European Cooperative Programme for Plant Genetic Resources

ECP/GR

PLANT GENETIC RESOURCES STRATEGY FOR EUROPE

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The European Cooperative Programme for Plant Genetic Resources (ECPGR) is a collaborative programme among most European countries aimed at contributing to rationally and effectively conserve *ex situ* and *in situ* Plant Genetic Resources for Food and Agriculture, provide access and increase sustainable use (http://www.ecpgr.cgiar.org). The Programme, which is entirely financed by the member countries, is overseen by a Steering Committee composed of National Coordinators nominated by the participating countries. The Coordinating Secretariat is hosted by The Alliance of Bioversity International and CIAT. The Programme operates through Working Groups composed of pools of experts nominated by the National Coordinators. The ECPGR Working Groups deal with either crops or general themes related to plant genetic resources (documentation, information and *in situ* and on-farm conservation). Members of the Working Groups carry out activities based on specific ECPGR objectives, using ECPGR funds and/or their own resources.

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Contents

Executive Summary

Introduction

As part of an urgent call to action, this **Plant Genetic Resources Strategy for Europe** (hereafter the PGR Strategy) is complementary to the *Genetic Resources Strategy for Europe*, aiming to halt the ongoing loss of genetic resources and ensure their continued facilitated use. Plant Genetic Resources (PGR) are currently neither adequately conserved nor sufficiently accessible, but are vital for addressing agricultural challenges. These include mitigating the effects of climate change, enhancing food quality and security, and developing a sustainable bioeconomy. Efficient management and utilisation of PGR can reduce agricultural input levels, and improve environmental sustainability and biodiversity conservation. Implementing the PGR Strategy will ensure transformative changes to more effective and efficient PGR conservation and use in Europe, and will support regional commitments under key international agreements.

As part of linking European commitments with global policy frameworks and international networks and agreements, European countries have established their national PGR management programmes, and set up the European Cooperative Programme for Plant Genetic Resources (ECPGR) to coordinate PGR conservation and use initiatives. However, effective implementation of activities is constrained by weak, uneven political support. The EU recently strengthened its commitment, partly by calling for the need to prepare an *EU Strategy for Genetic Resources for Aquaculture, Forests and Agriculture*, and also through its Biodiversity Strategy for 2030 and the Farm to Fork Strategy.

PGR Strategy Objectives

By 2030, the PGR Strategy will catalyse and begin the transformation of European-wide PGR conservation and sustainable use via its implemented actions and achieved targets. This includes i) Expanded ***in situ*** conservation of crop wild relatives (CWR) and wild food plants (WFP); ii) Improved and promoted **on-farm** European PGR conservation and management; iii) Consolidated and sustained European ***ex situ*** PGR conservation; iv) Promoted **sustainable use** of European PGR; v) A strengthened **germplasm information** system that supports better conservation and use of European PGR; and vi) **Monitored progress** in PGR conservation and use.

In situ *CWR and WFP* conservation and use has been neglected, mainly due to insufficient awareness of the economic and environmental gains they can bring to agriculture with their useful traits that are not part of the domesticated genepools.

Hence, by 2030 the PGR Strategy aims to **significantly increase CWR and WFP inventories** to better understand their distribution and target priority populations. The PGR Strategy also aims at strengthening *in situ* CWR and WFP conservation and management so that, by 2030, **European countries** will be ready **to implement their National CWR and WFP conservation strategies** and set up and manage a network for *in situ* management of priority CWR populations.

On-farm landraces and other heterogeneous populations maintain particular diversity in agronomic, quality and adaptive traits or local cultural values. These are threatened by replacement with new commercial varieties in changing production systems, as well as by regulation and marketing obstacles to on-farm PGR use. Lack of a comprehensive overview of on-farm PGR is an impediment to promoting their conservation and use. The link between farmers and community, NGOs or institutional genebanks is poorly developed and opportunities to an efficient on-farm management need to be developed.

By 2030 the PGR Strategy therefore aims for a complete updatable European **inventory of on-farm landraces**, the identified diversity of which **will be comprehensively conserved** on-farm, complemented with *ex situ* back-ups, and made available for sustainable use with adequate marketing rules.

Ex situ *PGR*: More than 2 million PGR accessions are conserved across around 400 institutions and NGOs in Europe. However, quality and efficiency of conservation are extremely variable, and there is little guarantee of accessions' long-term safety. A more coordinated management at regional level and an increased commitment towards sharing responsibilities are the purposes of "A Genebank Integrated System (AEGIS)". A well-functioning AEGIS will best position Europe to efficiently use its valuable PGR as well as to serve as a primary contributor to the global conservation effort.

Hence, by 2030 the PGR Strategy aims to safely conserve PGR diversity in European genebanks and make it accessible for sustainable use, by improving the efficiency and efficacy of the European genebank infrastructure. Activities will **reinforce and expand AEGIS**, by establishing a certification and monitoring system, by building genebank managers' capacities and by avoiding further loss of European PGR. The PGR Strategy also aims to expand genetic diversity coverage in European genebanks, especially with regard to landraces, minor and underutilised crops and CWR. Hence by 2030, the PGR Strategy aims to ensure European genebanks' **long-term conservation**

of relevant PGR along with **their appropriate access.**

Promoting sustainable use of Europe's PGR is increasingly necessary to establish more sustainable, higher quality and healthy food and other production systems, and to face the challenges of climate change and reducing agricultural inputs. Although Europe is rich in PGR, it is not utilizing them to their full potential.

To promote greater access to PGR and their more sustainable use by 2030, the PGR Strategy will: i) help ensure **access to well-documented ex- and in situ genetic diversity**; ii) establish dynamic PGR **crop portals** for European crops; iii) secure commitment for targeted **phenotypic and genotypic characterization and evaluation** of European PGR, as well as improving digitization, harmonization, availability and exchange of existing and newly-generated PGR characterization and evaluation data; iv) achieve a systematic **use of CWR genetic diversity** in research and crop improvement; v) ensure farmers and civil society actors can **add value to European landraces** through participatory breeding methodologies; and, vi) ensure **more diversified European production systems** are established, by removing disincentives and promoting incentives.

Strengthening the PGR information system: As a cornerstone of the European PGR Information System, the European Search Catalogue for Plant Genetic Resources (EURISCO) links to the Multilateral System (MLS), to AEGIS, to the global genetic resources catalogue Genesys, and to the Global Information System. The data flow from countries to EURISCO is assured by a network of National Focal Points (NFPs). Some shortcomings need addressing, including: i) varying capacity and skills gaps of PGR holders and data providers; ii) a lack of adequate financial support to ensure regular transfer of data to the EURISCO hub; iii) limited interoperability with other open-access databases and crop portals; and iv) limited awareness and use of EURISCO.

In a three-steps approach, by 2030 the PGR Strategy will: i) ensure the NFPs are supported to **collect and upload PGR genebank passport data**; ii) **provide** publicly available **quality phenotypic data** to EURISCO via standardized methods, and adopting standards and tools for harmonised management of phenotypic data, thus allowing publicly-available**, harmonised phenotypic datasets in EURISCO**; and iii) ensure **EURISCO** comprehensively **applies the FAIR guiding principles for data management** (findability, accessibility, interoperability, and reusability), and the NFPs are trained to also adopt these principles for managing local data sources. With its high standard

data governance and management **EURISCO will become a trusted European and Global open-access database repository.**

Monitoring conservation and sustainable use of European PGR will assess the PGR Strategy implementation towards meeting its 2030 targets. Currently, lack of knowledge of existing levels of conserved and used genetic diversity hinders the identification of priorities, redundancies and gaps within the conservation systems.

Lack of robust, agreed and user-friendly indicators and of a mechanism to collect and aggregate data at local, national and regional level prevents i) publishing regular syntheses on European PGR conservation and use status and, ii) fostering positive and reversing negative trends.

By 2030, implementing the PGR Strategy will develop/adapt and agree on **sets of indicators of genetic resource conservation and use** to ensure that genetic diversity is maintained or increased in European production systems. A **hub will be created** to gather and publish local, national and regional PGR conservation and use data; and **trends in the conservation and sustainable use of PGR will be assessed, analysed and published** every five years, and necessary corrective measures proposed.

International Cooperation

Cooperation within and beyond Europe is essential to optimize PGR conservation and use. In helping shape global policies and partnerships that promote sustainability, synergies, efficiencies and cost-effectiveness, ECPGR and other European PGR networks bring conservation and use closer together.

The EU and the European Region: Additional collaborative actions are needed at national and European levels to mainstream PGR conservation and use into wider, coherent policies and programmes and to raise awareness. Key collaboration areas include: i) *In situ* CWR work; ii) *Ex situ* PGR conservation; iii) On-farm PGR management; iv) Promoting PGR use in research and breeding; v) PGR documentation and information strengthening; and vi) Scientific and technical exchange and networking. The ECPGR is the logical body to coordinate conservation and use of PGR in Europe, through its existing structures and a range of bilateral arrangements with stakeholders and non-ECPGR-member-countries.

Other Regions: In recognising a common PGR heritage with other regions, inter-regional initiatives should embrace the Near East and North Africa (NENA) region and the Caucasus, where many crops have their historic domestication origin. The inclusion of non-European collections

into AEGIS, safety duplications outside of Europe and southern hemisphere growing cycles, offer opportunities to widen the diversity conserved within European *ex situ* collections. National Programmes and ECPGR should be supported in European cooperation with other regions within both the framework of the *Genetic Resources Strategy for Europe* and this closely-linked PGR Strategy.

Global Cooperation: Given its successful track-record of PGR conservation and use, Europe is well placed to lead future initiatives aiming to fulfil international commitments within and beyond its own borders. Coordination should be improved or established within and among the groups of existing national focal points and representatives for Europe in international fora, dealing with PGR conservation and use.

Enabling transition to an optimal European system for PGR conservation and use

ECPGR aims to enable transformative change, whereby Europe can reinforce its leading role in global PGR conservation, and meet its commitments through strategic cooperation. This requires an appropriate policy framework and appropriate financing to strengthen national and regional programmes, as well as the necessary institutional and human capacities for PGR conservation and use. Additionally, ECPGR will continue to raise awareness of the value of PGR, especially for a sustainable and resilient agriculture. For long-term European PGR conservation and use, ECPGR will strengthen collaboration and coordination between multiple stakeholders.

Hence the PGR Strategy recommends establishing:

A coherent European policy framework: This includes: i) reviewing the EU PGR policy and legislative landscape, and implementing all relevant initiatives, coordinated for sustained long-term PGR conservation and use; ii) establishing – accordingly – a coherent European legal framework; and iii) developing and implementing coherent national conservation and use action plans in each of the European countries.

A long-term European infrastructure: This includes: i) infrastructure for *ex situ* and *in situ* PGR conservation and use, which includes a decentralized/virtual European genebank, routine screening facilities, and a European Network of managed and monitored priority *in situ* populations; ii) PGR *documentation and information* infrastructure to a) support conservation, monitoring, research, breeding, sustainable use, and human capacity building; b) provide information about potential financial support; and iii) **capacity-building schemes**, including

PGR education and long- and short-term training programmes.

A European Coordination and Information Centre on Genetic Resources: This centre will host and support, *inter alia*, the ECPGR Secretariat and support implementing the PGR Strategy, by i) assisting the EU and European governments; ii) coordinating and monitoring the Strategy implementation; iii) acting as a European PGR project implementation and financing agency; iv) raising stakeholders' awareness on plant genetic diversity and its value; v) coordinating input for international cooperation; and vi) reporting on these activities.

A secure and sustained financial base backed by political will, will replace the scattered and insufficient funding support for PGR conservation and use, as part of an overarching investment plan.

Conclusion

The ongoing erosion of PGR poses a dramatic global challenge, worsened by the climate-change crisis. The EU is committed to a transition to more sustainable and resilient agriculture and forestry, while ensuring food and nutrition security, health, inclusive and fair value chains, and maintaining a sustainable circular bioeconomy, all calling for long-term conservation and sustainable use of PGR. Informed by ECPGR's long experience of promoting cooperation among European countries and stakeholders, this PGR Strategy will help reverse this decline in line with the *Genetic Resources Strategy for Europe*, enabling Europe to meet its international commitments to PGR conservation and sustainable use.

Acronyms

ABS	Access and Benefit-Sharing
AEGIS	A European Genebank Integrated System
AQUAS	AEGIS Quality System
BIP	Biodiversity Indicators Partnership
(Br)API	(Breeding) Application Programming Interface
BSF	Benefit-sharing fund
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CGRFA	(FAO) Commission on Genetic Resources for Food and Agriculture
CWR	Crop wild relative(s)
DOI	Digital Object Identifier
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
ECPGR	European Cooperative Programme for Plant Genetic Resources
EU	European Union
EUCARPIA	European Association for Research on Plant Breeding
EURISCO	European Plant Genetic Resources Search Catalogue
EVA	European Evaluation Network
F2F	Farm-to-Fork Strategy
FAIR	findability, accessibility, interoperability, and reusability (data principles)
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FIGS	Focused Identification of Germplasm Strategies
GPA	Global Plan of Action (for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture)
GWAS	Genome-wide association study (ies)

→ Acronyms

IBPGR	the International Board for Plant Genetic Resources
ISO	International Organization for Standardization
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	International Union for Conservation of Nature
LR	Landrace(s)
MIAPPE	Minimum Information about Plant Phenotyping Experiments
MLS	Multi-lateral system
NENA	Near East and North Africa
NFP	National Focal Point
NGO	Non-governmental organization
PGR	Plant genetic resources
PGRFA	Plant genetic resources for food and agriculture
PDO	Protected Designation of Origin
PGI	Protected Geographical Indication
PHR	Plant health regulation
RDP	Rural Development Programme
SDGs	[United Nations] Sustainable Development Goals
(S)MTA	(Standard) Material Transfer Agreement
TSG	Traditional Specialities Guaranteed
UN	United Nations
UPOV	International Union for the Protection of New Varieties of Plants
VIR	Vavilov Institute of Plant Genetic Resources
WFP	Wild food plant(s)
WIEWS	World Information and Early Warning System (FAO)
WG	Working Group

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On behalf of ECPGR, we most gratefully acknowledge the commitment of the European plant genetic resources community who actively contributed to the development of the Plant Genetic Resources (PGR) Strategy, tightly linked to the Genetic Resources Strategy for Europe.

A very first working document was developed during summer 2020 with contributions from ECPGR Working Group members and Chairs, including experts from NGOs, as well as several National Coordinators. This document served as the basis for the further elaboration of the PGR Strategy.

