (related to major crop)
Majella National Park	Floristic	National	1991	National agency	Threatened species	PA Natura 2000	None	Public	74095 ha	Single large	55	Biological importance; Conservation linked to use (related to major crop)
Besh-Aral State Nature Reserve	Monographic (related to *Marmota menzbieri*)	Local	1979	National agency	Ecosystems	PA National designated area	None	Public	112018 ha	Single large	N/A	Biological importance; Cultural importance

***Sierra de Manantlán* Biosphere Reserve**	Monographic	Local	1988	Group of experts	CWR	PA National designated area	Biosphere Reserve	Mixed	139577 ha	Single large	2	Conservation linked to use (related to major crop)
Wadi Sair Genetic Reserve	Floristic	International	2004	Research project	CWR	Mixed	None	Private	200 ha	Single large	15 genera	Socio-economic use; Conservation linked to use (related to major crop)
Biodiversity Micro-Reserves network	Monographic	National	2005	National agency	Threatened, rare and endemic flora	Mixed	None	Mixed	N/A	Several small	7	Biological importance
***Beta patula* genetic reserve**	Monographic	National	2014	NGO	CWR	PA Natura 2000	None	Public	N/A	Several small	1	Biological importance; Conservation linked to use (related to major crop)
Valencian Plant Micro-Reserves network	Floristic	Local	1998	Local agency	Threatened, rare and endemic flora	Mixed	Plant micro-reserve	Mixed	1918.2 ha	Several small	232	Biological importance
***Sierra del Rincón* Biosphere Reserve**	Floristic	Local	2019	Group of experts	CWR	PA Natura 2000	Biosphere Reserve	Mixed	1.671	Several small	15	Conservation linked to use (related to major crop); Cultural importance; Socio-economic use
***In situ* conservation of forage plants genetic diversity**	Floristic	National	2019	National agency; Group of experts	CWR	Outside PA: agriculture fields	None	Private	2750	Several small	17	Conservation linked to use (related to major crop)
The Coronado National Forest	Floristic	National	1953	National agency	Ecosystems	PA National designated area	None	Mixed	720340	Single large	1	Cultural importance; Socio-economic use; Conservation linked to use (related to major crop)
Organ Pipe Cactus National Monument	Floristic	National	1937	National agency	Ecosystems	PA National designated area	Biosphere Reserve	Public	133925 ha	Single large	1	Cultural importance; Socio-economic use; Conservation linked to use (related to major crop)
Lizard Peninsula CWR Reserve	Floristic	Local	2015	National agency; Group of experts	CWR	PA Natura 2000	None	Mixed	2426 ha	Several small	8	Conservation linked to use (related to major crop)

Table 14. Implementation information of genetic reserve network showcases.

Showcase	Current status of the conservation	Warranted period	Funds origin	Available financial and human resources	CWR conservation institutional framework	Involved partners	External supporting partner (adjoining network)	Specific CWR management plan	Active conservation	*Ex situ* back-up	Other reserve uses
Erebuni State Reserve	Active	Long-term	National	Not enough	Yes	National government; Research group	Yes, before through GEF project	On-going	Demographic monitoring; Actions not specified	Yes	N/A
Genetic reserve network for wild celery	Active	Long-term	Research project; National; Local; Private	Not enough	Yes	Research groups; National government; Local people; NGOs; Local government; Enterprises	Yes, national	Yes	Demographic monitoring; Control/removal of animals; Population genetic analyses; Habitat conservation or restoration	Yes	Livestock farming; Others
Network of Genetic Reserves for *Vitis sylvestris* in Germany	In process	N/A	Research project; National	Not enough	Yes	Research groups; National government; Local government	Yes, national	On-going	Demographic monitoring; Morphological and genetical characterization; Reintroduction	Yes	N/A
Sub-regional Network for Grassland Genetic Reserves	In process	N/A	Research project; National	Not enough	Yes	Research groups; National government; Local people	Yes, national	On-going	Demographic monitoring; Population genetic analyses	Yes	Agriculture
National Citrus Gene Sanctuary - West Garo Hills	Active	Long-term	National	N/A	No	Research groups; National government	No	No	N/A	Yes	Agriculture

