European Cooperative Programme for Plant Genetic Resources

ECP/GR

ECPGR Concept for on-farm conservation and management of plant genetic resources for food and agriculture

Endorsed by the ECPGR Steering Committee in January 2017

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Wheat fields at the organic farm ‘Floriddia’, Peccioli, Pisa, Italy © L. Maggioni, Bioversity International.

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Acronyms and abbreviations

AEGIS	A European Genebank Integrated System
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CGRFA	FAO Commission on Genetic Resources for Food and Agriculture
CTA	Technical Centre for Agricultural and Rural Cooperation
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
ECPGR	European Cooperative Programme for Plant Genetic Resources
EEA	European Environment Agency
EU	European Union
EUCARPIA	European Association for Research on Plant Breeding
EURISCO	European Plant Genetic Resources Catalogue (or European Internet Search Catalogue)
FAO	Food and Agriculture Organization of the United Nations, Rome, Italy
GEF	Global Environment Facility
GIAHS	Globally Important Agricultural Heritage Systems *(FAO)*
GPA	Global Plan of Action for Plant Genetic Resources for Food and Agriculture *(FAO)*
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	International Union for Conservation of Nature
MAB	Man and the Biosphere Programme *(UNESCO)*
MAPA	Most Appropriate Area
PGRFA	Plant genetic resources for food and agriculture

1. Introduction

1.1. The ECPGR concept

Document preparation

At its Thirteenth Meeting (Vienna, Austria, December 2012), the European Cooperative Programme for Plant Genetic Resources (ECPGR) Steering Committee agreed on the need for ECPGR to develop a concept for on-farm conservation and management of landraces, for the Steering Committee's consideration and adoption. During its preparation, realizing that the definition of landraces is not sufficiently comprehensive of all the existing, threatened and/or potentially useful diversity in cultivated fields, this concept was expanded to encompass on-farm plant genetic resources for food and agriculture (PGRFA)[1]. This document, in combination with the *Concept for* in situ *conservation of crop wild relatives in Europe* (Maxted et al. 2015), and the AEGIS initiative[2], will constitute ECPGR's contribution to a future European strategy for the conservation of genetic resources for food and agriculture.

After a short introduction describing the rationale for on-farm conservation and management in Europe, this document includes a chapter outlining the appropriate framework for the ECPGR concept (Chapter 2). The proposed ECPGR approach (Chapter 3) then identifies five areas of intervention and potential funding opportunities. Finally, an Annex to this document provides information on legislation and policies, the definitions of types of materials grown on-farm, range of management approaches, actors and stakeholders. Bibliographic references are also provided at the end of the document.

Acknowledgements

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1.2. Rationale for on-farm conservation and management in Europe

Although most agricultural production in Europe is based on registered, uniform and certified varieties, landraces and occasionally obsolete cultivars and other heterogeneous materials are grown under alternative or more extensive agricultural methods especially and predominantly in marginal areas. Home garden cultivation with diverse materials is also widespread. Within specific niche sectors including organic or bio-dynamic producers, there is growing popularity to maintain and even create modern landraces.

Notwithstanding the introduction and extensive spread of high-input agriculture, landraces have often been maintained in cultivation, since they offer two key advantages: (1) adaptation to specific environments and/or (2) agronomic or cultural values for farmers and local communities owing to their

[1] PGRFA refers to any genetic material of plant origin of actual or potential value for food and agriculture (FAO 2001).

[2] The goal of AEGIS is to create A European Genebank Integrated System for plant genetic resources for food and agriculture (www.ecpgr.cgiar.org/aegis)

[3] Negri V, Freudenthaler P, Gasi F, Maxted N, Mendes Moreira P, Strãjeru S, Tan A, Veteläinen M, Vogel R, Weibull J. 2016. A European *In Situ* (On-Farm) Conservation and Management Strategy for Landraces. In: Maxted N, Dulloo ME, Ford-Lloyd BV (eds.). Enhancing Crop Genepool Use: Capturing wild relative and landrace diversity for crop improvement. CAB International, Wallingford. pp. 297-312. ISBN 9781780646138.

taste, shapes and colours. In other cases, traditional materials have not survived in cultivation, either because they have been replaced by modern cultivars or the land use and the traditions maintained have changed.