An outline of the working document was presented to and discussed with the ECPGR Steering Committee and a few other stakeholders (over fifty participants[1]) in November 2020 during a specific side-event of the "Stakeholder Feedback Workshop" for the Genetic Resources Strategy for Europe. This discussion laid the foundations of the PGR Strategy, in harmony with the overarching Strategy covering agricultural and forest genetic resources. We gratefully acknowledge all those who critically contributed to the first working document[2], as well as the participants of the November 2020 side-event, for driving the PGR Strategy through its initial crucial steps of elaboration.

A Drafting Team gathering volunteers from National Coordination offices[3] was then set up to contribute to three subsequent drafts of the PGR Strategy during winter, spring and summer 2021. We sincerely acknowledge all members of the team, who accepted to dedicate a significant part of their working time to this difficult task, for their precious contribution to collective discussions on the future of PGR conservation and use in Europe and for their constructive consideration of the feedback received from various stakeholders on draft versions 1 and 2.

The drafts 1 and 2 of the PGR Strategy were circulated in spring and summer 2021 among a wide group of stakeholders – National Coordinators, ECPGR Chairs and Working Group members and other stakeholders outside the ECPGR circles.

[1] The list of participants is available at: https://www.ecpgr.cgiar.org/about/steering-committee/ad-hoc-meeting-of-the-ecpgr-steering-committee.

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[5] Vanessa Bryant, Nora Capozio, Sandra Goritschnig, Lorenzo Maggioni, Loredana Maria.

[6] Vincent Johnson

Preamble

The **Plant Genetic Resources Strategy for Europe (PGR Strategy)** is linked to the **Genetic Resources Strategy for Europe**, produced in the context of the GenRes Bridge [1] EU-funded project that deals with genetic resources conservation and sustainable use in Europe which has a wider focus that embraces animal, forest and plant domains.

In the context of this Strategy, Plant Genetic Resources (PGR) are defined as any genetic material of plant origin of actual or potential value for food and agriculture, and including horticulture with the production of medicinal, aromatic and ornamental plants.

Plant genetic resources are declining, even though they are vital for addressing the new challenges for European agriculture over the coming decades, particularly in terms of environment, food and nutrition security and safety, in the context of climate change.

The **PGR Strategy** is presented by the Steering Committee of the European Cooperative Programme for Plant Genetic Resources (ECPGR) as an approach to enhancing long-term conservation and enabling sustainable use of plant genetic resources. The present Strategy provides an opportunity for complementing actions, recommendations and targets considered under the two existing strategies that are part of the EU Green Deal: "***A Farm to Fork Strategy*** *for a healthy and environmentally-friendly food system*" and "***The EU Biodiversity Strategy for 2030***".

While relying on previous European achievements and agreed ECPGR objectives, the ambition of the Strategy is to expand such objectives and the associated implementing actions in the European region, to ensure the step change for more effective and efficient plant genetic resources conservation and use. This **PGR Strategy** is therefore proposed as the new framework, including for ECPGR operations, to permanently secure and sustainably use PGR for food and agriculture in Europe.

The full implementation of the **Plant Genetic Resources Strategy for Europe** will be a key factor in effectively harnessing the agricultural potential of Europe in the coming decades and enable continuing sustainable production. It will also increase Europe's capacity to meet its commitments under several international agreements—notably the UN Sustainable Development Goals, the 2nd Global Plan of Action of the FAO Commission on Genetic Resources for Food and Agriculture, the International Treaty on Plant Genetic Resources for Food and Agriculture and the Convention on Biological Diversity.

The **PGR Strategy** articulates an urgent call to action for conserving and sustainably using European Plant Genetic Resources. **Section one** sets the context, highlighting the urgency of action. **Section two** outlines issues and approaches associated with conserving and sustainably using European PGR. Sub-sections include: i) Expanding *in situ* conservation of crop wild relatives and wild food plants; ii) On-farm European PGR conservation and management; iii) Consolidating and sustaining European *ex situ* PGR conservation; iv) Promoting sustainable use of European PGR; v) Strengthening the germplasm information system that supports conservation and use of European PGR; and vi) Monitoring progress in PGR conservation and use. **Section three** covers international cooperation within and beyond Europe and other actors' collaboration. **Section four** explores how best to enable the transition to a fully functional European system for conserving and using its PGR in terms of policy framework and infrastructure, and establishing a **European Coordination and Information Center on Genetic Resources** to this end. Finally, **section five** offers overarching conclusions. As such, this Strategy is addressed to all relevant stakeholders, including the European Commission, with an invitation to strive for its endorsement and implementation.

This Strategy was circulated and received the support of the ECPGR Steering Committee in November 2021.

THE NEED FOR URGENT ACTION

Plant genetic resources are the foundation of our food and bioeconomy, since they form the raw material that is used for selecting or breeding new varieties, and that society values in diverse, sustainable agriculture and production systems. Old and new varieties offer an essential contribution to agricultural adaptation to new circumstances, such as climate change. **Plant genetic resources are essential for feeding Europe and enabling an innovative bioeconomy**.

1.1 Plant genetic resources: an endangered asset

Europe is rich in plant genetic resources. Amongst other locations, they occur on farms, in gardens and in nature (*in situ*), and are conserved in many European field, seed, and *in vitro* genebanks (*ex situ*). **However, these resources are not always adequately conserved *ex situ*, rarely conserved *in situ* and on-farm, and often hardly accessible**.

Many European genebanks function sub-optimally, due to insufficient European task-sharing and lack of resources, capacities, infrastructures and quality control. Even with good will, the genetic resources that they aim to conserve are thus under threat. The *in situ* situation is even worse. Climate change and deleterious changes in land-management practices are seriously threatening many wild plant genetic resources. Also, genetic resources managed on farms are threatened by changes in agricultural land-use prompted by changing production systems that replace traditional varieties and landraces with new ones, as well as by regulation and marketing obstacles to their use. **Without immediate remedial action, climate change, insufficient coordination, the poor state of genebanks and the vulnerability and decline of landraces and wild relatives, will continue to cause severe loss of plant genetic resources and impede crop improvement in Europe**.

The situation is also problematic for European PGR users. Increased political awareness of the value of plant genetic resources and legal uncertainty about their exchange has prompted countries and institutes to restrict access to these resources. Scientific crop research and plant breeding are increasingly faced with problems in accessing material in genebanks, and *in situ* managed European PGR currently remain largely inaccessible. As a result, **scientific researchers**

and plant breeders find it increasingly difficult to access the resources they need to address the mounting challenges posed by climate change and declining food security.

Better coordination of and support for activities that ensure effective genetic resources conservation and access are therefore urgently needed. Apart from assuring effective European PGR management, **better coordination and targeted investments will also reduce wasting funds on inefficient operations and duplication of work**.

This *Plant Genetic Resources Strategy for Europe* outlines a route towards improving the situation and addressing this **need for urgent action**.

1.2 Towards a firm political commitment for urgent action

Conservation and use of plant genetic resources are taken into consideration within a rich and complex global policy framework. The activities of the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) [2] illustrate the global awareness regarding plant genetic resources issues, resulting in valuable descriptions of the 'State of the World's Plant Genetic Resources for Food and Agriculture'(PGRFA) [3], and corresponding 'Global Plans of Action' [4]. In addition, the United Nations' Sustainable Development Goals (SDGs) call for the conservation of PGRFA. Since 2004, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) [5] has constituted a legally binding global framework for conservation, sustainable use and fair and equitable benefit sharing of PGRFA, in line with the principles and obligations of the Convention on Biodiversity (CBD) [6].

In response to the commitments and obligations of the EU and other European countries to these global policy frameworks and instruments, and with the aim of achieving effective conservation and sustainable use of PGR, countries have established national PGR programmes and set up the government-supported European Cooperative Programme for Plant Genetic Resources (ECPGR) [7]. Over recent decades, ECPGR has been the main European coordinating instrument for technical activities on the conservation and sustainable use of PGR and its related collaborative frameworks. These include coordinating conservation and documentation of the state of PGR in Europe using the European Search Catalogue for Plant Genetic Resources (EURISCO) [8] and A European Genebank Integrated System (AEGIS) [9], as well as through the

activities of the crop-specific and thematic working groups (methods, tools, concepts, etc.) [7]. In addition, a European Network for the Evaluation of PGRFA (EVA) [10] has been established to support the harmonized use of European PGRFA in research and breeding.

Despite these tremendous national and regional efforts, it must be noted that the effective implementation of all planned and needed activities is lagging far behind for several reasons. The main ones include a general weak political will and an important disparity of political support between European countries, in particular unequal capacities of national programmes and stakeholders.

Recently, the EU made a strong commitment with the European Green Deal [11] to make the EU's economy sustainable, by turning climate and environmental challenges into opportunities. As part of the Green Deal, two strategies are currently underscoring the need to preserve genetic resources. In its Farm-to-Fork Strategy (F2F) [12], the EU Commission acknowledges the mounting threats to its food chains—including droughts, floods and new pests and diseases—and emphasizes the need to rely on seed security and diversity to strengthen the sustainability and resilience of food production systems. The EU Council has responded on these plans by CALLING ON the Commission to '…take concrete actions for ensuring the protection, restoration and sustainable use of plant and animal genetic resources… [and INVITING the Commission] '…to present an EU strategy for genetic resources for aquaculture, forests and agriculture' [13]. The EU Biodiversity Strategy for 2030 [14] also highlights the concerning decline in genetic diversity and emphasises the need to reverse this trend.

A firm political commitment is taking shape in support of the EU and the other European countries urgently strengthening their efforts for effective long-term genetic resources conservation and sustainable use. This is prompted by the interdependency of countries on PGRFA, and their need to increase the sustainable use of these critical resources for food production, and for circular bioeconomy developments and sustainable agro-ecosystems. **Hence, this PGR Strategy, which is tightly linked and complementary to the 'Genetic Resources Strategy for Europe'** [15], **should be an important element of the European Green Deal**.

CONSERVING AND SUSTAINABLY USING PLANT GENETIC RESOURCES

This section reviews the status of conservation, sustainable use and monitoring of PGR in Europe within five areas of activities: *in situ*, on farm, *ex situ*, promoting sustainable use and strengthening the information system for plant genetic resources.

The PGR Strategy defines clear **objectives** to make significant and meaningful progress in transforming conservation and sustainable use of PGR in Europe as well as articulating the **needed actions or steps** and **associated targets** to achieve these objectives by 2030. The objectives and associated targets can only be achieved if there is a comprehensive transformative change in the European policy framework for conservation and sustainable use of its PGR, combined with secure and appropriate financing to ensure long-term national and regional capacities (see section 4).

2.1 Expanding *in situ* conservation of crop wild relatives and wild food plants

Crop wild relative (CWR) genetic resources native to Europe are related to the many socio-economically important crops cultivated in the region and in other parts of the world (food, fodder, forage, beverage, food-additive, oil, biofuel, biomass, medicinal, ornamental) [16] and contain a wide pool of evolving genetic diversity, not duplicated in the crop itself, and that is of potential value for crop improvement. Southern Europe is second only to the Fertile Crescent in terms of native diversity [17]. The role of CWR as a provisioning ecosystem service for underpinning future food security is receiving increased attention for the economic and environmental gains they can bring to Europe and beyond: an interesting study from the grey literature has estimated that the use of CWR in the 26 top global crops alone could be valued at US$115 billion per year worldwide [18].

Some wild species are harvested from the wild for direct use as food or feed and constitute a potential source for further domestication and creation of new crops. Nevertheless, CWR genetic diversity and wild food plants (WFP) are being eroded and threatened with extinction in

their natural environment by habitat fragmentation and destruction, competition from alien invasive species, expansion of modern agriculture, and climate change.

A diversity of organizations (protected areas' responsible bodies, botanical gardens, arboreta and genebanks), individuals (committed farmers and private landowners) and institutions (agencies responsible for the conservation of PGR and for the protection of wild plants in general or of the habitats in which they grow) contribute or could potentially contribute to CWR and WFP conservation activities. However, the nature and extent of European CWR genetic diversity conserved through these activities is *ad hoc* and insufficient. CWR of seven out of 23 highly economically-important food crops in Europe are not represented in the region's genebanks at all, and of the remaining 16 crops, accessions of European origin of less than half of the high-priority wild relatives are represented [19], and only a handful of *in situ* genetic reserves are actively conserving CWR diversity [20].

Despite using both *in situ* and *ex situ* approaches, conservation of CWR diversity has been largely neglected due to: i) **insufficient awareness** and valuation of CWR and WFP, as well as insufficient interest and coordination by agencies representing environmental and agricultural sectors with consequent lack of suitable national conservation activities; ii) **insufficient knowledge** of CWR, their distribution, potential threats and the measures to be taken to ensure genepool diversity maintenance at local, national and European levels; iii) **weak links** with the *ex situ* conservation and germplasm use sectors including through conventional (pre-)breeding programmes as well as genomics-assisted breeding including wide exploration of allelic diversity by next generation sequencing [21, 22]; iv) **lack of a solid organizational and financial basis** for CWR conservation at national level leading to weak partnerships and insufficient sharing of experiences.

However, the need to better conserve and sustainably use CWR genetic diversity is recognized by several global and European policy instruments that are implemented at national level. These instruments include: the rolling Global Plan of Action (GPA) for the conservation and sustainable utilization of PGRFA, the International Treaty on PGRFA, the CBD Global Strategy for Plant Conservation 2011–2020 [23], and the EU Biodiversity Strategy 2030.

To overcome the risks of erosion of CWR and wild food diversity in Europe, there is an urgent need to survey and inventory these resources at population level in each European country, to strengthen their conservation and management

and to facilitate their wider use. These efforts also call for a comprehensive and coherent plant genetic resources policy framework linked to sustainable funding support for conservation, to enable the transformative change in CWR conservation policy and outcomes[1].

2.1.1 Surveying and inventorying CWR and other wild plant genetic resources for food and agriculture

Background

Many national programmes within the European region have a growing evidence-base concerning CWR diversity, conservation and use. EC-funded projects (see below) have promoted the production of checklists and inventories in over 20 countries in Europe, and national or regional strategies or concepts for CWR conservation have been developed [24, 25, 26]. In Europe, Germany was the first country to have officially designated genetic reserves for selected CWR, and a few other countries are in the process of doing the same.

Among its objectives, ECPGR includes the improvement of *in situ* conservation and use of CWR, and has endorsed a concept for *in situ* conservation [27]. This concept promotes the designation of CWR populations for priority conservation[2], defined by several criteria including i) being native in Europe or having been naturalized for at least 10 generations; ii) containing originality and/or diversity in specific traits; iii) being subject to active and sustainable management based on minimum conservation standards; iv) not being critically threatened; and v) its genetic material being publicly available, as appropriate.