Ammi'ad Reserve in Israel	Active	Long-term	National	Not enough	No	Research groups; National government	No	No	Demographic monitoring; Control or removal of animals; Morphological and genetical characterization	Yes	Agriculture; Livestock farming; Military purposes
Majella National Park	Active	Long-term	National; Own funds	N/A	No	Research groups; National government; Organizations	Yes	On-going	Demographic monitoring; Population genetic analyses; *In vivo ex situ* conservation	Yes	Tourism; Agriculture
Besh-Aral State Nature Reserve	Active	Long-term	National	Not enough	No	National government	No	No	N/A	N/A	Ecotourism
***Sierra de Manantlán* Biosphere Reserve**	Active	Long-term	National; Research Project; International	Not enough	No	Research groups; National government	No	No	Demographic monitoring; Actions not specified	Yes	Agriculture; Livestock farming; Forestry; Tourism
Wadi Sair Genetic Reserve	Active	Long-term	Research project; External organizations	Not enough	No	Research groups; National government; Organizations; Local people	Yes	Yes	Demographic monitoring; Actions not specified	Yes	Agriculture; Livestock farming
Biodiversity Micro-Reserves network	Active	Medium-term	National; Private; International	Not enough	No	Research groups; National government; Local government; NGO; Local people	Yes	No	Demographic monitoring; Actions not specified	Partially	Agriculture; Livestock farming
***Beta patula* genetic reserve**	In process	Long-term	Research project; National	N/A	Yes	Research groups; National government	No	On-going	Demographic monitoring; habitat conservation or restoration; control or removal of animals; invasive species control	Yes	None
Valencian Plant Micro-Reserves network	Active	Long-term	Research project; Local	Not enough	On-going	Research groups; Local government; Local people; NGOs; Organizations	Yes	No	Demographic monitoring; Actions not specified	Yes	Education; Ecotourism

***Sierra del Rincón* Biosphere Reserve**	Active	Short-term	Local	Not enough	On-going	Research groups; Local government; Local people	No	On-going	Demographic monitoring; Phytosociological monitoring	Yes	Education; Agriculture; Livestock farming
***In situ* conservation of forage plants genetic diversity**	Active	Long-term	National	Yes	Yes	National government; Research groups; Local government; NGOs; Breeders	No	Yes	Demographic monitoring; Phytosociological monitoring; Actions not specified	Yes	Agriculture; Livestock farming; Education
The Coronado National Forest	Active	Long-term	National	Not enough	No	National government; NGOs; Local people	Yes	Yes	Demographic monitoring; Controlled fire; Control or removal of animals	Yes	Education; Agriculture
Organ Pipe Cactus National Monument	Active	Long-term	National	Yes	No	National government; Local government; NGOs and other Organizations; Local people	No	No	Demographic monitoring; Habitat conservation or restoration; Actions not specified	N/A	Education; Tourism; Others
Lizard Peninsula CWR Reserve	Active	Long-term	Research project; National	Not enough	On-going	National government; Research group; Organizations; Local people	Yes	Yes	Demographic monitoring; Actions not specified	Partially	Agriculture; Livestock farming

Table 15. Social aspects of genetic reserve network showcases.

Showcase	Conservationists and agro-biodiversity community working together	Local community involved in site management	Local stakeholders' recognition	Economic return for stakeholders	Public awareness and education CWR activities	Involved in other environmental networks/public awareness conservation programmes	Civil society engaged
Erebuni State Reserve	No	Yes	Yes	No	No	No	No
Genetic reserve network for wild celery	Yes	Yes	Yes	No	Yes	Yes	Yes
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Yes	No	Yes	No	No	Yes	No
Sub-regional Network for Grassland Genetic Reserves	No	Yes	Yes	No	No	Yes	No

National Citrus Gene Sanctuary - West Garo Hills	No	Yes	No	No	Yes	No	N/A
Ammi'ad Reserve in Israel	No	No	No	No	No	No	No
Majella National Park	Yes	No	No	No	Yes	Yes	Yes
Besh-Aral State Nature Reserve	N/A	N/A	N/A	N/A	N/A	N/A	N/A
***Sierra de Manantlán* Biosphere Reserve**	No	Yes	No	No	Yes	No	Yes
Wadi Sair Genetic Reserve	Yes	Yes	Yes	No	No	No	Yes
Biodiversity Micro-Reserves network	No	Yes	Yes	No	No	Yes	Yes
***Beta patula* genetic reserve**	N/A	No	N/A	N/A	N/A	On-going	No
Valencian Plant Micro-Reserves network	No	Yes	Yes	Yes	No	Yes	Yes
***Sierra del Rincón* Biosphere Reserve**	Yes	Yes	Yes	No	Yes	Yes	Yes
***In situ* conservation of forage plants genetic diversity**	Yes	Yes	Yes	Yes	Yes	No	Yes
The Coronado National Forest	Yes	Yes	Yes	Yes	No	Yes	Yes
Organ Pipe Cactus National Monument	N/A	Yes	Yes	On-going	No	Yes	Yes
Lizard Peninsula CWR Reserve	Yes	Yes	Yes	No	Yes	Yes	No

Annex III: Target CWR taxa current conservation status, international legislation and any additional distinction.