Genetic diversity, maintained in the fields at different levels (inter- and intra-specific, spatial and temporal levels), provides a number of recognized socioeconomic, environmental and genetic values (Jarvis et al. 2016). The **economic** values consist of the direct value to the producers (such as from niche markets) and the indirect value to society at large as a source of useful traits for future crop improvement. Various segments of **society** perceive different benefits from their choice to grow or consume traditional varieties and different crops (such as maintenance of food sovereignty and diversification of food choices). Specific **adaptation** to different environmental (biotic and abiotic) conditions, possibly in a state of continuing evolution, may reduce genetic vulnerability in specific situations, as well as the need for chemical treatments. The dynamic management of landraces and other diverse plant materials, including their exposure to different production regimes, environments, farmers' selection and seed exchange systems, maintains a reservoir of continuously evolving genetic variability. The above-mentioned complex series of 'values' that are expressed by the cultivation of diversity in the field are all interconnected in a way that provides justification for on-farm conservation and management beyond the exclusive point of view of conservation of genetic diversity per se.

From numerous studies carried out in Europe (Lateur 2003; Veteläinen et al. 2009; Maxted et al. 2012) and worldwide (Jarvis et al. 2016; Maxted et al. 2016), it has been concluded that the driving force that maintains our crop heritage is **the diversity of cultivation and management strategies of a large number of smallholder farmers** who confront different production situations, have different needs and adopt different practices. Another important element is that traditional and other varieties remain in agricultural production systems because they meet the needs of farmers and/or consumers and because farmers choose to maintain them. In fact, in the end it will (and should) always be the farmers themselves who choose what to grow, and such choice needs to be assured.

In view of the aforementioned, it is important to promote on-farm conservation and management of landraces and other heterogeneous materials in Europe wherever appropriate. The approaches to maintaining diversity on-farm can be diverse, depending on the emphasis that different stakeholders and local or country-level administrations wish to give to the relative importance of benefits to conservation, production system properties, or the livelihood of farmers and local communities. Thus, the focus may be directed, for example, to the maintenance of the genetic materials themselves, to the adoption of agro-ecological approaches, to supporting farmers' rights, etc. Independently from the preferred approach, the importance of crop genetic diversity within agricultural systems, be it for genetic, productive, ecological or cultural reasons, is recognized.

2. Framework for the ECPGR concept

The aim of ECPGR is the conservation, provision of access to and increased utilization of *ex situ* and *in situ* PGRFA in Europe. This specific objective is harmonized with international agreements and recommendations, and also allows ECPGR to focus its action without any intention of shaping the agricultural production systems or interfering with marketing and development choices. From the ECPGR perspective, it is therefore important to adopt an operating definition of 'on-farm conservation and management', to define which material falls within the scope of conservation and management, to list a number of potential benefits deriving from on-farm conservation and management, to acknowledge different sub-regional and national approaches to conservation and management, and finally to identify the role of ECPGR to facilitate management and conservation approaches, in addition to the achievement of related benefits. Suitable areas of intervention through a regional collaborative network approach will normally concern initiatives that can only be achieved through international collaboration, while site-level approaches will be more appropriately defined and implemented by the different national programmes.