Several tools and methodologies to facilitate conservation planning for CWR diversity have been defined through different initiatives and projects, such as: i) a series of EU- and UK government-funded projects led by and involving ECPGR Working Group Chairs and members [28, 29, 30, 31, 32, 33, 34]; ii) the FAO initiative to establish a global network for *in situ* conservation of CWR [35]; iii) the publication of standardized descriptors for CWR *in situ* by the Secretariat of the International Treaty for PGRFA [36], and iv) the

[1] See section 4 for further information for enabling this change

[2] *These "priority CWR's populations" are referred to as "Most Appropriate Wild Populations" (MAWP) in the ECPGR concept (Maxted et al. 2015)*

Bioversity International[3]-led CWR projects [37], amongst others. However, lack of resources and of political priority in some countries is limiting the application of the tools and methodologies developed.

EU-funded projects, such as Farmer's Pride [38], have undertaken a Europe-wide analysis of taxonomic and ecogeographic diversity of priority CWR taxa, developed guidelines and tools for population management and proposed a European strategy for CWR conservation and sustainable use based on the ECPGR *In Situ* Concept [27]. However, the achievements obtained by the EC-funded projects need to be further disseminated in Europe and extended to fill remaining gaps in knowledge and to systematically implement priority CWR conservation across the region.

Associated with CWR conservation planning is the component of threat assessment, that can be used to identify priority CWR for active conservation. Kell *et al*. (2012) [39] assessed the International Union for Conservation of Nature (IUCN) Red List status of 572 priority European crop wild relative species in 2010 [40]. Eleven percent of the species were threatened with extinction and a further 5% expected to become threatened in the near future. The main threatening factors were unsustainable farming practices (such as severe overgrazing, conversion of land to monocultures and the heavy application of fertilizers and agrochemicals), development for tourism and recreation, and urbanization [39].

Objective

By 2030, Europe has significantly **increased** its **CWR and WFP inventories** to enable a more comprehensive view of available CWR and WFP' genetic diversity, to better understand how this diversity is distributed across the region and its neighbouring countries, and to identify which are the priority populations to actively conserve.

Approach

1. Invite all European countries to prepare or complete and publish national CWR checklists and inventories, and to undertake diversity and gap analyses to determine priority CWR populations of interest from either a national or European perspective. This could be achieved using the voluntary guidelines published by FAO [41].

[3] Bioversity International is now part of the Alliance of Bioversity and CIAT

2. Where national data gaps persist, conduct a CWR diversity survey to fill remaining knowledge gaps about existing CWR, their distribution, level of threat and conservation status. Wherever possible, work with neighbouring countries in Western Asia, particularly the Fertile Crescent, where numerous European crops were domesticated and where still most genetic diversity is found.
3. Advance the identification of CWR diversity hotspots that are critically important at national and European level for their diversity richness, uniqueness or utility (based on genetic diversity and ecogeographic analyses).
4. Support national authorities to appoint CWR National Focal Points and then provide data – as appropriate – from *in situ* conserved populations of CWR and WFP (from National Inventories) to a centralized information system, based on agreed data exchange standards [42].
5. Regularly monitor priority CWR populations using demographic and genomic techniques, and monitoring the adverse practices that result in population and genetic diversity erosion / extinction in their habitats as well as specific threats such as climate change.
6. For the European region, complete the second IUCN Red List Assessment of the estimated level of threat for the sample set of CWR first assessed in 2011/12 and based on this, provide an assessment of their potential risks of future genetic erosion, in terms of population loss.
7. Extend the approach used for CWR to survey, inventory and prioritize WFP, as relevant and appropriate.

2.1.2 *Strengthening* in situ *conservation and management of crop wild relatives and wild food plants*

Background

Today, very few CWR and WFP species are protected *in situ* when under threat and actively conserved *in situ* where they are then able evolve under natural conditions. Generally, protected natural areas have not been established for the conservation of genetic diversity of specific categories of plants, such as CWR. Management plans for protected areas do not specifically address genetic diversity of CWR and WFP, but could be modified to complement other conservation approaches [43]. Many CWR and WFP are associated with semi-

natural habitats that exist thanks to human activity. It is therefore necessary to complement conservation in protected areas with *in situ* conservation outside of protected areas to provide a proper coverage of measures aimed at conserving intraspecific genetic diversity. Outside such areas, management would require agreement with the landowner [43].

EC-funded projects, including Farmer's Pride, have advanced our understanding of CWR diversity in the region. The projects have also elaborated a range of commonly-agreed and widely-tested scientific concepts and techniques to contribute to designing and implementing management plans and operations of genetic reserves. Genetic reserves are sites for the management and monitoring of genetic diversity of natural wild populations within defined areas designated for active, long-term conservation [43]. The previous initiatives demonstrate that Europe has the potential to set up and implement a sound strategy to conserve *in situ* CWR and WFP species. What is largely missing is putting theory into wide practice in Europe.

Objective

By 2030, the European countries have elaborated and approved **National CWR and WFP conservation strategies**, and set up and manage a network for *in situ* management of priority CWR populations as part of an integrated CWR conservation strategy for Europe, in which active and sustainable long-term *in situ* conservation actions are implemented at national level.

Approach

1. Establish and develop a European network of CWR based on genetic reserves designated by national authorities.
2. Collaborate with Natura 2000 [44] and other protected areas' networks to enhance CWR *in situ* conservation.
3. Agree upon a series of tools and guidelines for the *in situ* management of CWR and WFP populations [45]. These will include quality standards and reporting requirements [46], and entail periodic reviews based on a set of monitoring indicators.
4. Undertake further research on the *in situ* management of CWR and WFP populations outside existing protected areas.
5. Provide an inventory of successful *in situ* CWR and WFP conservation and management approaches [47].

2030 Targets for expanding *in situ* conservation of crop wild relatives and wild food plants

1. All countries in Europe have included CWR and WFP conservation in national PGR programmes and actions.
2. All countries in Europe have identified CWR priority taxa and populations– including those in protected areas - forming the basis of their national and a European *in situ* network of CWR.
3. Europe has a coherent, comprehensive, coordinated and centralized documentation of CWR and WFP *in situ* diversity.
4. CWR priority populations within the European network of CWR are managed and monitored following agreed guidelines for the *in situ* management of CWR populations.
5. *In situ* conserved CWR populations are safely backed-up in *ex situ* collections and made available to users.

2.2 Promoting on-farm plant genetic resources conservation and management

Landraces, obsolete cultivars and other heterogeneous populations (hereafter referred to as 'landraces') are precious genetic resources maintained and dynamically evolving through cultivation and breeding on-farm and/or in-garden and through breeding. These landraces are adapted to specific environments and provide particular agronomic, quality and adaptive traits or cultural values for farmers, gardeners and local communities, as well as contributing to the provision of agro-ecosystem services. They are very often closely linked with valuable and ephemeral indigenous knowledge.

On-farm conservation and management are complementary and intertwined approaches contributing to conservation and sustainable use of genetic resources. They provide, at different scales, benefits related to conservation and development of crop and landscape diversity. These approaches also support i) upholding related traditions and cultural heritage; ii) continuing crop evolution and adaptation to changing field conditions; iii) diversifying agriculture and consequently increasing consumer choice; iv) providing ecosystem benefits and

services, and v) opportunities for developing local and niche quality markets. On-farm PGR management can be developed through local networking approaches that connect actors sharing experiences and knowledge of the dynamic management of genetic diversity.

On-farm PGR conservation and management is presently practiced by a range of stakeholders including: farmers; amateur gardeners; farmer/gardener networks and associations; diversity seed distributors; seed savers; commercial seed companies; breeders; researchers; retailers; and actors within short supply-chains, including local communities, associations and NGOs.

Several EC-funded projects have recently made steps towards implementing on-farm conservation and management actions in Europe [30,38,48,49,50]. Through the work of the ECPGR Working Group on On-farm conservation and management, a "Concept for on-farm conservation and management of PGRFA" [51] was developed and endorsed by the ECPGR Steering Committee in 2017. The concept identified priority actions for collaboration in Europe, such as surveying and inventorying on-farm landraces and promoting best practices for on-farm management, conservation and adding value.

FAO has published voluntary guidelines for the conservation and use of farmers' varieties/landraces including national level approaches [52].

Several EU countries have registered conservation varieties in the EU Common catalogue, based on European Commission's Directives 2008/62/EC and 2009/145/EC [53]. The European Agricultural Fund for Rural Development (EAFRD) provides support for the conservation and for the sustainable use and development of genetic resources in agriculture. EU farmers can thus be rewarded for the preservation of plant genetic resources on their farms that are under threat of genetic erosion [4].

However, fully developed national strategies on on-farm landrace conservation have been prepared by four countries (the Czech Republic, Finland, Italy and the UK) [30]. All strategies recommend drafting inventories and conducting surveys of the genetic material and its on-farm status. They reinforce complementary *ex situ* conservation, and call for conducting further research, and promoting on-farm PGR use.

[4] Rural Development Regulation (EU) No. 1305/2013

Even though concepts, guidelines and tools to produce inventories and manage on-farm landraces have been developed and have been partially implemented, a consolidated pathway towards their long-term implementation in Europe is still lacking.

2.2.1 *Surveying and inventorying on-farm plant genetic resources for food and agriculture*

Background

Until recently there were no on-farm landrace diversity inventories at the European level and few at national levels. This was due to difficulties associated with organizing standardized field surveys involving a large diversity of mostly private stakeholders that grow landraces and that deploy a wide range of practices. However, FAO is promoting the global completion of national landrace inventories as an effective basis for PGRFA conservation planning, and recommends collecting several types of data, ranging from very simple information (checklists) to more elaborated data (genetic analysis). Based on experiences from previous EU-funded projects, the EU-funded project Farmer's Pride has collected records of landraces of various crops maintained *in situ* within 14 countries [54]. Based on these data, 100 diversity hotspots were also identified [55].

There is a need to develop or improve national inventories to cover all crops present in European countries, to have capacity to better conserve and monitor this valuable diversity for wider use, and to anticipate actions in case of threats. Better connections are needed between national and local levels that comprehensively embrace the diversity of actors and organizations involved.

Objective

By 2030, **an inventory of on-farm landraces** has been made in Europe, based on national inventories, compiled in close collaboration with local actors and organizations and with periodic updating.

Approach

1. Ensure national strategies for conservation and sustainable use of PGR include a specific section dedicated to landrace on-farm conservation and management, prepared in collaboration with relevant actors. These sections identify ways and means to ensure effective coordination between local and national surveys and include identifying 'On-farm National Focal Points'

(NFPs) to support and oversee landrace conservation and management strategy implementation.

2. Establish a comprehensive European Inventory of on-farm genetic diversity and of related stakeholders, based on a data-sharing agreement. The inventory will make use of existing methodologies and an agreed set of criteria for identifying material to be inventoried, as well as a minimum set of agreed passport and characterization descriptors for data exchange (points 3 and 4). It will also include the support of designated On-farm NFPs and relying on the expertise of local actors and the development of tools for a participatory approach.
3. Define a minimum set of standardized passport and characterization data, as well as effective indicators for monitoring genetic diversity and threats, through the European collaborative programme and agreed at European level.
4. Gather *ad hoc* passport and preliminary characterization & evaluation data at national level and provide to the European Inventory.
5. Identify valuable landrace diversity for complementary measures.

2.2.2 *Supporting on-farm plant genetic resources conservation and management*

Background

There is no single way to promote and/or develop on-farm management and conservation, but rather an evolving set of approaches, some of them proposed by the FAO voluntary guidelines [52] or developed in the above-mentioned European projects. PGR conservation, management and improvement are often tightly linked when dealing with on-farm landrace "conservation". Landraces are associated to a continuous evolution of adaptive capacities in local environments and are subject to human selection. Their conservation engages a broad range of actors. Even if some progress has been made to better understand the technical basis on which PGR management relies, there is still room for capitalizing on results from a wider range of experiences and practices [56].

Genebanks, research institutes, community seedbanks, seed savers' and seed multipliers' networks all play important roles in facilitating access to on-farm conserved landraces at local, national and regional levels. However, the link between farmers maintaining landraces on-farm and community or institutional

seedbanks is often weak, thereby limiting the wider distribution and safety back-up of valuable genetic resources.

Despite the importance of precious on-farm genetic resources to face climate change issues, the wider dissemination and use of on-farm-derived PGR is limited due to lack of support in terms of little or no training on best practices and of associated funding. Also, legal barriers to PGR use and marketing need to be overcome to ensure continued conservation and management of on-farm PGR.

Objective

By 2030, valuable **landraces' identified diversity is comprehensively conserved** on-farm, complemented with *ex situ* back-ups, and is made available for sustainable use.

Approach

1. Locally implement long-term **conservation and management of on-farm PGR**, using and adapting current knowledge to conserve landraces and populations and local experiences [57].
2. Identify **farmer incentives** for continued maintenance of diversity hotspots as well as encourage **complementary *ex situ* conservation**. This will embrace building and using public awareness about the value of local diversity.
3. Maintain and expand an **inventory and a database of knowledge and practices**, related to successful experiences of conservation, management and examples of partnership agreements dealing with on-farm conservation and sustainable use of landraces in Europe. This approach will publicize and promote best practices, while complying with relevant data protection legislation. Enriching the database using local actors and national and European consortia will contribute to broadening methodological knowledge for such conservation practices.
4. **Include valuable landraces in *ex situ* collections** as safety back-ups, based on a landraces gap analysis, while aiming to **reintroduce landraces** from genebanks and other sources (e.g. community seedbanks) **into their locations of origin** and home gardens.
5. **Identify legal and technical obstacles** to on-farm landrace conservation and management, and propose solutions to overcome these barriers (related to access to data and material, availability, marketing, etc.), for example facilitating registration of landraces in the European Common Catalogue of varieties (see also section 2.4).

2030 Targets for on-farm conservation and management of plant genetic resources

1. All countries in Europe include on-farm PGR conservation and management in national programmes and actions.
2. A European Inventory of on-farm genetic diversity is formally established; a minimum set of passport and characterization descriptors for data exchange is defined.
3. All landraces recorded in the European Inventory have *ex situ* backup in national genebanks.
4. Conservation and management guidelines for on-farm landraces have been defined in the context of the European collaborative programme and are implemented at local level.