Showcase	Taxa	Genus	Target taxa current conservation status	According to	Target taxa international legislation	Target taxa additional distinction
Erebuni State Reserve	*Triticum araraticum*	*Triticum*	LC	IUCN	Yes	
Erebuni State Reserve	*Triticum boeoticum*	*Triticum*	LC	IUCN	N/A	
Erebuni State Reserve	*Triticum urartu*	*Triticum*	DD	IUCN	Yes	
Erebuni State Reserve	*Aegilops tauschii*	*Aegilops*	LC	IUCN	Yes	
Erebuni State Reserve	*Aegilops cylindrica*	*Aegilops*	LC	IUCN	Yes	
Erebuni State Reserve	*Aegilops triuncialis*	*Aegilops*	LC	IUCN	N/A	
Erebuni State Reserve	*Aegilops columnaris*	*Aegilops*	LC	IUCN	Yes	
Erebuni State Reserve	*Aegilops trivialis*	*Aegilops*	LC	IUCN	Yes	
Erebuni State Reserve	*Amblyopyrum muticum*	*Amblyopyrum*	EN	IUCN	Yes	
Genetic reserve network for wild celery	*Apium graveolens* ssp. *graveolens*	*Apium*	EN	National publication	N/A	
Genetic reserve network for wild celery	*Helosciadium repens*	*Helosciadium*	CR	National publication	Yes	
Genetic reserve network for wild celery	*Helosciadium inundatum*	*Helosciadium*	EN	National publication	N/A	
Genetic reserve network for wild celery	*Helosciadium nodiflorum*	*Helosciadium*	EN	National publication	N/A	
Network of Genetic Reserves for *Vitis sylvestris* in Germany	*Vitis sylvestris*	*Vitis*	EN	National publication	N/A	Only endemic taxon of the Vitaceae family in Europe
Sub-regional Network for Grassland Genetic Reserves	*Dactylis glomerata*	*Dactylis*				
Sub-regional Network for Grassland Genetic Reserves	*Festuca ovina*	*Festuca*				
Sub-regional Network for Grassland Genetic Reserves	*Festuca pratensis*	*Festuca*				
Sub-regional Network for Grassland Genetic Reserves	*Festuca rubra*	*Festuca*				
Sub-regional Network for Grassland Genetic Reserves	*Lolium multiflorum*	*Lolium*	LC	IUCN	N/A	

Sub-regional Network for Grassland Genetic Reserves	*Lolium perenne*	*Lolium*	LC	IUCN	N/A	
Sub-regional Network for Grassland Genetic Reserves	*Phleum pratense*	*Phleum*	LC	IUCN	N/A	
Sub-regional Network for Grassland Genetic Reserves	*Poa pratensis*	*Poa*	LC	IUCN	N/A	
Sub-regional Network for Grassland Genetic Reserves	*Poa trivialis*	*Poa*				
Sub-regional Network for Grassland Genetic Reserves	*Trifolium pratense*	*Trifolium*	LC	IUCN	N/A	
Sub-regional Network for Grassland Genetic Reserves	*Trifolium repens*	*Trifolium*				
National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills	*Citrus indica*	*Citrus*				
National Citrus Gene Sanctuary - West Garo Hills	*Citrus macroptera*	*Citrus*				
Ammi'ad Reserve in Israel	*Triticum dicoccoides*	*Triticum*				
Ammi'ad Reserve in Israel	*Hordeum spontaneum*	*Hordeum*				
Ammi'ad Reserve in Israel	*Olea europaea*	*Olea*				
Ammi'ad Reserve in Israel	*Avena sterilis*	*Avena*				
Majella National Park	*Lathyrus* spp.	*Lathyrus*				
Majella National Park	*Lotus* spp.	*Lotus*				
Majella National Park	*Lupinus* spp.	*Lupinus*				
Majella National Park	*Medicago* spp.	*Medicago*				
Majella National Park	*Melilotus* spp.	*Melilotus*				
Majella National Park	*Pisum* spp.	*Pisum*				
Majella National Park	*Trifolium* spp.	*Trifolium*				
Majella National Park	*Vicia* spp.	*Vicia*				
Besh-Aral State Nature Reserve	*Pyrus korshinskyi*	*Pyrus*	CR	IUCN	N/A	
Besh-Aral State Nature Reserve	*Malus Sieversii*	*Malus*	VU	IUCN	N/A	