2.1. Definition of on-farm conservation and management and static vs. dynamic processes

The term 'conservation' is an aim or an action that is often considered to be a static process, i.e. the maintenance of the genetic integrity of a given genotype or population. On the other hand, 'management' is a more dynamic process, which involves changes in the genetic pattern of the managed populations. In recent years some confusion has arisen regarding the two terms 'on-farm conservation' and 'on-farm management' as synonymous, while they are not. The focus of **on-farm conservation** is the genetic conservation of landrace diversity held within on-farm systems. Here the landrace diversity is used directly by the farmers maintaining the diversity, while it also has potential for use by external breeders or other users interested in exploiting the full range of diversity held within landraces. In contrast, **on-farm management** focuses on maximizing the diversity of landraces held within any on-farm system. The diversity is maintained to maximize direct benefit to the local farmers (Suneson 1956; FAO 2012; Ceccarelli 2014), particularly those in marginal environments (Di Falco and Chavas 2006; Ceccarelli et al. 2012), and potential use by external breeders or other users is of less importance. Alien landrace or cultigen material may be introduced to hybridize with native landrace material to help sustain or increase production from the on-farm system. The alien landrace or cultigen material introduced may replace and cause loss of native landrace material, yet overall the local farmers benefit and the on-farm system is sustained. On-farm conservation and management should be considered as complementary approaches for maintaining and promoting on-farm systems and both should be supported. The appropriate balance between static conservation and dynamic management processes is variable, depending on the type of material that is grown in the fields and the associated prevailing purpose. Consequently, cultivation of any type of material described below under 2.2 can be regarded as 'on-farm conservation' and/or 'on-farm management' providing, at different scales, one or more of the following benefits:

- Complementary conservation approach linked to *ex situ* collections
- Conservation and development of cultural landscapes
- Conservation and development of crop diversity originating in Europe and its linked traditions
- Conservation and development of diversity that is not covered by the formal sector
- Mitigation of genetic erosion
- Crop evolution and adaptation to changing conditions in the field
- Diversification of agriculture and consequent increased consumer choice, ecosystem benefits and services
- Opportunities for sustaining current, and developing potential, niche markets.

Appropriate specific priority actions within the remit and scope of ECPGR are identified in Chapter 3 as the most conducive to promoting conservation, availability and increased use of genetic resources from a regional perspective, as well as increasing diversity within on-farm systems.

2.2. Types of material subject to on-farm conservation and management

The following types of material, fully described in Chapter II of the Annex, are genetic resources grown to a varying extent on-farm. They contribute to diversification of production, livelihoods and mitigation of genetic erosion. Their conservation as potential assets for future use, including for breeding purposes should be ensured with appropriate and complementary *ex situ* conservation measures.

- **Landraces**

  In the case of landraces, it is assumed that populations are subject to genetic change, being selected for agronomic traits and allowed to adapt to environmental biotic and abiotic changes, while maintaining the 'core' phenotypic traits and features that define them and for which they are valued under the management of the farmers. Conservation of genetic variability within the framework of a defined phenotype is a successful outcome of on-farm conservation and management. This pattern is valid for both autogamous (= selfing) and allogamous (= out-

crossing) herbaceous crops, as well as for clonally propagated tree crops, in case of the presence of clonal variation, while also in offering opportunities for open-pollinated crops to express new genetic variation. Cultivation of *sensu stricto* landraces is strongly rooted in a defined geographical area, thus conservation and management are very often linked to site-specific conditions. The size of these specific sites may vary considerably, ranging from highly localized areas to entire countries. Landraces under threat of genetic erosion can be identified and registered as 'Conservation varieties', as per the European Commission's Directives 2008/62/EC (European Commission 2008) and 2009/145/EC (European Commission 2009). As most of the landraces fall within the threat of genetic erosion, the process of registration and marketing of their seed can be useful to increase the chances of both conservation and use (Spataro and Negri 2013).

- **Obsolete and other cultivars having no or limited intrinsic value for commercial crop production**

  Within this category, including either seed or clonally propagated crops, conservation aims at the preservation of a given genotype with an expected narrow variability. Therefore, *ex situ* conservation seems to be appropriate to ensure the genetic conservation target. Growing these genotypes on farm responds to specific production purposes, usually as niche or in-garden production. Some obsolete cultivars with limited commercial value may have continued to exist where they fulfil a niche demand, such as the long-stemmed wheat straw for thatching or local fruit cultivars well-adapted for processing products (Planchon and Lateur 1999; Ambrose and Letch 2009). The link to cultural and traditional values could sometimes be relevant, although not necessarily site-specific. Also from within this category it is possible to register 'Conservation varieties' as per the European Commission's Directives 2008/62/EC (European Commission 2008). In addition, 'Vegetable varieties with no intrinsic value for commercial production' can be registered as 'Amateur varieties', as per Commission Directive 2009/145/EC (European Commission 2009), thereby enabling seed marketing and increasing the opportunity for on-farm conservation and management.