2.3 Consolidating and sustaining *ex situ* conservation

Systematic germplasm conservation activities within Europe were first initiated in Germany in the 1940s and followed later by other countries. These arose after the pioneering and legendary plant genetic resources collecting expeditions of N.I. Vavilov and his colleagues at the Russian Vavilov Institute of Plant Genetic Resources (VIR) during the 1920s and 1930s. It was also based on the concerning evidence emerging in the mid-1930s that traditional crop varieties and adapted landraces were being replaced by new improved varieties. In the 1970s *ex situ* collections were promoted by international institutions, in recognition of the importance of plant genetic resources for global food security. Both the Food and Agriculture Organization of the United Nations (FAO) and the International Board for Plant Genetic Resources (IBPGR) played key roles in this regard. In 2021, at least 400 institutes scattered over more than 40 European countries hold *ex situ* PGR collections [8] and maintain a substantial part of globally available plant genetic resources. Genebanks provide a vital service for farmers, breeders and researchers by maintaining and facilitating access to genetic resources, as well as for securing genetic material as an insurance for losses *in situ*, and for the purposes of restoration or reintroduction. For over 40 years ECPGR has brought actors together to exchange experiences, draft common descriptor lists, set up various joint projects and improve their

documentation. The actors have developed strong working relationships and there are various ECPGR resources and initiatives supporting this *ex situ* PGR community. More recently, ECPGR established 'A European Genebank Integrated System' (AEGIS) [9], to rationalize and improve the efficiency of plant genetic resources conservation and sustainable use in Europe. Both the demands for sustainable agriculture and food quality, especially in the context of climate change, and the opportunities offered by allelic diversity mining and genomics-assisted breeding are evolving. It is therefore necessary to boost conservation capacities and increase facilitated access to the unique germplasm conserved in Europe. Progress so far has been slow due to imbalanced activities and investments across the region. Furthermore, European collections mainly comprise old and modern cultivars, landraces and breeding or research lines of main crops, while inter- and intra-specific diversity of still underutilized crops, CWR and WFP remains critically under-represented [58].

2.3.1 *Strengthening* ex situ *coordinated conservation capacities in Europe*

Background

The network of *ex situ* genebanks in Europe is relatively well organised, consisting of scientists and managers of around 400 genebanks and other collections (i.e. other institutions such as universities, research centres, botanic gardens, etc.) providing data to their respective national inventories. However, despite this excellent starting point, the existing infrastructure of *ex situ* genebanks could be further refined to improve the efficiency and efficacy of coordinated germplasm management. Some characteristics of the current situation are:

- The wide variety of actors, i.e. genebanks greatly vary, especially in terms of size (from a few hundred to a few hundred thousand accessions) and quality monitoring (from no written protocols to proper ISO-certified quality management systems). Some countries have only one genebank, others have tens of them, some genebanks are governed and funded by the national government, others rely on their hosting institute, an NGO or external projects for their funding. Other actors also hold *ex situ* PGR collections, such as universities and botanic gardens, the latter specialized in living collections. In addition, also breeding companies may conserve collections that could be of public interest.
- There is a high level of redundancy among the total of around 2 million European accessions. Even though an accurate figure is not available,

estimates made on specific genera (*Avena* and *Lactuca*) found that only 30-40% of the samples were distinct, as a result of known or unknown duplication of accessions within and between genebanks [59].

- Conservation protocols vary across genebanks. The capacity and procedures for storage, field collection management, viability testing, safety-backup, regeneration and other genebank operations also vary greatly between genebanks, frequently operating below the FAO Genebank Standard [60].
- The availability of information about the conserved material varies. EURISCO, a database managed by ECPGR, provides an overview of the identity of much of the conserved material. Trait-based information may be very poor or lacking, and where existing, not always easily accessible. Genomic data is becoming available in some genebanks for some material.
- The policy and capacity for germplasm distribution also varies between genebanks. Some high-quality genebanks provide full access to their material. Other genebanks/countries are unable to do so for various reasons, or apply PGR access procedures that create obstacles to germplasm distribution depending on the origin of the material request. Lack of stock for distribution or phytosanitary issues can further complicate access, depending on import requirements enforced by different countries.

These issues may contribute to under-exploitation of germplasm diversity and it cannot always be clearly demonstrated that material is securely conserved. Upgrading genebanks to appropriate levels is feasible, as it sometimes only requires removing specific bottlenecks. These bottlenecks can consist of, for example, lack of a proper back-up power generator, or lack of knowledge regarding legal issues concerning the international distribution of PGR.

To improve this situation and help develop more efficient and sustainable *ex situ* PGR conservation system in Europe, ECPGR has established 'A Genebank Integrated System (AEGIS)'. This aims to upgrade i) cooperation among European genebanks by sharing responsibilities, ii) the standardisation of protocols, and iii) the availability of quality accessions for use. AEGIS promotes joint (decentralized) management of the unique European germplasm diversity, common management principles and good practices. A Quality System (AQUAS) based on jointly-agreed protocols is under development. Monitoring through peer visits has started as a case study with the aim of stimulating capacity building and quality improvement. Terms for access to genetic resources and benefit sharing arising from their use are also uniform and based on ITPGRFA

principles. However, despite the affirmed support from the complete ECPGR Steering Committee, the practical implementation of AEGIS has been very limited.

Objective

By 2030, the **PGR diversity in European genebanks is conserved reliably and made accessible for sustainable use**, by improving the efficiency and efficacy of the European genebank infrastructure. Thus, the European *ex situ* conservation system will be raised to a level of excellence in terms of i) long-term quality (conservation management, viability, genetic integrity and phytosanitary protection), and ii) accessibility of conserved material to users, thereby positioning Europe as a primary contributor to the global PGR conservation and use effort.

Approach

Reinforce and expand AEGIS, the framework for the maintenance and development of the European Collection, through:

1. Establishing a **certification system**, that is economically sustainable and accessible to genebanks and collection holders, based on a quality management system (AQUAS) with standards and a (external) monitoring system. AEGIS will embrace some or all of the certified genebanks' collections. Through these means, material in these genebanks will be reliably conserved, documented and fully accessible (all crops under the SMTA of the ITPGRFA for research breeding and education, with a simplified MTA for direct use). This will involve:
    a. Consolidating AQUAS using generic FAO genebank conservation standards and agreed crop-specific adaptations when appropriate, along with simple and inexpensive performance indicators and a reporting system.
    b. Establishing and running a monitoring system, based on both internal and independent peer reviews and a certification mechanism.
2. Creating **capacity-building and facility improvement** mechanisms that **support genebank managers** to **achieving the standards needed** for AEGIS certification, as follows:
    a. Establishing and running a system for identifying needs for capacity and facility improvements, based on a monitoring system.

b. Creating capacity-building activities, raising knowledge at all levels (technical, scientific and managerial) as required. This will also involve supporting exchange of knowledge and experiences via websites, publications, and social media, as well as staff exchanges and conferences. It will also require creating appropriate training material at all levels.

c. Supporting facility improvements, both in terms of funding and advice regarding the choice of methods, equipment and materials.

d. Improving management strategies and methods for clonally-propagated plants (e.g. fruit trees) and recalcitrant seeded plants, as well as for species that have been neglected in current conservation activities. This will also include exploring options and opportunities for a cryopreservation network and complementary on-farm conservation, in particular for fruit trees.

e. Ensuring that relevant genetic and genomic stocks (such as mutant collections and reference true-to-type accessions used for phenotyping and sequencing) are properly conserved and available for future use.

f. Contributing to developing and adapting phytosanitary procedures for both seed and clonally-propagated PGR for germplasm management to ensure they are fit for germplasm exchange purposes (as they are usually developed for commercial seed shipments and not always appropriate to the PGR context).

g. Improving conservation management by identification of redundancies within and between collections. Developing standard operating protocols of how to identify and how to handle duplicated accessions.

3. **Avoiding further loss of European PGR** in conservation programmes by:

a. (for *ex situ* conserved diversity) Assessing and addressing urgent regeneration needs and safety-duplication backlogs (at another AEGIS Associate-Member genebank, possibly in a different country and/or at the Svalbard Global Seed Vault).

b. (for *in situ* and on-farm conserved diversity) Coordinating backing-up diversity actions of *in situ* and on-farm PGR in *ex situ* facilities, in collaboration with actors in these formal and NGO sectors, and/or by setting up and implementing collecting missions.

2.3.2 Expanding the coverage of genetic diversity in European genebanks

Background

The germplasm currently conserved in institutional genebanks or by NGOs does not adequately represent the total variation of PGR of European origin or needed by the European potential user communities for future European production systems. This situation particularly puts at risk the diversity found in nature or on-farm and threatened by climate change and limits present and future use of traits with adaptive capacities for climate resilience, resistance to new or continuously evolving biotic and abiotic stresses and other traits associated with sustainable agroecosystems.

Many major crops have generally been well collected, but gaps still exist, including for many landraces. Collections of most regional, minor, and underutilized crops are often much less complete. Many partners are working in conservation activities at local level, as NGOs aiming for short-term conservation for immediate use. They have little or no formal links with institutional genebanks that better ensure longer-term conservation.

CWR, even of major crops, have received too little attention relative to their potential importance in breeding, both in terms of the CWR taxa conserved and the number of population samples per CWR taxon. Only a few are conserved either in genebanks or botanical gardens or are easily available from their natural habitats. For example, based on data available via EURISCO, around 9% of total germplasm accessions in genebanks are of wild origin and they represent about 6% of the CWR taxa that exist in Europe [61]. Further, the ratio of the number of accessions of cultivated species to wild species is striking at 12:1, with an average of 167 *ex situ* accessions for each cultivated species compared to 14 for each wild species [20].

Comprehensive analysis of the existing and needed genetic diversity, and the diversity represented in the European genebanks will better indicate the extent of these gaps. Based on genotyping and phenotyping of all accessions, a systematic evaluation of this diversity has started for a few crops within the framework of the ECPGR European Evaluation Network (EVA) initiative (see 2.4.3).

Objective

By 2030 European genebanks **ensure the long-term conservation of PGR** and **provide access to appropriate samples of the genetic diversity** that

has occurred and/or is still occurring in European agriculture and in-nature. This covers the diversity needed for direct use, research and plant breeding that contributes to the continuous adaptation of European agriculture to current and future needs.

Approach

1. European genebanks increasingly designate **genetically unique material** as part of the AEGIS European Collection, to be considered a joint regional responsibility for long-term conservation and use.
2. Take stock of **important genetic diversity** that is **conserved by botanic gardens and NGOs**, currently not documented in EURISCO and where appropriate, incorporate into the network of certified genebanks.
3. Identify the **crop genetic diversity** of potential interest that is **not yet incorporated in genebanks** by:
    a. Regularly assessing the plant genetic diversity occurring in Europe and its corresponding conservation status. This will be based on existing and developing *ex situ*, *in situ* and on-farm inventories and will ensure that *ex situ* complementary conservation measures are in place (see section 2.6 on monitoring diversity).
    b. Creating and maintaining a permanent dialogue with the users' community to understand and meet the needs of the plant breeding industry, farming communities (including direct use purposes) and research community. Dialogue will be achieved through establishing and regularly updating appropriate communication channels, to inventory PGR users' current and anticipated needs (potential role of Crop Portals and Crop Expert Groups, see 2.4.2).
4. Ensure **collecting of identified crop diversity** and its long-term conservation through:
    a. Acquiring the needed diversity to prevent loss and allow use through the organisation of collecting activities, primarily in Europe and if/when needed outside Europe. Also, specific material could be requested and/or exchanged from genebanks outside Europe, or from less-accessible genebanks within Europe.
    b. Conserving and providing access to the newly-acquired diversity by depositing it in an AEGIS-certified genebank.

2030 Targets for consolidating and sustaining *ex situ* conservation

1. The AEGIS Certification System, guaranteeing the quality of genebank operations, has been developed and is widely recognized and implemented in Europe through a decentralized network of AEGIS-certified genebanks.
2. Up to one third of European genebanks have been AEGIS-certified (100 – 150, including all those with more than 1000 accessions), relying when needed on a capacity-building and support system to facilitate their upgrading to reach the AEGIS certification level.
3. The coordinated European collection (i.e. the combined collections of AEGIS-certified genebanks) contains a substantial part of the accessions conserved in European genebanks. All these accessions are conserved to AQUAS standards (see section 2.3.1) and fully available from the AEGIS-certified genebanks via a request system through EURISCO. All AEGIS material is safety-duplicated possibly in another European country and/or in the Svalbard Seed Vault and/or at one of the CGIAR Centres.
4. A comprehensive assessment of European plant genetic resources and diversity required by users for present and future needs in food and agriculture and the corresponding gaps in the conservation system has been completed and is regularly updated.
5. The genetic diversity maintained in European AEGIS-certified genebanks includes: i) the vast majority of the European landraces; ii) a wide range of CWR diversity of crops grown in Europe, iii) a representative selection of developed varieties, and iv) other relevant material related to crops grown in Europe, including WFP.

2.4 Promoting sustainable use of PGR

Europe is rich in PGR, but their potential is not fully utilized today. The world faces many challenges including establishing more sustainable food and other production systems to meet growing demand; adopting more nutritious and balanced diets to curb obesity and address other health aspects, redressing an ageing and vanishing rural population, and addressing on-going climate change. The solutions will require using all available tools, as the EU F2F

Strategy also outlines. Promoting increased genetic diversity is an explicit goal of the *EU Biodiversity Strategy for 2030*, where diversity should be the guiding principle. Widening and intensifying the use of more cultivated diversity may help to achieve a range of UN Sustainable Development Goals. New technologies are increasingly available to describe and understand genetic variation at the phenotypic as well as at the molecular level and these can facilitate a more rapid and precise use of genetic diversity, either by crossing and/or selection or creating new allelic variation.

There are several levers to promote genetic resources' sustainable use to face the above challenges: i) unlocking hidden diversity through more systematic characterization and evaluation of genetic resources, while facilitating availability of associated standardized data and resources to all stakeholders; ii) enhancing and enriching present crop diversity through breeding and base-broadening efforts, with a specific attention to the potential of underutilized crops, local on-farm landraces as well as CWR; iii) diversification of crop production and consumption for sustainable and more resilient agri-food systems.

Such levers will call for concerted efforts of a wide spectrum of stakeholders (e.g. private and public stakeholders, small and medium enterprises, conventional and participatory plant breeding actors, scientists) including the food industry and wholesalers, to help make the diversity known and enhanced and available in a range of formats and expressions. This will also require adaptation of policy and market production frameworks to facilitate innovations contributing to wider use.