Besh-Aral State Nature Reserve	*Juglans* spp.	*Juglans*				
***Sierra de Manantlán* Biosphere Reserve**	*Zea diploperennis*	*Zea*	EN	IUCN	N/A	
***Sierra de Manantlán* Biosphere Reserve**	*Zea mays* subsp. *parviglumis*	*Zea*	LC	IUCN	No	
Wadi Sair Genetic Reserve	*Lathyrus* spp.	*Lathyrus*				
Wadi Sair Genetic Reserve	*Lens* spp.	*Lens*				
Wadi Sair Genetic Reserve	*Medicago* spp.	*Medicago*				
Wadi Sair Genetic Reserve	*Trifolium* spp.	*Trifolium*				
Wadi Sair Genetic Reserve	*Vicia* spp.	*Vicia*				
Wadi Sair Genetic Reserve	*Aegilops* spp.	*Aegilops*				
Wadi Sair Genetic Reserve	*Avena* spp.	*Avena*				
Wadi Sair Genetic Reserve	*Hordeum* spp.	*Hordeum*				
Wadi Sair Genetic Reserve	*Triticum* spp.	*Triticum*				
Wadi Sair Genetic Reserve	*Olea* spp.	*Olea*				
Wadi Sair Genetic Reserve	*Prunus* spp.	*Prunus*				
Wadi Sair Genetic Reserve	*Pyrus* spp.	*Pyrus*				
Wadi Sair Genetic Reserve	*Allium* spp.	*Allium*				
Biodiversity Micro-Reserves network	*Armeria pseudoarmeria*	*Armeria*	EN	IUCN	Yes	Endemic to Europe
Biodiversity Micro-Reserves network	*Juncus valvatus*	*Juncus*	DD	IUCN	Yes	Endemic to Europe
Biodiversity Micro-Reserves network	*Dianthus cintranus* subsp. *cintranus*	*Dianthus*	VU	National publication	Yes	Endemic to Europe
Biodiversity Micro-Reserves network	*Ulex jussiaei* subsp. *congestus*	*Ulex*				Endemic to Europe
Biodiversity Micro-Reserves network	*Narcissus pseudonarcissus* subsp. *nobilis*	*Narcissus*	VU	National publication	Yes	Endemic to Europe
Biodiversity Micro-Reserves network	*Linaria ricardoi*	*Linaria*	EN	IUCN	Yes	Single-country endemic
Biodiversity Micro-Reserves network	*Linaria hirta*	*Linaria*				
***Beta patula* genetic reserve**	*Beta patula*	*Beta*	EN	IUCN	Yes	Single-country endemic
***Sierra del Rincón* Biosphere Reserve**	*Vicia sativa*	*Vicia*	LC	IUCN	N/A	
***Sierra del Rincón* Biosphere Reserve**	*Aegilops geniculata*	*Aegilops*	LC	IUCN	Yes	
***Sierra del Rincón* Biosphere Reserve**	*Lathyrus aphaca*	*Lathyrus*	LC	IUCN	Yes	
***Sierra del Rincón* Biosphere Reserve**	*Lupinus angustifolius*	*Lupinus*	LC	IUCN	No	

***Sierra del Rincón* Biosphere Reserve**	*Lupinus hispanicus*	*Lupinus*	LC	IUCN	Yes	
***Sierra del Rincón* Biosphere Reserve**	*Ornithopus compressus*	*Ornithopus*				
***Sierra del Rincón* Biosphere Reserve**	*Trifolium angustifolium*	*Trifolium*	LC	IUCN	N/A	
***Sierra del Rincón* Biosphere Reserve**	*Trifolium campestre*	*Trifolium*				
***Sierra del Rincón* Biosphere Reserve**	*Trifolium pratense*	*Trifolium*	LC	IUCN	N/A	
***Sierra del Rincón* Biosphere Reserve**	*Trifolium strictum*	*Trifolium*				
***Sierra del Rincón* Biosphere Reserve**	*Daucus carota*	*Daucus*				
***Sierra del Rincón* Biosphere Reserve**	*Linum bienne*	*Linum*				
***Sierra del Rincón* Biosphere Reserve**	*Salvia verbenaca*	*Salvia*				
***Sierra del Rincón* Biosphere Reserve**	*Hypericum perforatum*	*Hypericum*	LC	IUCN	N/A	
***Sierra del Rincón* Biosphere Reserve**	*Papaver rhoeas*	*Papaver*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Agrostis gigantea*	*Agrostis*				
***In situ* conservation of forage plants genetic diversity**	*Alopecurus pratensis*	*Alopecurus*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Arrhenatherum elatius*	*Arrhenatherum*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Dactylis glomerata*	*Dactylis*				
***In situ* conservation of forage plants genetic diversity**	*Festuca rubra*	*Festuca*				
***In situ* conservation of forage plants genetic diversity**	*Lolium multiflorumam*	*Lolium*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Lolium perenne*	*Lolium*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Lotus corniculatus*	*Lotus*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Medicago sativa*	*Medicago*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Onobrychis viciifolia*	*Onobrychis*	LC	IUCN	N/A	