2.4.1 Facilitate availability to all stakeholders of genetic diversity from European ex situ *and* in situ *conservation sites*

Background

Conserving and facilitating sustainable use of genetic resources are core activities of genebanks. The use of PGR is the main reason for conserving all PGR. Assuring access and availability is therefore a central task. European genebanks are often underfunded and cannot completely fulfil their potential, for example in providing high-quality material to users and offering easily-accessible information on their conserved material stored in national, regional, and European level information systems for PGR conserved *ex situ*. Potential PGR users are often uncertain about the legal framework regarding access to and use of PGR and therefore hesitate to use such material. Moreover, procedures and policies

for *in situ* PGR conservation and access are not established in most European countries [62].

Objective

By 2030, assure **access to well-documented genetic diversity** that is conserved *ex situ* and, where and as appropriate, *in situ* in Europe.

Approach

1. **Strengthen national and regional genebanks**/genetic resource centres to act as access points for *ex situ* conserved PGR, as intermediaries for access to *in situ* conserved PGR, and as knowledge centres regarding the legal aspects of access to PGR [62].
2. **Provide access to *ex situ* material** under SMTA conditions as per the rules of AEGIS, **and to material conserved *in situ*** also using SMTA whenever possible, subject to national legislation.
3. **Improve access to information on PGR** conserved both *ex situ* and *in situ* by developing and improving existing national, regional, and European public information systems. Special efforts should be made to maintain or improve user-friendliness and accessibility of all systems for a wide variety of stakeholders (conventional breeders, farmers, NGOs and other direct users). Such efforts will also establish linkages between national systems and appropriate local databases and PGR information systems.
4. Support the development of national-level **policy instruments and/ or standard procedures to facilitate access to PGR** conserved *in situ* (landraces, CWR and WFP).
5. Develop and provide **access to easily understood documentation on the rights and obligations** associated with the SMTA of the International Treaty and about the possibility of using alternative MTAs for direct use.

2.4.2 Facilitate access to information about plant genetic resources targeted to specific user-groups

Background

Apart from what is available in EURISCO, there is a lot of scattered information on PGR that is often hard to find. Even for EURISCO, it is not always clear what material is available, how and under what conditions to obtain it and what additional information exists about it.

Even questions such as 'where can I find readily available PGR for cold tolerance in sunflower?' or 'what are appropriate old lettuce varieties for an organic farming breeding programme?' might be more easily answered if existing scattered knowledge and information could be better compiled, organized and made available in a user-friendly format by appropriate experts.

To provide answers to these questions, so-called PGR crop portals should be set up, that can function as entry points for questions about the use of PGR. These can be created with the support of Crop Expert Groups, based on the ECPGR Crop Working Groups, complemented by the European Association for Research on Plant Breeding (EUCARPIA) sections' experts, representatives of the private seed sector and other stakeholders. Examples of these crop portals already exist [63].

Setting up a Crop Portal requires a modest technical infrastructure and a dedicated content manager who can rely on PGR Crop Expert Group (also through online meetings and *ad hoc* consultations) to collect information and feedback and provide website content. Crop Portals would benefit to be established and maintained by crop specialized institutions, at the same time tapping the expertise of the ECPGR Working Groups. They can be made accessible from the ECPGR website, providing complementary and processed information, beyond the raw data provided by EURISCO.

Objective

By 2030, **PGR crop portals for European crops** have been established and maintained.

Approach

1. Set up **Crop Portals** created by a content manager, supported and advised by Crop Expert Groups, intended to serve the needs of the PGR community.
2. Establish PGR Crop Portals as a starting point for any (potential) PGR user who is **looking for information about and access to PGR**. Establish connections with databases such as EURISCO, Genesys [64] and also FAO's World Information and Early Warning System (WIEWS) [65], existing international crop portals and other relevant information sources.
3. Promote the Crop Portals in **potential user communities**.

2.4.3 Expanding phenotyping and genotyping characterization and evaluation of European PGR

Background

Characterization and evaluation of collections are of strategic importance for Europe to better utilize PGR to facilitate adaptation of European agriculture to climate change, and to increase crop diversification and food security and quality, in the context of diversified sustainable agri-food systems.

Phenotyping protocols and methodologies have been developed by the ECPGR Crop Working Groups. These aim to harmonize PGR phenotypic characterization for several targeted traits using common descriptors. Mainly EC-funded projects and national programmes have contributed to partial characterization and evaluation of European collections. However, existing data have been only marginally centralized in online public repositories. A systematic and harmonized characterization effort for all crops and collections is still needed. Additionally, characterizing and evaluating more diversified traits associated to new agricultural challenges is only progressing slowly.

The development of molecular markers and genomic tools, as well as new methods for microphenomics (automated microscopy and phenotyping) and macrophenomics (phenotyping of macroscopic traits), offer new opportunities for characterization, for example high-throughput low-cost genotyping allows investigating a wide coverage of accessions' genomes. Furthermore, high-throughput phenotyping associated with innovative tools such as genome-wide association studies (GWAS) and genomic selection offer promising means to identify and select useful traits for building resilience into sustainable agricultural systems under changing climatic conditions. Another innovative method, Focused Identification of Germplasm Strategies (FIGS), allows the prediction of useful traits in PGR based on their geographic origin and adaptation to prevalent environmental conditions and could be used to increase the likelihood of identifying a trait in a set of accessions. Mass genome sequencing of crops and wild relatives, together with high throughput phenomic screening in multiple environments is also expected to identify novel genes and alleles and thus accelerate crop breeding [66]. A phenotyping method that maximizes the individual plant's phenotypic expression and differentiation and is appropriate for all stages of a breeding program, is also particularly relevant for accurate phenotyping of crop wild relatives and landraces, where each plant has a different genetic/genomic composition [67].

Provision of high-value genotypic and phenotypic information will be strongly dependent on the availability of true-to-type (homozygous) material. Thus, the traditional accession-based conservation of PGR will need to be extended by a genotype-based system that will allow for an accurate genotype to phenotype mapping.

In 2019 the ECPGR European Evaluation Network (EVA) for PGRFA [10] was established by ECPGR in the form of Public/Private Public Partnerships within the framework of the ECPGR, which is open for participation by both public and private stakeholders in order to facilitate generating and exchanging evaluation data in a standardized format.

Objective

By 2030, promote and secure commitment for **targeted phenotypic and genotypic characterization and evaluation of European PGR** and improve digitization, harmonization, availability and exchange of existing and newly-generated PGR characterization and evaluation data for private and public actors.

Approach

Promote the phenotypic and genotypic characterization and evaluation of European PGR through coordinated and collaborative efforts at all levels, including within the framework of the ECPGR EVA network by:

1. **Harmonizing methods** and standard protocols for characterization, evaluation and genotyping of European PGR, in collaboration with the user community.
2. **Establishing crop- or crop group-specific European public and public-private partnerships** including also for promising CWR and on-farm material.
3. **Digitizing and making available relevant existing and newly-generated data** from a centralized dynamic information system (EURISCO), including genotypic data (SSRs, SNPs, etc.), as appropriate.
4. Using **innovative tools** such as predictive characterization techniques and GWAS to discover and test useful traits contributing to food security and sustainable agriculture, in collaboration with the research sector.
5. **Sharing knowledge about characterization and evaluation** methodologies and protocols between genebanks, and crop research and breeding communities, including farmers' associations.

2.4.4 Supporting use of CWR genetic resources in pre-breeding and in research for discovering useful traits

Background

The particular value of CWRs resides in the presence of potentially useful genetic variation not available in domesticated genepools. The main areas in which CWR diversity is used are therefore plant breeding and research, particularly in crop evolution and adaptation.

Pre-breeding is a key step in linking the valuable traits of CWR to modern variety development by providing breeders with wild genetic diversity in a more immediately usable form. This process requires a significant amount of time, resources, and human capacity.

A range of users are engaged in pre-breeding schemes using CWR to produce innovative material. However, they are confronted with several barriers such as lack of data on CWR (phenotypic, genotypic, and species biology data), and limited availability of germplasm due to under-representation of CWR diversity in genebank collections. Yet, the use of **predictive characterization** techniques can aid breeders' selection of individual conserved populations or accessions.

In situ conservation actions are currently only weakly linked with the *ex situ* sector for long-term preservation, better use of predictive characterization techniques [68] and actual characterization and dissemination of resources. Potentially valuable *in situ* diversity could be unlocked and characterized.

Objective

By 2030, achieve a coordinated and systematic **use of CWR genetic diversity in** research and **crop improvement**.

Approach

1. **Fill the gaps** in *ex situ* collections of CWR genetic diversity (see also Section 2.3.2).
2. **Identify priority crops** where the **introduction of CWR** in research and breeding is a pressing need and facilitate systematic characterization of CWR collections for targeted traits.
3. **Enhance capacities to identify useful traits** and **utilise CWR** genetic resources **in pre-breeding** and crop improvement, through training and communication of advances, best practices, and opportunities, etc., including increasing predictive characterization of CWR populations.

4. Promote the **provision of CWR data to centralized information systems** by National Focal Points, through agreed exchange formats.
5. Strengthen the **links between *ex situ* collections and** existing and developing **national and European *in situ* networks** of genetic reserves. This will be achieved through supporting targeted selection (and collection) of populations of specific interest for breeding (e.g. through predictive characterization) thereby increasing the availability of these resources (also see Section 2.1.2).
6. Develop **tailored CWR germplasm sets** such as mapping populations and core collections to advance genetic analysis and trait evaluation.

2.4.5 Supporting use of PGR in participatory and decentralised breeding efforts for the development of innovative locally-adapted populations

Background

During recent years, a breeding-focused approach to boosting agrobiodiversity has been increasingly accompanied by on-farm- or sustainable use-oriented approaches that involve a wider range of actors, including from civil society (e.g. seed savers, seed networks, and community seedbanks). These actors have great potential to lead initiatives for introducing or reviving underutilized PGR into farming and food systems and raising awareness among consumers.

On-farm landraces are an interesting and invaluable reservoir of diversity, particularly in terms of resilience, quality traits and adaptation to environmental fluctuations including climate change. However, because they are little known and hardly available, they are poorly-considered in most researchers' and breeders' characterization and evaluation designs.

On-farm landraces are often genetically highly heterogeneous. This heterogeneity contributes to their resilience in changing environments over the years, calling for renewed breeding methods. Alternative breeding objectives are important criteria for developing resilience within local environments and in the context of climate change, and for long-term yield stabilization, including inter-varietal variation, and/or within variety diversity. For example, evolutionary breeding and dynamic management of crop populations demonstrably maintain a wide range of genetic diversity that also allows adaptation to local climates [69, 70] and/or high yields and yield stability under limiting environments (e.g. organic and low input agriculture) [71, 72].

Apart from a few fodder crops and, as of 2022, of organic heterogeneous material[5], registration and marketing of crop varieties incorporating intra-varietal diversity is not yet authorized in the EU. A temporary experiment is ongoing, aiming at allowing the marketing heterogeneous populations of wheat, barley, oats and maize in the EU[6]. Due to the potential of these populations to face new challenges such as resilience and adaptation to climate change, results from this experiment may open an opportunity to adapt the present directive for seed marketing to better take into consideration such heterogeneous material.

Objective

By 2030, farmers and civil society actors are better enabled to **add value to European landraces through participatory breeding methodologies** such as evolutionary breeding, thus contributing to crop diversity in landscapes and over time.

Approach

1. Promote **collaborative projects** at local, national and EU levels that involve *ex situ* conservation institutions, farmers and civil society actors, based on participatory and decentralised breeding of heterogeneous populations.
2. Identify ways and means to **facilitate access to and exchange of resilient heterogeneous varieties**, including by exploring alternative licensing forms.
3. Supporting public-private agreements for **facilitating regeneration or multiplication of PGR** to facilitate increased use by the civil society.

2.4.6 Promoting diversification of crop production for sustainable and resilient agri-food systems through a revised regulatory framework

Background

To realise the main objectives of the recently-launched F2F Strategy – *a fair, healthy and environmentally-friendly food system* – many actions need implementing. Besides continued innovation and development within the commercial plant breeding sector, actions could be undertaken to better consider

[5] Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007 and Commission Delegated Regulation (EU) …/... supplementing Regulation (EU) 2018/848 of the European Parliament and of the Council as regards the production and marketing of plant reproductive material of organic heterogeneous material of particular genera or species

[6] Commission Implementing Decision 2014/150

the policy needs of small enterprises for the registration and marketing of new varieties for local and niche markets. Central components to address these needs include an analysis and, possibly, revision and updating of the relevant regulatory landscape. Of the EU's 10.5 million farms reported by FAOSTAT in 2016, two thirds (67.6 %) have an average annual agricultural output below € 8,000. A similar situation accounts for enterprises involved in the sale and marketing of plant reproductive material (seeds and plants), which according to a report prepared by the European Parliament in 2013 [73] were heavily biased towards micro-, small or medium-sized seed companies (SMEs in the EU definition). This was particularly true for countries in Eastern Europe, as well as for France and Italy, with SMEs ranging between 80% and 98% of the respective totals. In the latter, practically all companies involved in the fruit and vine sectors were classified as micro-enterprises. All over Europe, these actors play an important role in conserving and promoting crop diversity, in both agriculture and horticulture, especially at the local scale. However, conservation and promotion of intra- and inter-specific crop diversities are not proportionately reflected in the complex, incoherent and fragmented regulatory framework related to plant reproductive material. A review of plant and seed marketing legislation processes has recently restarted after a hiatus in 2014. In addition, the implementation of the new EU Plant Health Regulation (2016/2031) and its requirements for plant health certificates may place additional economic burden on small enterprises. This may, in the end, compromise the Commission's explicit ambition regarding conservation of agrobiodiversity and, in the longer term, how Europe conserves and sustainably uses its PGR.

Objective

By 2030, **more diversified European agricultural and horticultural production systems** are established for the benefit of sustainable food production, entrepreneurial development, and long-term management of PGR.

Approach

1. Identify and promote the **removal of currently experienced disincentives for diversification** of crop production for sustainable and resilient agri-food systems, including:

    a. Support and contribute to the review and update, as necessary, of the existing legislation regarding production, marketing and sale of plant propagation material to better serve the needs of SME producers.

b. Analysing the effects of legislation (i.e. Commission Directives 2008/62/EC and 2009/145/EC) regarding conservation varieties from a PGR conservation and sustainable use perspective, and suggesting options for updating, as appropriate.

c. Examining the financial implications for seed-producing SMEs regarding plant health certificates stipulated by both seed marketing and plant health regulation (PHR) legislations and promoting their adjustment, as appropriate.

2. Develop and strengthen **incentives for diversification of crop production** for sustainable and resilient agri-food systems, including:

a. Ensuring full access to PGR diversity for the commercial plant breeding sector aiming at exploiting this untapped diversity through innovative technologies.

b. Stimulating rural enterprises working on genetic resources conservation and use, including user networks (farmer networks, seed savers, community seedbanks).

c. Promoting nutritional and sensorial/organoleptic research, thereby linking genebank communities with the food sector.

d. Strengthening value-chain research and development to identify and build links that increase diversity of crops and varieties on the food market, especially of underutilized and neglected crops.

2030 Targets for promoting sustainable use of PGR

1. Collections of PGR in Europe are increasingly characterized and evaluated under standard conditions, as well as genotyped with suitable sets of molecular markers.
2. Data and accessions in the public domain, including those with relevant agronomic and quality traits identified at molecular level, are available to users through open centralized information systems, including Crop Portals.
3. A wider use of pre-breeding of CWR and participatory-breeding on landraces on-farm generates added value to the unique diversity of these materials.
4. All elements of existing relevant legislation have been reviewed, and elements of previously developed disincentives for (small-scale) producers of diversified plant propagation material, are eliminated, where appropriate.

2.5 Strengthening a comprehensive information system for plant genetic resources for food and agriculture

The CBD requires measures that facilitate the exchange of information relevant to the conservation and sustainable use of biological diversity[7]. The GPA and the ITPGRFA offer recommendations to strengthen comprehensive PGR information systems. In response to these requirements and recommendations, the European Region developed EURISCO in the early 2000s. EURISCO is a European online searchable database that brings together data from European germplasm collections. The data flow from countries to EURISCO is assured by a network of National Focal Points (NFPs). Each has a mandate to develop and maintain national inventories of the PGR holdings conserved in PGR collections within their countries, and to transfer non-confidential data to EURISCO for public access. EURISCO currently provides passport data for over two million PGR accessions from over 400 institutes in 43 European countries. These data refer to old and modern cultivars, traditional varieties or landraces, as well as breeding or research lines and samples of crop wild relatives collected from nature. It focusses primarily on *ex situ* collections, but is also open to data on well-managed *in situ* material conserved outside genebanks. EURISCO

[7] Article 17 of the CBD is encouraging countries "to facilitate exchange of information from all publicly available sources, relevant to the conservation and sustainable use of biological diversity".

was developed to also host non-standardized characterization and evaluation data. Today such data are available for around 85,000 accessions. Through EURISCO, European national governments can designate accessions that are part of the Multilateral System (MLS) defined by the ITPGRFA, as well as those that are part of the European Genebank Integrated System (AEGIS). EURISCO also provides European data to the global genetic resources catalogue Genesys and contributes to the Global Information System [74].

EURISCO is a cornerstone of the European PGR Information System. However, to fully harness its potential over the medium-term some shortcomings need addressing, including : i) widely varying capacity and skills gaps of associated PGR holders and data providers ; ii) a lack of adequate financial support within and between countries to ensure the regular transfer of quality passport, characterization and evaluation data to the EURISCO hub; iii) the current limited interoperability with other European and Global open-access databases and European or international crop portals (see Section 2.4.2); and iv) the limited awareness and use of EURISCO among PGR users. This component aims at addressing these shortcomings.

2.5.1 Strengthen and support EURISCO and its National Focal Points network to ensure the provision of passport data for all accessions of National Collections

Background

EURISCO receives data from each contributing country through National Focal Points (NFP) who generate national inventories, standardize the data and upload them to EURISCO. Passport data are transferred to EURISCO according to FAO international standards for data exchange [75, 76]. NFPs play a crucial role in within country coordination of data quality and availability, thereby providing international access to high-quality genebank documentation.

However, while the standards for exchange of passport data are widely adopted, the quality of the data content is often variable across countries and improvements in the coverage of the information provided for each accession, as well as the accuracy of the individual occurrence data points need to be improved. This is especially true for some key data (e.g. taxonomy, and GPS location) that are essential for linking knowledge and data from different communities (e.g. CWR or forest trees data with crops data). Also, current data are far from complete, notably for material not managed by genebanks, such as in-nature CWR and on-farm landraces.

As key contributors to the EURISCO database, NFPs need stronger support including training to ensure the provision of high-quality data from national accessions, part of the European collection.

Objective

By 2030, the **NFPs are supported** in their activities **to collect the passport data of all PGR genebanks in their countries and upload them to EURISCO**. They are trained appropriately (e.g. on data standardization and quality), and feel part of a network that provides mutual support. The NFPs play an active role in supporting the genebanks in their country in improving the quality of the data, and support actors in the *in situ* community in providing access to their data. EURISCO grows to become a respected, well-known and well-used repository of European PGR passport data.

Approach

1. **Build capacity** of PGR-holders and NFPs **to provide high quality data** for EURISCO, data standardisation, and quality and the FAIR [77] data principles (findability, accessibility, interoperability, and reusability). Capacity building activities, including training and networking, will benefit from activities included in section 2.5.3.
2. **Develop a comprehensive inventory of PGR data** conserved in Europe, based on the commitment of NFPs and PGR holders, and on the existing EURISCO infrastructure, with expanded data coverage, quality and standardization of *ex situ*, *in situ* CWR and, as appropriate, on-farm conserved PGR (see also 2.1 and 2.2).
3. **Intensify the dialogue for understanding** the various stakeholder groups' **needs**; optimise user interfaces for serving the various groups, and create awareness of EURISCO amongst potential users as the best starting point for European PGR related web-searches.

2.5.2 *Increase availability of reliable phenotypic data via EURISCO and the community of National Focal Points*

Background

International standards for data exchange are not available or not generally adopted for phenotypic (characterization and evaluation) data. Such data are very useful to help users select sources of diversity from the online catalogue.

Expanding EURISCO to host non-standardized phenotypic data aimed at better harmonizing methodologies and protocols for data generation and scoring. Initiatives such as Minimum Information about Plant Phenotyping Experiments (MIAPPE) [78] or Crop Ontology [79] could lead to a significant improvement in the collection, coding, entry, exchange and interpretation of phenotypic data. Also, the developing ECPGR European Evaluation Network (EVA) is helping to connect genebanks and breeders so they may better harmonize data standards.

The inclusion of phenotypic data in EURISCO should be considered as an intermediate step necessary for the development of standardized data provision methods for phenotypic data, and to stimulate and train NFPs and other actors involved in applying these methods. In the longer run it is foreseen that access to these and other data will be decentralized, as with access to the various 'omics' data types (see 2.5.3). However, EURISCO acting as repository can also fill a gap for countries or stakeholders that lack a central repository for such data.

Objective

By 2030, **provide publicly available quality phenotypic data** to EURISCO that are collected using standardized methods and in collaboration with various public and private partners. EURISCO acts as the phenotypic dataset's repository.

Approach

1. Create, promote and support the **adoption of standards and tools** allowing harmonised collection and documentation of phenotypic data by:
    a. Developing and adopting standards (ontologies) for phenotypic data, in collaboration with the actors generating these data.
    b. Establishing a platform for curation of PGR-related ontology terms.
    c. Training National Focal Points and other relevant actors in applying these standards.
2. Include **publicly-available, harmonised phenotypic datasets** in EURISCO, through:
    a. Curating existing phenotypic data sets in EURISCO.
    b. Supporting NFPs and other actors (genebanks, institutions and companies) to develop incentives for networks and consortia committed to phenotyping GR, to documenting the data produced according to the FAIR principles, and to uploading data in EURISCO.

2.5.3 Assure interoperability of EURISCO with other information systems by adopting the FAIR principles

Background

Exchange of information between open databases gathering PGR information is currently largely based on custom-made scripts for transferring data from one data structure to another. By adopting standards, this process can be automated. Furthermore, the use of these standards also allows other systems, such as the ones used in bioinformatics or in plant breeding to automatically find, access, search and use these data. The FAIR standards for doing this largely exist, but EURISCO and individual genebanks are yet to adopt them. Based on open science practices and on the FAIR guidelines, automating information exchange and linking relevant information across sectors and domains, offers the opportunity to operationally share and connect genebank data within wider communities. This could deliver a wider range of services for biodiversity (e.g. LifeWatch-ERIC[8]) and agroecology research communities to address new challenges as well as contributing to life sciences research (ELIXIR[9]). This will also facilitate the development of sustainable applications and portals dedicated to users such as the crop portals by allowing automatic data updates and integrations.

Objective

By 2030, EURISCO comprehensively **applies the FAIR principles**, and the NFPs are trained to also adopt the principles for local data sources (see 2.5.1). EURISCO's **data governance and management are improved** to reach an acceptable high standard. As a result, EURISCO becomes a **trusted European and Global open-access database repository**.

Approach

1. **Establish the infrastructure** needed **to make** PGR data **FAIR**, using existing standards (e.g. voluntary DOIs[10] to uniquely identify all PGR in a

[8] LifeWatch ERIC is a European Infrastructure Consortium providing e-Science research facilities to scientists seeking to increase our knowledge and deepen our understanding of Biodiversity Organization and Ecosystem functions and services in order to support civil society in addressing key planetary challenges: https://www.lifewatch.eu/

[9] ELIXIR is a European intergovernmental organization that coordinates and develops life science resources across Europe so that researchers can more easily find, analyse and share data, exchange expertise, and implement best practices: https://elixir-europe.org/

[10] Digital Object Identifiers

genebank, or implementing BrAPI[11] to connect to breeding and research platforms) and other relevant standards such as those developed in 2.5.2 for phenotyping data.

2. NFPs, genebanks and other PGR-holders are given access to the technology, through sound and accessible **documentation on processes and technologies**, accompanied by a **training** program for NFPs and interested PGR documentation experts (in coordination with activities in 2.5.1).
3. Establish **workflows** to facilitate a smooth **(semi-)automated data flow** from the data sources (NFPs, genebanks, other PGR-holders and their collaborators) **to EURISCO** and other relevant international information systems.
4. Create several convincing **demonstration cases** to show the advantages of improving EURISCO's compliance to open data requirements. These cases could come from research and plant breeding communities.
5. **Self-profile EURISCO** as an active **member of the open science community**, developing standards and resources necessary for data management according to the FAIR principles.

[11] breeding application programming interface

2030 Targets for strengthening a comprehensive PGR information system

1. The EURISCO network of National Focal Points is optimally supported.
2. EURISCO contains high-quality passport data of all European *ex situ* collections, progressively extended to include actively-managed *in situ* CWR populations and appropriate on-farm landraces data.
3. NFPs assure access to all publicly-available quality phenotypic data related to the conserved PGR, in collaboration with various public and private partners. Access is provided initially via inclusion in EURISCO.
4. European genebanks and other PGR holders have improved (or can improve) their data management practices through access to, and use of facilitating tools, resources and services, having adopted (or allowing them to adopt) the FAIR principles and becoming part of the open data community.
5. Both data in EURISCO and the associated IT infrastructure are compliant with the FAIR principles, allowing a better use of the data by a wide community of users across sectors and domains.
6. EURISCO becomes a trustable repository in the arena of European and Global open-access databases with acceptably high governance and data-management standards.

2.6 Developing a system to monitor European conservation and sustainable use of PGR

Monitoring the conservation and sustainable use of PGR, as outlined by the objectives identified in Section 2 provides the framework for assessing the implementation of the present Strategy and is essential to meet the 2030 targets. It will use selected robust indicators for monitoring the different activities associated with conservation and sustainable use of PGR, agreed and implemented by various actors at local, national or European levels. Monitoring also requires collection and aggregation of data from various providers (from local to national, and from national to European). This allows i) publishing regular syntheses on the status of conservation and sustainable use of PGR in Europe and, ii) where relevant, initiating appropriate remedial or preventive action to foster positive and reverse negative trends.

The key factor that needs measuring is the status of conserved and used PGR genetic diversity in Europe. This allows appropriate measures to be taken that avoid genetic erosion, enrich conserved PGR diversity, and improve access to the genetic resources for breeders, researchers and other users. As indicated in Sections 2.1, 2.2 and 2.3, existing levels of genetic diversity need to be known to effectively select and manage priority populations of CWR and WFP, and to better understand and manage on-farm crop diversity. Also, knowledge of conserved *ex situ* diversity could be used to identify redundancies as well as gaps within the system, including genetic loss during regeneration, and in relation to what is threatened *in situ*.

To be fully effective, conservation systems (i.e. the *ex situ* and *in situ* conservation units) need appropriate regular reviews to maintain high quality standards.

Furthermore, monitoring the use of PGR is essential to determine the contribution of conserved diversity to increasing agricultural diversity. Such monitoring could also help create new diversity for future needs and challenges.

2.6.1 Defining and implementing relevant sets of indicators for monitoring genetic diversity conservation and sustainable use

Background

Several indicators have been developed by FAO for the Second Global Plan of Action for PGRFA (GPA2) [58], by the United Nations for the Sustainable Development Goals (SDG) [80], by the CBD for the Aichi Biodiversity Targets [81], and by the European Environment Agency and DG Environment of the European Commission to assess the state of and pressures on biodiversity (SEBI) [82]. The GPA2 indicators also include the PGR-related indicator 2.5.1 of the Sustainable Development Goals (SDG)[12].

A global initiative called Biodiversity Indicators Partnership (BIP) [83] identified a long list of available indicators for monitoring elements of the proposed CBD post-2020 goals and targets [84, 85].

Recently, a methodology to elaborate a multi-criteria 'Agrobiodiversity index' to enhance GR management for present and future use options and for sustainable agriculture has also been defined, measuring biodiversity across three sectors usually disconnected, i.e. nutrition, agriculture and genetic resources [86].

[12] SDG 2.5.1: Number of plant genetic resources for food and agriculture secured in either medium or long term conservation facilities [81]

Based on a review of all indicators available, the GenRes Bridge [1] project recommended a range of domain-specific indicators to monitor conservation of GR and its underlying genetic diversity, as well as its use[13]. These can be a starting point for further elaboration. Also, an FAO-commissioned thematic background study about indicators of genetic diversity, genetic erosion and genetic vulnerability for PGRFA [87] offered a solid scientific analysis and practical recommendations on the optimal properties of indicators, their limits and strengths.

The range of existing monitoring indicators is wide, particularly for conservation activities. However, few of them are effectively implemented, due to technical difficulties to assess or collect data as well as to the diversity of potential actors involved in data gathering and the insufficient support of national agencies to accompany this very specific task. Moreover, most of the indicators are hardly suitable to monitoring within-species genetic diversity (both *in situ* and *ex situ*) and use, with the high degree of specificity proposed by this Strategy and its assessment appears impractical from a technical, organizational or financial point of view. There is, therefore, a need to develop an acceptable and usable set of European indicators, complementing and extending existing indicator sets, to achieve the objectives and associated targets identified in Section 2, without causing excessive extra burden to the actors involved.