***In situ* conservation of forage plants genetic diversity**	*Phleum pratense*	*Phleum*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Poa pratensis*	*Poa*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Schedonorus arundinaceus*	*Schedonorus*				
***In situ* conservation of forage plants genetic diversity**	*Schedonorus pratensis*	*Schedonorus*				
***In situ* conservation of forage plants genetic diversity**	*Trifolium pratense*	*Trifolium*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Trifolium repens*	*Trifolium*	LC	IUCN	N/A	
***In situ* conservation of forage plants genetic diversity**	*Trisetum flavescens*	*Trisetum*				
The Coronado National Forest	*Capsicum annuum* var. *glabriusculum*	*Capsicum*	LC	IUCN	N/A	
Organ Pipe Cactus National Monument	*Capsicum annuum* var. *glabriusculum*	*Capsicum*	LC	IUCN	N/A	
Lizard Peninsula CWR Reserve	*Allium schoenoprasum*	*Allium*				
Lizard Peninsula CWR Reserve	*Allium ursinum*	*Allium*				
Lizard Peninsula CWR Reserve	*Asparagus officinalis* subsp. *prostratus*	*Asparagus*				
Lizard Peninsula CWR Reserve	*Beta vulgaris* subsp. *maritima*	*Beta*				
Lizard Peninsula CWR Reserve	*Daucus carota* subsp. *gummifer*	*Daucus*				
Lizard Peninsula CWR Reserve	*Raphanus raphanistrum* subsp. *maritimus*	*Raphanus*				
Lizard Peninsula CWR Reserve	*Trifolium occidentale*	*Trifolium*				
Lizard Peninsula CWR Reserve	*Trifolium repens*	*Trifolium*				

Annex IV: SWOT analyses (Strengths, Weaknesses, Opportunities and Threats) for each *CWR genetic reserve network*.

Table 16. The main strengths found in each studied showcase.

Showcase	Description
Erebuni State Reserve	Damages from not fencing and fires have never occurred
Erebuni State Reserve	Many years of conservation already on-going
Erebuni State Reserve	Specific monitoring plan for cereal CWR
Genetic reserve network for wild celery	Wild Celery Network coordination unit
Genetic reserve network for wild celery	Maintenance of the network is guaranteed through a permanently funded institution
Genetic reserve network for wild celery	Public awareness and support were raised
Genetic reserve network for wild celery	Gathered data will be stored at a central location and will largely be available to the public
Genetic reserve network for wild celery	Consideration of sites beyond the Natura 2000 network
Genetic reserve network for wild celery	Image gain for all participants of the network
Genetic reserve network for wild celery	Criteria for the designation of genetic reserves (Iriondo *et al*., 2012) were weighted pragmatically to ease the initiation of the network
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Located in protected areas
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Baseline for monitoring generated
Sub-regional Network for Grassland Genetic Reserves	Areas protected against destruction or deterioration
National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills	Permanent agreement with village headmen of the area
National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills	Many years of conservation already on-going
National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills	Legal protection granted long-time by the Indian Council
Ammi'ad Reserve in Israel	It does not require high maintenance, not open to the general public
Ammi'ad Reserve in Israel	Scientific studies developed with the target CWR in the reserve for more than 25 years
Majella National Park	Authorization to sell plants
Majella National Park	Belong to a network of institutions
Besh-Aral State Nature Reserve	Many years of conservation already on-going
Besh-Aral State Nature Reserve	Tourism activities are limited and must be ecological tourism with a guide

Sierra de Manantlán Biosphere Reserve	Declaration of the protected area contemplates the maintenance of forms of tenure existing and work with local people
Sierra de Manantlán Biosphere Reserve	Many years of conservation already on-going
Sierra de Manantlán Biosphere Reserve	Resources do not depend only on one source
Wadi Sair Genetic Reserve	Socio-economic-political-ethnographic factors were also taken into account at the selection of the sites
Wadi Sair Genetic Reserve	Implement appropriate but minimally intrusive site management
Wadi Sair Genetic Reserve	A committee of 10 farmers represent them to follow up on all management options together with specialized staff from the Ministry
Wadi Sair Genetic Reserve	Several institutions provided technical support, network building, dissemination of project activities and developing the management plan
Biodiversity Micro-Reserves network	Proximity and involvement of landowners and civil society
Biodiversity Micro-Reserves network	Low level of investment versus good conservation results
Biodiversity Micro-Reserves network	Reduced areas of interventions
Beta patula genetic reserve	Rigorous scientific work
Beta patula genetic reserve	Genetic reserve occurs within existing conservation areas
Beta patula genetic reserve	Genetic reserve occurs in very isolated sites far from human disturbance
Beta patula genetic reserve	They are endorsed by governmental authorities and managed by them
The Valencian Plant Micro-Reserves network	It is already a well-consolidated and settled network
The Valencian Plant Micro-Reserves network	Public funds
Sierra del Rincón Biosphere Reserve	Co-ordinated work involving design, implementation and social aspects
Sierra del Rincón Biosphere Reserve	Protected area support (Biosphere Reserve) as set in the objectives
In situ conservation of forage plants genetic diversity	Important role displayed by the farmers
In situ conservation of forage plants genetic diversity	Farmers recognition and economic return
In situ conservation of forage plants genetic diversity	Many resources allocated
In situ conservation of forage plants genetic diversity	Agro-biodiversity community well represented
In situ conservation of forage plants genetic diversity	Maintenance of the network is guaranteed through the government
The Coronado National Forest	Well-established and extended network of partners and collaborators