For *ex situ* conservation, the information system EURISCO [8] provides an important centralized information hub facilitating the task of European countries to meet their national and regional commitments under various policy frameworks. Inventories of *in situ* CWR populations and on-farm landraces have been developed at either local or national levels in a number of countries, and are under development in others. However, the number of *ex situ* conserved accessions and, to a certain extent, the number of conserved landraces or CWR populations, does not reflect the amount of genetic diversity that occurs *in situ*. Complementary indicators for *ex situ* and *in situ* collections should assess the genetic and phenotypic diversity within collections and allow the identification of gaps and the assessment of the efficacy of conservation actions. Furthermore, indicators could be developed or adapted for assessing progress in characterizing and evaluating genetic resources and also on access to associated data and

[13] GenRes Bridge internal document: Charvolin, E., Hiemstra, S.J., Adam-Blondon, A.F., Didier, A., Maxted, N., Sturaro, E., Lefevre, F., Thormann, I., Maggioni, L., Danchin-Burge, C., Kraigher, H., Bozzano, M. (2021). Indicators for monitoring the efficiency and effectiveness of conservation and management of GenRes (MS16). H2020 project no. 817580 SFS-28-2018-2019-2020 European Commission, 35 pp.

quality planting material.

Other indicators could also contribute to monitoring the effective deployment of genetic resources for sustainable use through: i) incorporating increased diversity in breeding programmes including pre-breeding; ii) registering and commercializing a wide range of genetically different varieties, including measures to facilitate registration of on-farm landraces or other underutilized original material, and iii) European and national authorities promoting crop diversification. These indicators need to be elaborated in coordination with the relevant stakeholders.

The involvement of all actors mobilized in conservation and sustainable use of genetic resources will be vital in defining relevant and operational sets of indicators for monitoring associated activities as well as in using them through the collection of baseline data.

Objectives

By 2030, **sets of indicators of genetic resource conservation and use** are developed/adapted and agreed by all stakeholders involved, and integrated and deployed within monitoring strategies to ensure that genetic diversity is maintained or increased in Europe.

Approach

1. A process is elaborated to **define agreed sets of indicators**, in partnership with various groups of stakeholders including scientists and users to ensure the monitoring of conservation and use of genetic resources. Based on the review of previous references, sets of approved indicators are selected, adapted and enriched, as appropriate[14].
2. The implementation of the above process allows the **identification of indicators** to assess:
    a. *ex situ* and *in situ* genetic diversity present status, availability to users and quality of conservation and management methods as well as trends and risks of erosion, in partnership with conservation managers (see 2.1, 2.2 and 2.3);

[14] Useful key criteria identified by BIP for selecting indicators include i) alignment with the goal or target, ii) availability and suitability for use at global and national scales, iii) scientific, iv) data availability, v) geographic coverage of data, vi) indicator already in use at global or national level, vii) easily understandable, viii) "championed" by an institution responsible for the indicator's continued availability and communication, ix) balanced representation of both target outcome and process/ effort-related indicators

b. *ex situ* and *in situ* characterization and evaluation data collection and availability to all stakeholders in order to document "quality material", in partnership with conservation unit managers and other stakeholders (see 2.4);

c. the use of genetic diversity in breeding, production of new varieties and seed distribution and its contribution to crop diversification, in partnership with breeders, seed distributors, agricultural extension services and other stakeholders, operating at local, national and European levels (see 2.4 and 2.5).

3. The **implementation of previous sets of indicators** - with the contribution of various stakeholders and, where appropriate, support of NFPs and ECPGR - facilitates the monitoring of genetic resources conservation and use activities in Europe.

4. **Implementation and usefulness of indicators are regularly assessed** with all previous stakeholders and adjusted if required.

Targets for defining and implementing relevant sets of indicators for monitoring genetic diversity conservation and sustainable use.

1. By 2025, sets of relevant indicators and associated baseline data to be collected for monitoring activities under this Strategy, have been consensually defined by all involved stakeholders.

2. By 2030, a sound system for the collection of all relevant baseline data has been set up and data are being actively collected and compiled, providing the baseline for further monitoring.

2.6.2 Establishing a system to ensure the effective transfer and the analysis of relevant information from local to European levels

Background

The indicators defined and implemented through the process outlined in 2.6.1 should enable monitoring the conservation, characterization and evaluation, and use of PGR in Europe, at the same time feeding existing relevant global monitoring mechanisms, thereby facilitating a better harmonized data gathering without duplicating national obligations. Monitoring of the implementation of the

PGR Strategy is to be carried out by the European Coordination and Information Centre on Genetic Resources (see subsection 4.3).

The existing network of ECPGR National Focal Points providing data from PGR conserved *ex situ* for the European database EURISCO already manages to collect mainly passport information from over 400 institutions, based on agreed common standards for data exchange. These data already automatically feed global databases, such as Genesys, based on a commonality of data standards. The FAO WIEWS monitoring mechanism of the GPA2 already enables countries to decide whether FAO is allowed to directly retrieve from EURISCO the relevant information related to SDG 2.5.1 indicators. It should be beneficial and effective for the European countries to reproduce a similar mechanism, based on revised and suitable indicators, including for the monitoring of genetic diversity within genebanks as well as other aspects of the conservation and use activities. This means creating for the first time a European source of indicators' data, as well as interacting with the Global Information System on PGRFA towards a solid and cooperative form of data collection.

The proposed monitoring system should be easy to use, rely on automated data collation and analysis of existing data where possible, and as much as possible, be complementary to, and integrated with, other reporting mechanisms (e.g. FAO GPA2), thus avoiding multiple reporting to different agencies.

Objectives

By 2030:

1. The proposed European coordination and information centre for conservation and sustainable use of agricultural genetic resources becomes the **hub to gather and publish PGR conservation and use data** provided by local and national networks under the guidance of ECPGR National Coordinators.
2. **Trends in the conservation and sustainable use of PGR are assessed, analysed and published** every 5 years and necessary corrective measures are proposed.

Approach

1. **Collection of agreed indicator data and reporting** is based on ECPGR EURISCO expertise and inventories to ensure the transfer of qualified and quality data from the local and country levels to a European documentation and information infrastructure (see 4.2), through the channel of National Inventory Focal Points and National Coordinators.

2. **A European coordination and information centre** hosting the information infrastructure (see 4.3) **organizes and summarizes indicator data information**, as well as compiles higher/elaborated indicators. These indicators are used primarily to ensure monitoring of PGR conservation and use activities in Europe, but also to raise awareness among various audiences and to ensure European input for international monitoring of conservation and sustainable use of agricultural genetic resources at the global level, such as GPA2, CBD, etc.
3. **Monitoring data are periodically analysed** to assess the status of conservation and sustainable use activities in Europe. Based on these analyses, rapid reactions to correct negative trends and encourage positive ones are initiated, while maintaining public awareness on the need for conservation and use of PGR. Also, disseminating summaries of available and up-to-date information via crop portals (see 2.4.2) ensures efficient interaction between experts and users.

2030 Targets for establishing a system to ensure the effective transfer and the analysis of relevant information from local to European levels

1. Trends in the conservation and use of PGR in Europe are being monitored, and the information from local, national and regional levels is compiled and available via the European coordination and information centre for conservation and sustainable use of agricultural genetic resources.
2. Information about trends in the conservation and use of PGR in Europe is readily available and regularly disseminated through different forms to PGR managers and users, policy-makers and the wider public.
3. Europe is actively and efficiently contributing to international reports on monitoring of conservation and use of genetic resources.

3

International Cooperation

Europe plays a crucial role in global efforts regarding genetic resources management by coordinating and leading initiatives to strengthen their conservation and sustainable use. Though countries have sovereign rights over their genetic resources, they also have a shared responsibility for ensuring that adequate conservation measures are in place as all countries are clearly interdependent on one another's genetic diversity. In times of climate change, new environmental conditions, emerging and existing pests and diseases, and increasing food and nutrition insecurity, information on and access to PGR are more important than ever. Hence, international cooperation is essential to boost and optimize plant genetic resources conservation and sustainable use, across political borders within and beyond Europe. Coordinated efforts through cooperation improve data and knowledge sharing, capacity development, technology transfer and research. In this context, ECPGR and other European PGR networks play essential roles in supporting these efforts. This brings conservation and use closer together and creates a stronger voice in the development of global policies through strengthened government support. Partnerships and collaboration among countries are more efficient and cost-effective as they avoid duplication and ensure the sustainability of efforts by identifying the benefits of cooperation and their contribution to PGR conservation and use at all geographical levels.

The following subsections outline where various areas of inter-relationships, on different scales, are identified and provide a base for cooperation and collective capacity building.

3.1 The EU and the European Region

For more than 40 years, European cooperation on plant genetic resources, promoted by ECPGR, has proven highly effective in identifying needs and priorities for safeguarding PGR diversity, highlighting the benefits of long-term cooperation. However, additional collaborative actions need to be taken between the EU and individual European actors and countries to improve the conservation and sustainable use of PGR at national and European levels. These actions should aim at mainstreaming PGR conservation and use into wider, coherent policies and programmes and at raising awareness for this field. Key areas for collaboration are as follows:

1. ***In situ* Crop Wild Relatives**: Notable progress has been made during the past years in developing concepts, theoretical frameworks and guidelines for conservation of CWR. ECPGR has developed an integrated CWR conservation concept for Europe. European projects have proposed criteria and standards for selection of CWR populations and their management in genetic resources. Evident, however, is the lack of information and actively managed sites for CWR conservation and the need to enhance implementation. The further identification of CWR priority populations at national and regional level and their inclusion in a European *in situ* conservation network should be part of advancing implementation. CWR hotspots in Europe should be designated as important areas for special management, monitoring and protection. These would provide baseline information for conservation planning, prioritization, monitoring and action within the integrated European concept to guide EU and national policy development on CWR *in situ* conservation.

2. ***Ex situ* PGR conservation**: The efficiency and efficacy of germplasm conservation could be improved through the increased participation of European genebanks and other *ex situ* collection holders (e.g. botanic gardens, community seedbanks). These could join or reinforce the AEGIS network and apply its principles for harmonization while strengthening operations and ensuring agreed minimum standards. A quality and monitoring system stimulates capacity building and quality improvement, through joint collecting explorations, peer visits and sharing of expertise to enlarge skills and activities e.g. in cryopreservation. Moreover, a safety duplication policy requires that a representative sample of each accession in a collection is stored for safety reasons at another Associate-Member genebank, possibly in a different European country and/or at the Svalbard Global Seed Vault and/or at one of the CGIAR Center genebanks. At a more advanced stage, AEGIS will build the framework for the maintenance and development of the European Collection representing optimal genetic diversity with jointly and reliably conserved germplasm, which is fully accessible under the SMTA.

3. **On-farm PGR management**: Although European agricultural production mostly relies on registered cultivars, different factors favour landrace maintenance, including resilience and productivity under harsh climatic conditions, cultural and socio-economic drivers, and their suitability for sustainable agricultural systems. Very few coordinated actions have been undertaken worldwide to monitor the presence, characteristics and

availability of on-farm maintained PGR. The identification of European sites of on-farm cultivated plant diversity and their networking across Europe would allow farmers to benefit from other farmers' expertise to enlarge their skills and activities and promote technical and cost-effective solutions to on-farm conservation obstacles, as well as exchanging appropriate support measures for on-farm PGR conservation within the new EU Common Agricultural Policy and Rural Development Programme.

4. **Promoting PGR use in research and breeding**: Based upon the wide range of stakeholders and agro-ecologies in Europe, synergies in promoting the use of PGR in research and breeding can be developed through European networks, cooperative research projects and student-exchanges. For instance, the ECPGR European Evaluation Network EVA, increases the use of crop genetic diversity through providing new phenotypic and genotypic evaluation data for various accessions and landraces. The establishment of European public-private partnerships within the network (nearly fifty breeding companies involved in EVA [88]) offers new possibilities of collaboration and support. Results from participatory plant breeding actions and other collaborative projects with breeding companies, such as testing disease resistance of selected vegetables, feed into the ECPGR European Evaluation Network, as well as into EURISCO.

5. **PGR documentation and information**: Data exchange within and between European countries on *ex situ* and *in situ* PGR conservation and sustainable use can be strengthened by promoting compatibility and reusability of datasets and by feeding into the common European catalogue EURISCO. This can be achieved by using agreed documentation standards and common descriptors. The more countries and national inventories link to EURISCO, the more data are electronically accessible and information gaps such as the documentation of CWR populations and on-farm PGR are essential to be filled.

6. **Scientific and technical exchange and networking**: Regular European PGR conferences and workshops for European stakeholders from the PGR community ensure a continuous dialogue and information exchange between the public and private sector. ECPGR is closely collaborating with other European organizations and NGOs such as EUCARPIA to promote scientific and technical cooperation on subjects of wider interest such as plant breeding.

The ECPGR represents a successful structure and way of cooperation between European countries, including countries outside the EU and is open to membership of further countries of the European region. Spanning across many European countries ECPGR would be the logical coordinating body of conservation and use of PGR in Europe, including the CWR in situ *conservation, on-farm management and other networking activities, acting through its existing structures and bilateral arrangements with stakeholders and countries not being members of ECPGR.*

3.2 Europe and other Regions

Historically, Europe has evolved in a wider environment with other regions. As peoples have moved throughout centuries, they were accompanied by their crops and farm animals, today called genetic resources. Cooperation and knowledge-sharing related to such PGR should hence not end at the borders of Europe, but a common heritage with other regions be recognized. Focus regions for maintaining and developing inter-regional networking structures should be the Near East and North Africa (NENA) region and the Caucasus where many crops have their historic domestication origin as Europe and these regions are highly inter-dependent.

In several of the above-listed key areas of cooperation in Europe, an extension of such cooperation to other regions is possible and desirable. *In situ* conservation of CWR will benefit from experts' networking related to biogeographic issues. These would include: i) information on geographic distribution; ii) ecology issues; iii) degree of representation in conservation activities, and iv) the possible inclusion of additional conservation sites in the wider CWR conservation network. Networking on technical issues of and experience in on-farm management of landraces can lead to reciprocal benefits for actors in all regions. The inclusion of non-European genebanks and field collections into AEGIS, safety duplications outside of Europe and southern hemisphere growing cycles, all offer opportunities to widen the unique diversity conserved in the European *ex situ* collection. Promoting use of PGR in research and breeding can also extend into other regions through cooperative research projects, or the expansion of the ECPGR European Evaluation Network EVA, extending the range of PGR evaluated and including additional evaluation sites in different agroecological and climatic areas. Scientific exchange and networking can be strengthened

by expanding European PGR conferences and workshops regularly to other regions, in particular the NENA region, and be supported by mutual exchange of knowledge and data and the sharing of technologies and tools.

National Programmes and ECPGR should be supported in the role of implementing the European cooperation with other regions in the framework of the Genetic Resources Strategy for Europe and its related PGR Strategy (See Section 4.3).

3.3 Europe and Global Cooperation

At the heart of Europe's importance is its leadership role in international cooperation and research, which is essential for the conservation and sustainable use of genetic resources. The region has contributed to various achievements of current utilization of plant genetic resources' diversity and their key contributions for food and agriculture.

The sustainability concept, the development of the theory of the Vavilov centres of diversity and the establishment of the first genebanks for crops, all originated in Europe and demonstrate the importance of the region for genetic resources conservation and sustainable use at the global level. As the conservation and sustainable use of PGR is a global task, European countries have committed to international agreements, which aim to foster sustainable agriculture and food security, preserve nature's biodiversity and mitigate the adverse effects of climate change. The existing international commitments clearly call for urgent actions, as well as for building institutional capacities at global, regional (European) and national levels.

Ample opportunities exist for a coordinated European contribution and collaboration at global level, that would strengthen Europe's role as a global player and provide mutual benefits to global and European actors. Here are some examples: i) a well-coordinated European contribution to the work of FAO's CGRFA would increase Europe's role in addressing and solving issues at global level, and support the implementation of the GPA2 in Europe; ii) ECPGR, the AEGIS network and the European collection represent an important contribution to the implementation of the ITPGRFA and its Multilateral System of Access and Benefit Sharing; iii) Europe should strengthen its cooperation with the Treaty, *inter alia* by the enhancement of its Multilateral System while considering the

important provisions of the International Union for the Protection of New Varieties of Plants (UPOV); iv) the European collection and the collective expertise in *ex situ* conservation would benefit from increased cooperation with the Global Crop Diversity Trust (Crop Trust), and experts at global level, to improve *ex situ* conservation, data management and data exchange between EURISCO and the Crop Trust's global information system Genesys; v) cooperation with CGIAR could open the possibility of developing a joint certification system for genebanks with the CGIAR Genebank Platform, while highlighting the importance of European collections in the global effort.

Coordination measures and processes should be improved or established within and among the groups of existing national focal points and representatives for Europe in international fora dealing with conservation and sustainable use of genetic resources, such as the FAO Commission on Genetic Resources for Food and Agriculture, the Convention on Biological Diversity, the Nagoya Protocol, the International Treaty on Plant Genetic Resources and the Global Diversity Trust.

4

Enabling the transition to a fully functional European system for conserving and using its PGR

Within a global arena, ECPGR aims to enable transformative change whereby Europe can reinforce its leading role in conservation and sustainable use of PGR and achieve its various commitments through strategic cooperation. This requires an appropriate policy and legal framework, combined with secure and appropriate financing to strengthen national and regional programmes as well as the institutional and human capacity needed to meet the obligations of all stakeholders to conserve and sustainably utilize genetic resources. Additionally, ECPGR will continue to raise awareness of the value and fundamental roles of genetic resources in providing the foundations of a sustainable and resilient agriculture. Finally, ECPGR will also strengthen collaboration and coordination between the many stakeholders involved.

4.1 Establishing a coherent European policy framework

Plant and other genetic resources for food and agriculture are covered in several policy areas and the conservation and sustainable use of genetic resources is linked to numerous strategies and policies, which are dealt with by various Directorates of the European Commission. The Genetic Resources Strategy for Europe developed by the GenRes Bridge project calls for a coherent European policy for agricultural and forest genetic resources. It provides a general vision in which the conservation and sustainable use of PGR are linked to a currently missing coherent legal and policy framework, in which European institutions would have a significant role to play in conservation and sustainable use of PGR.

The European Green Deal and the EU Biodiversity and F2F strategies have set the scene for raising awareness on agrobiodiversity and the needed step-change for its conservation and sustainable management. In this context, the Council conclusions on the F2F Strategy provide a first step by inviting the European Commission "*to present an EU strategy for genetic resources for aquaculture, forests and agriculture that is based on the work of the Commission on Genetic Resources for Food and Agriculture of the FAO*" [13].

To develop and implement appropriate measures for safeguarding PGR throughout Europe the above-mentioned, highly fragmented policy landscape needs to be reviewed and related measures coordinated.

The identified gaps and needs should be included in a European comprehensive and coherent legal framework that facilitates and promotes genetic resources conservation, material sharing and sustainable use. This framework should be linked with existing policies, laws and structures such as the EU Common Agricultural Policy (CAP), the network of Natura 2000, the EU seed legislation, research and research infrastructure, as well as development policies. It will be essential for policymakers in the EU to recognize the crucial contribution that plant genetic resources make to food and nutrition security and adaptation to climate change, and to ensure policies are in place to support the enhanced long-term conservation and sustainable use of PGR. As these measures rely on very diverse actors it will be essential to efficiently coordinate public, private and policy stakeholders within an integrated framework. Furthermore, the future framework will need to be harmonized across the EU, taking the differences between European countries into account, and enabling compliance of Europe's obligations within the FAO, CBD and the SDGs.

Additional specific coordination mechanisms are needed to support preparation of meetings within the FAO´s CGRFA, the ITPGRFA and the CBD, including involving UPOV. The multilateral system that facilitates access to specific PGR needs further enhancement, even if it already provides a degree of fair and equitable benefit-sharing arising from their use. For instance, shared benefits from the international benefit-sharing fund (BSF) have been moderate and the access of PGR under the SMTAs needs to be enlarged and facilitated. In the context of the new CAP and the Rural Development Programmes (RDP), appropriate support measures for on-farm conservation and management of PGR need to be developed.

In implementing the legal framework, it will be essential to promote collaboration and stakeholder participation and to allow sustainable management measures to be implemented at the appropriate scales. European countries should develop and implement national action plans that consider all forms of conservation and utilization of genetic resources (*in situ*, *ex situ*, on-farm, research, breeding etc.), which are supported by various EU instruments and link to regional and global strategies.

The following recommendations aim at designing a coherent and appropriate policy framework to facilitate the conservation and use of plant genetic resources in Europe and hence the timely achievement of the targets specified in section 2:

1. **The EU policy and legislative landscape related to PGR should be reviewed, and the implementation of all relevant programmes, measures and instruments coordinated for a sustained long-term conservation and more effective utilization of PGR.**
2. **A European legal framework that facilitates and promotes genetic resources conservation, documentation and sustainable use at both national and European levels should be established.**
3. **European countries should develop and implement national action plans for the conservation and sustainable use of PGR, supported by different instruments and regulations at the EU level.**

4.2 Establishing an efficient long-term European infrastructure for conservation, documentation and sustainable use

For Europe to achieve its ambition to effectively support high-quality research and to strengthen its global outreach, there is an urgent need for establishing an efficient infrastructure[15] for PGR conservation, documentation and sustainable use, in coordination with other genetic resources domains. Research and technology transfer play essential roles in promoting PGR policy development and in implementing coordinated actions. Joining forces and collaborating with other European networks creates synergies to lobby for common objectives more effectively, such as strengthening comprehensive PGR information systems.

Infrastructure-building and long-term support is needed to conserve and utilize PGR and includes the preservation of collections through supporting the documentation and exchange of genebank information and the inventories of on-farm landrace diversity and corresponding locations/maintainers. For instance, *ex situ* passport data in EURISCO will progressively be extended with additional data, such as for actively managed *in situ* CWR populations, to contain comprehensive data of all PGR managed in Europe. In order to expand the

[15] The word infrastructure is understood in a wide sense, including resources (such as personnel, buildings, or equipment) required for an activity and/or the underlying foundation or basic framework (system or organization).

coverage, quality and standardization of data, NFPs who upload the information to EURISCO need stronger support, including training, to ensure provision of high-quality data and to propagate new technologies in their respective countries. These activities can be implemented as part of a genebank manager network or as part of a PGR education and training programme.

Establishing such an education and training programme as part of human capacity building should be implemented at different levels and with different timeframes such as post-graduate programmes, vocational or professional trainings. Furthermore, the education and training programme should include continuous education, to support farmers, breeders and actors involved in managing agro-ecosystems, updating them on most recent findings and guidelines and thus supporting communication channels between science and practices.

The following recommendations draw on the technical objectives from section 2 and are meant to support the timely achievement of the respective targets. They include aspects of *ex situ* and *in situ* conservation, characterization and evaluation, documentation, monitoring and capacity building in different infrastructures and programmes:

1. **A European infrastructure for *ex situ* and *in situ* PGR conservation and sustainable use should be established or further developed. This infrastructure should include, inter alia, the decentralized/virtual European genebank (building on the AEGIS experience and principles), routine screening facilities, and a European Network of managed and monitored priority *in situ* populations.**
2. **A European PGR documentation and information infrastructure should be developed to support conservation, monitoring, research, breeding, sustainable use, and human capacity building among the main PGR actors and provide information about potential financing sources to better manage PGR at national, EU and European regional levels.**
3. **A European human capacity-building scheme, including PGR education and training programmes in schools, undergraduate biology degrees and MSc programmes and vocational and professional training that involves modules in PGR conservation and use should be established, continuing professional development short courses, and opportunities to undertake research topics for doctoral studies.**

4.3 Establishing a European Coordination and Information Centre on Genetic Resources

Given the current scattered and dispersed landscape of activities for agricultural conservation and use in Europe, a new European Coordination and Information Centre for conservation and sustainable use of agricultural genetic resources should be established to improve the coordination of activities for the conservation and sustainable use of PGR and other GRFA. This centre will support the European Commission and the European governments and their national programmes in implementing the PGR Strategy, creating improved institutional channels between the EU, the European networks, the FAO and other international partners.

It is particularly important to create an interface for research and policies regarding cross-domain genetic resources and coordinating activities. This should ensure that efforts are not duplicated, gaps are filled, and resources are used efficiently. Moreover, the centre will support the administration responsible for PGR conservation and facilitate implementing national plans, technical support, guidelines, recommendations and harmonized management approaches. It should be emphasized that the work of the ECPGR Secretariat will be supported and strengthened but not be replaced by the new centre.

The legal entity of the European Coordination and Information Centre for Genetic Resources, to be established by the EU on behalf of the European region, should host a newly-established Secretariat working across domains and host and support the ECPGR Secretariat and other domains' Secretariats, where applicable. The European Coordination and Information Centre could be attached to an existing European authority, or be established as an entity with a legal status similar to bodies such as the European Patent Office (epo.org/) or EU agencies such as the Community Plant Variety Office (cpvo.europa.eu/).

The Centre should execute the following tasks on agricultural genetic resources:

- Report on all its activities to the EU and European governments.
- Assist/advise the EU and European governments in establishing or further developing the policy and regulatory framework for the conservation and sustainable use of plant genetic resources in Europe.
- Coordinate and monitor the implementation of the PGR Strategy.

- Act as a European project implementation and financing agency for the conservation and sustainable use of plant genetic resources.
- Raise public, policy-makers' and other relevant stakeholders' awareness of the status and trends of plant genetic diversity.
- Coordinate the European input for international cooperation as it relates to the conservation and sustainable use of agricultural genetic resources, including for the FAO CGRFA, the CBD, the Nagoya Protocol, the ITPGRFA, the Global Crop Diversity Trust and other potentially relevant Treaties and fora.

Recommendation:

1. **A European coordination and information centre should be established to support the European Commission, European governments and cooperative programmes for conservation and sustainable use of agricultural genetic resources and national programmes in implementing the European and domain-specific genetic resources strategies.**

4.4 Securing a sustained financial basis for collaborative European and national programmes

Collaborative European and national programmes can only overcome the many current obstacles to safeguarding agrobiodiversity and its genetic resources, when backed by political will and adequate financial resources. ECPGR and other networks face the challenge of missing long-term availability of resources. Adequate, accessible and stable funding is essential to finance efficient, effective and lasting activities and associated infrastructures for the conservation and sustainable use of genetic resources.

Several funding instruments and payment structures in Europe are in place related to the CAP, the RDP and research programmes. However, funding is scattered and insufficient for important elements related to the conservation and sustainable use of plant genetic resources. Hence, developing a sustained financial basis necessitates providing long-term investment in genetic resources conservation and use infrastructures such as the European collections and

genebanks. This could be achieved by co-funding of national programmes by the EU, introduced for European collaborative measures. Highlighting synergies and identifying joint initiatives on national and regional levels across domains may appear especially attractive to the funding agencies.

Recommendation:

1. **Adequate and permanent co-funding of national programmes by the EU, introduced for sustained support of European collaborative measures in conservation and sustainable use of genetic resources needs to be established as part of an overarching investment plan.**

Conclusion

The ongoing erosion of plant genetic resources is a dramatic global challenge, worsened by the climate-change crisis, which seriously threatens the wellbeing of the planet and its people. European countries and the EU are committed to conserving PGR and its diversity through several global fora. Furthermore, the EU is committed to a transition to more sustainable and resilient agriculture and forestry while ensuring food and nutrition security, health, inclusive and fair value chains, and maintaining a sustainable circular bioeconomy, all calling for long-term conservation and sustainable use of PGR. **Today plant genetic resources are still declining in Europe**.

This Strategy for the conservation and sustainable use of PGR clearly demonstrates the ambition and the capacity of European countries to develop coordinated and consistent activities (conservation and management, characterization and evaluation, documentation) to reverse this decline, and position Europe as a reliable and active entity contributing to addressing the above-mentioned challenges. This **PGR Strategy for Europe is underpinned by the ECPGR's 40-year successful track-record, and by the expertise of many highly experienced, well-qualified and internationally recognized European actors and emerging stakeholders in the conservation and use of PGR. Perhaps more importantly, these stakeholders are the guarantors for the Strategy's effective implementation, subject to the firm political will and support of the EU**.

As part of its new "Green Deal" and in addition to the Farm to Fork Strategy, the Council of the EU has recently invited the Commission "*to present an EU strategy for aquaculture, forests and agriculture*". This new EU Strategy should provide the missing link between policies and strategies focused on wider biodiversity issues, and those that address agriculture, forestry and aquaculture. **The PGR Strategy** – complementing the Genetic Resources Strategy for Europe prepared by the GenRes Bridge project – **shall be seen as a contribution of the plant sector to the elaboration of the EU strategy, as called for by the Council of the EU**.

Critically, the realisation of the PGR Strategy will enable Europe to meet its international commitments to genetic resources conservation and sustainable use under the FAO GPAs, ITPGRFA, CBD, SDGs **and will foster and emphasize the region's position as a key player in the global arena**.

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