The Coronado National Forest	Public funds
The Coronado National Forest	Several decades of experience
The Coronado National Forest	Strong bonds with local communities, especially Native American Tribes (NATs)
The Coronado National Forest	Good integration of social initiatives, educational, volunteering and conservation programmes
Organ Pipe Cactus National Monument	It has a well-established and extended network of partners and collaborators
Organ Pipe Cactus National Monument	Public funds
Organ Pipe Cactus National Monument	Several decades of experience
Organ Pipe Cactus National Monument	Strong bonds with local communities, especially Native American Tribes (NATs)
Organ Pipe Cactus National Monument	Biosphere Reserve and Wilderness Areas designation attract scientists
Organ Pipe Cactus National Monument	Additional funds throught visitors and store and donations
Organ Pipe Cactus National Monument	National Monument and UNESCO biosphere reserve/ Protected areas
Lizard Peninsula CWR Reserve	Rigorous scientific work

Table 17. The main weaknesses found in each studied showcase.

Showcase	**Description**
Erebuni State Reserve	Management plan not approved by the Government
Erebuni State Reserve	Monitoring is not frequent
Erebuni State Reserve	Depends on the state and community budget
Erebuni State Reserve	Deficit of engagement of local communities for successful conservation of CWR
Genetic reserve network for wild celery	Genetic reserves are also located on private property. Therefore, intensive personal contact is necessary to engage the landowners
Genetic reserve network for wild celery	No legal obligation and limited benefits for private stakeholders to join the network, e.g. no additional management resources (i.e. financial support)
Genetic reserve network for wild celery	The network covers only one gene pool
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Management depends on voluntary collaboration
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Not integrated into management plans yet
Sub-regional Network for Grassland Genetic Reserves	The management required for conservation is not secured without agricultural support schemes
Sub-regional Network for Grassland Genetic Reserves	Management depends on voluntary collaboration

National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills	Public data is scarce and hard to reach
Ammi'ad Reserve in Israel	Episodes of uncontrolled grazing
Ammi'ad Reserve in Israel	Communities located around the reserve are not totally aware of the importance of the place
Ammi'ad Reserve in Israel	Social struggles prevent the reserve from being enlarged
Ammi'ad Reserve in Israel	Lack of funding that does not allow maintenance
Majella National Park	CWR management plans have not been developed yet
Besh-Aral State Nature Reserve	Flora in the reserve have been poorly studied
Besh-Aral State Nature Reserve	CWR management plans have not been developed yet
Besh-Aral State Nature Reserve	Public data is scarce and hard to reach
Sierra de Manantlán Biosphere Reserve	Conflicts over the definition of the boundaries
Sierra de Manantlán Biosphere Reserve	CWR management plans have not been developed yet
Wadi Sair Genetic Reserve	Public data is scarce and hard to reach
Biodiversity Micro-Reserves network	No financial incentives to landowners
Biodiversity Micro-Reserves network	Lack of legal regulation
Biodiversity Micro-Reserves network	Low level of social recognition
Biodiversity Micro-Reserves network	Low level of involvement from national government and other relevant entities
Biodiversity Micro-Reserves network	There is no real management yet of the target populations
Beta patula genetic reserve	Not recognized yet
Beta patula genetic reserve	Funds for management depend only on the government
Beta patula genetic reserve	Limited access and far away from human populations limit social support
The Valencian Plant Micro-Reserves network	Its main objective does not include CWR per se, as it is focused on endangered flora
The Valencian Plant Micro-Reserves network	No funds available to protect those CWR that are not listed as endangered
Sierra del Rincón Biosphere Reserve	Conservation actions just started, no previous experience
Sierra del Rincón Biosphere Reserve	CWR management plans have not been developed yet
Sierra del Rincón Biosphere Reserve	Many CWR in the area not actively protected
In situ conservation of forage plants genetic diversity	Conservation actions just started, no previous experience
The Coronado National Forest	Main objective does not include CWR per se
The Coronado National Forest	The main conservation efforts are focused on the chiltepin

The Coronado National Forest	NATs desire more accommodation of traditional and cultural uses in decision-making and planning
The Coronado National Forest	The forest plan does not provide guidance for the type of collaborative conservation efforts
Organ Pipe Cactus National Monument	Its main objective does not include CWR *per se*
Organ Pipe Cactus National Monument	Its geographical position makes it vulnerable to environmental disturbances due to legal and illegal border activities
Lizard Peninsula CWR Reserve	No official recognition yet
Lizard Peninsula CWR Reserve	No specific funding for GR yet
Lizard Peninsula CWR Reserve	Many CWR in the area not actively protected

Table 18. The main opportunities found in each studied showcase.

Showcase	**Description**
Erebuni State Reserve	Many other CWR in addition to the ones actively protected
Erebuni State Reserve	Civil society in Armenia is generally involved in conservation activities
Genetic reserve network for wild celery	The generation of a framework for CWR in situ conservation through the development of the planned "German Network of Genetic Reserves" demonstrates the support of the Germany government to continue this work
Genetic reserve network for wild celery	Nature conservation sector in Germany is increasing its engagement
Genetic reserve network for wild celery	The network improves the collaboration and communication between agriculture and nature conservation
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Public interest species
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Stakeholders are interested
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Potential financial support for monitoring
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Significant resistances to downy mildew, powdery mildew and black rot
Sub-regional Network for Grassland Genetic Reserves	The network can serve as example for other regions
Sub-regional Network for Grassland Genetic Reserves	Useful to increase awareness about the importance of grasslands
Sub-regional Network for Grassland Genetic Reserves	Potential financial support for monitoring
National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills	The area is a biodiversity hotspot and harbors a range of endangered species
National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills	Related to a very important crop with very limited distribution of wild populations

Ammi'ad Reserve in Israel	Four other contiguous territories where the reserve could be expanded
Ammi'ad Reserve in Israel	Many other CWR in addition to the ones actively protected
Majella National Park	Belonging to an *ex situ* conservation network
Majella National Park	CWR conservation recently earning more interest at the Park
Majella National Park	Many CWR in the area
Besh-Aral State Nature Reserve	Area without deep floristic studies
Sierra de Manantlán Biosphere Reserve	Up to 47 CWR present in the reserve
Sierra de Manantlán Biosphere Reserve	Several dissemination actions
Wadi Sair Genetic Reserve	The West Asia region contains one of the three major megacentres of diversity for crop of global significance
Wadi Sair Genetic Reserve	Belongs to a network of four different countries
Biodiversity Micro-Reserves network	Good conservation model to replicate to conserve more CWR
Biodiversity Micro-Reserves network	Greater involvement of society (citizens and private companies) in conservation
Beta patula genetic reserve	Opportunities due to its limited distribution
The Valencian Plant Micro-Reserves network	Managers of the protected area are willing to actively protect CWR
The Valencian Plant Micro-Reserves network	Local regional government management has unleashed a flood of local pride
The Valencian Plant Micro-Reserves network	Many CWR in the area
Sierra del Rincón Biosphere Reserve	Pilot study that has the potential of being implemented in other Biosphere Reserves
Sierra del Rincón Biosphere Reserve	Government showing true interest in CWR conservation
Sierra del Rincón Biosphere Reserve	Well received by the workshop participants and local people
Sierra del Rincón Biosphere Reserve	Many CWR in the area
In situ conservation of forage plants genetic diversity	Project expansion approved
In situ conservation of forage plants genetic diversity	Trust and freedom for farmers to take action in conservation
The Coronado National Forest	A non-profit conservation organization participating in chiltepin conservation, is partially funded by local varieties seed distribution, including chiltepin
The Coronado National Forest	Recreation activities may provide funds directed for conservation and/or local communities welfare
Organ Pipe Cactus National Monument	Future cooperation with Conservation Organizations would allow more efficient *in situ* and *ex situ* conservation of CWR

Organ Pipe Cactus National Monument	Cooperation with local communities and farms may allow for efficient in situ conservation of edible CWR
Lizard Peninsula CWR Reserve	Many different stakeholders involved
Lizard Peninsula CWR Reserve	Many other CWR in addition to the ones actively protected
Lizard Peninsula CWR Reserve	Some traits are exclusively present in this site

Table 19. The main threats found in each studied showcase.

Showcase	Description
Genetic reserve network for wild celery	Consent forms can be revoked any time without consequences by landowners and supporters resulting in disbanding a genetic reserve of the network
Genetic reserve network for wild celery	Recent changes in environmental regulations affecting farmers lead to frustration and general aversion towards nature conservation
Genetic reserve network for wild celery	Progressing climate change makes it difficult to ensure that genetic reserves persist over a long time
Genetic reserve network for wild celery	Funding of management is unsecured and mostly measure-specific
Genetic reserve network for wild celery	Staff of nature conservation agencies and NGOs as well as land users are overburdened permanently, generally resulting in slow responses and progress
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Work currently based on project funding
Network of Genetic Reserves for *Vitis sylvestris* in Germany	Species easy to be confounded by non-trained people
Sub-regional Network for Grassland Genetic Reserves	Changing economic framework in agriculture that does not favor the type of management required for the grassland areas
Sub-regional Network for Grassland Genetic Reserves	Work currently based on project funding
Sub-regional Network for Grassland Genetic Reserves	Nitrogen inputs via air threaten especially calcareous grasslands and fen meadows and can cause significant shifts in species composition
National Citrus Gene Sanctuary - Biosphere Reserve in the West Garo Hills	Activities, conservation actions and studies have not been renewed
Ammi'ad Reserve in Israel	Army practices that could cause fires, breaking fences and scratching the landscape
Ammi'ad Reserve in Israel	Monitoring, sampling and fencing depend on the budget
Majella National Park	CWR are not the main conservation purpose
Besh-Aral State Nature Reserve	Size of the reserve has decreased over the years

Sierra de Manantlán Biosphere Reserve	Irregular land tenure and use
Wadi Sair Genetic Reserve	Funding ended at the end of the project
Wadi Sair Genetic Reserve	Uncertainty due to the country's context
Biodiversity Micro-Reserves network	Some private lands only ensured short-term
Biodiversity Micro-Reserves network	Not all the CWR occurring in the GR are conserved ex situ
Biodiversity Micro-Reserves network	CWR are not the main conservation purpose
The Valencian Plant Micro-Reserves network	Its geographical location, sometimes close to Mediterranean touristic sites, make them vulnerable to vandalism and loss of biodiversity
The Valencian Plant Micro-Reserves network	National government still does not have a legal figure for "Genetic Reserve"
Sierra del Rincón Biosphere Reserve	Only ensured short term
Sierra del Rincón Biosphere Reserve	Active conservation depends on financial support
In situ conservation of forage plants genetic diversity	All the GR belong to farmers
The Coronado National Forest	Increasing demand for chiltepin peppers may affect wild populations
The Coronado National Forest	Public funds are declining
The Coronado National Forest	The ever-growing number of visitors may pose a future threat for ecosystems
The Coronado National Forest	Unplanned wildland fires may affect chiltepin populations
Organ Pipe Cactus National Monument	The ever-growing number of visitors may pose a future threat for the ecosystems
Organ Pipe Cactus National Monument	The increased legal and illegal border activities may have a negative environmental impact
Organ Pipe Cactus National Monument	The construction of border walls and fences may disrupt species movement between adjacent areas
Lizard Peninsula CWR Reserve	CWR occurring outside PA are not being actively conserved
Lizard Peninsula CWR Reserve	Not all the CWR occurring in the GR are conserved *ex situ*

Annex V: Summary of identified features involved at the SWOT analyses categorized and their number of occurrences among the studied *CWR genetic reserve networks.*

Category	Occurrences	Type	Category	Occurrences	Type
Gained experience	7	Strengths	Lack of resources	11	Weaknesses
Financial support	6	Strengths	Lack of management plan	7	Weaknesses
Social support	4	Strengths	Lack of local communities' engagement	4	Weaknesses
Long-term network guaranteed	4	Strengths	Does not cover all CWR taxa	4	Weaknesses
Scientific background	3	Strengths	Data not available to the public	3	Weaknesses
Network support	3	Strengths	First stages	3	Weaknesses
Local people involved	3	Strengths	Lack of recognition of GR	2	Weaknesses
Located in protected areas	3	Strengths	Need of CWR relevance	2	Weaknesses
Low costs	2	Strengths	Social struggles	2	Weaknesses
Monitoring plan	2	Strengths	Diverse locations imply more work	1	Weaknesses
Coordination unit	2	Strengths	Forest plan does not capture social reclaims	1	Weaknesses
Physical protection	2	Strengths	Lack of legal regulation	1	Weaknesses
Stakeholders recognition	2	Strengths	Lack of scientific research	1	Weaknesses
Biosphere Reserve support	2	Strengths	Lack of social support	1	Weaknesses
Certain budget self-control	2	Strengths	Not enough social recognition	1	Weaknesses
Agriculture and nature protection communities collaborating	1	Strengths	Physical damage	1	Weaknesses
Agriculture experts	1	Strengths	No more species in the country	1	Weaknesses
Conservation areas designed efficiently	1	Strengths	CWR biodiversity hotspot	8	Opportunities
Criteria for designation of GR will keep improving	1	Strengths	Social engagement	8	Opportunities
Data available to the public	1	Strengths	External supporting network	4	Opportunities
Land assured	1	Strengths	Growing possibilities	3	Opportunities
Local people agreement	1	Strengths	Potential financial support	3	Opportunities
Not intrusive site management	1	Strengths	Replicable model	3	Opportunities

Other activities protection	1	Strengths	Special importance for spp. potential use	3	Opportunities
Several types of locations	1	Strengths	Biodiversity hotspot	2	Opportunities
Strong legal protection	1	Strengths	Managers interest	2	Opportunities
Well-planned components	1	Strengths	Governmental interest	1	Opportunities
Lack of funds	8	Threat	Inter-sectoral approach	1	Opportunities
Damages	7	Threat	Link with other initiatives	1	Opportunities
Land uncertainty	5	Threat	National framework supporting	1	Opportunities
Need of CWR relevance	3	Threat	Special importance for spp. limited distribution	1	Opportunities
Environmental/Agriculture regulation	3	Threat	Stakeholders involvement	1	Opportunities
Ex situ	2	Threat			
General uncertainty	2	Threat			
Climate Change and pollution	2	Threat			
Outdated actions	1	Threat			
Over resource exploitation	1	Threat			
Social struggles	1	Threats			