- **Heterogeneous populations**

  In this case the starting material is generally a mixture of genotypes that are suitable for production in a specific environment. In most cases they are expected to evolve and continuously adapt. Conservation of a specific genotype or phenotype is not the objective in this case, but on-farm management of this genetic diversity serves different purposes: production and income generation, ecosystem services, site-specific adaptation to low input conditions, resilience to climate change as well as generation of new genetic combinations. Within the EU, marketing of propagating material of this category is limited to the forages seed mixtures and the cereal populations described under the derogations allowed by Commission Directive 2010/60/EU (European Commission 2010) and Commission Implementing Decision C(2014) 1681 (European Commission 2014a), respectively.

2.3. Production systems and seed supply

Although conservation and use of landraces and other heterogeneous materials is not strictly linked to a defined production system, it is more likely to find these genetic resources in home gardens and family farms, where production is dedicated to self-consumption or local markets. Organic and other non-conventional farmers may also prefer to use varieties with a broader genetic base, both for personal philosophy and with the intention of using materials that are agronomically more suitable to that type of production. Conventional farming may also involve the cultivation of diversity, especially when the market context is favourable, such as in the case of niche or even wider market promotion of local products. Motivation of the farmers, availability of propagating material and market value are more important factors than the production system in determining the extent and potential use of landraces and other heterogeneous materials. The following are areas that may deserve the attention of ECPGR, in its monitoring, analysis and management advisory role:

- **Personal motivation of the farmers**

  What motivates farmers relates to a mix of traditions, beliefs, preferences, conveniences, economic status or lack of appropriate alternative germplasm for a certain area. Knowledge of the existing motivating forces that have assured the maintenance of genetic resources in the field to date is important to enable policy or strategic decisions that maintain, renew or promote these motivations.

- **Supply of seed and propagating material**
  Re-use, availability and supply of seed and propagating material determine maintenance of genetic diversity in the field. An inventory of the existing genetic diversity should be able to record those processes that influence its permanence, generation after generation. For example, those who maintain seed need to be identified and the ongoing dynamics of seed exchange or sale must be understood, as far as these contribute to shaping genetic diversity in the field. Whenever key individuals or processes related to seed supply are compromised, genetic diversity is likely also threatened. Thus, intervention becomes crucial. Intervention is necessary also to simplify access and availability of propagating material, to satisfy existing or new motivations of farmers. Such interventions relate to any measure that can facilitate the legal transfer or sale of the seed among farmers and from genebanks or other maintainers/seed producers to the users.
- **Existence of market demand**
  Several model examples exist of the development of niche markets and the organization of value chains, involving actors such as farmers or community associations, non-governmental organizations (NGOs), consortia and other institutions at different stages. Preparing documented case studies of how these value chains have fostered a favourable market context to grow genetically diverse materials will serve as examples for similar initiatives, thereby promoting and enhancing the conservation and use of these materials.

2.4. Sub-regional/national approaches to on-farm conservation and management

Different options for on-farm conservation and management and different materials suitable for on-farm conservation exist at national and European levels. In some southern and northern regions of Europe, on-farm conservation and management are primarily based on *sensu stricto* landraces maintained because of the value of the products obtained, their links to local culture or for educational purposes, or both. In other parts of Europe, on-farm conservation and management activities are mainly based on introduced (from different areas) or re-introduced (from genebanks) landraces; or, on heterogeneous populations developed to satisfy the demands for a more environmentally-friendly agriculture and for a broader choice of diversity by the consumers.

3. The ECPGR approach

The following activities are identified among the most suitable to be addressed through the ECPGR networking activity, as a contribution to on-farm conservation and management in Europe, in the spirit of the FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and the Second Global Plan of Action (GPA) and without prejudice for the different approaches that may be adopted at sub-regional, national and local levels by the respective administrations.

3.1. Create European Inventory of on-farm genetic diversity

It is commonly acknowledged that diversity present on farms can be wider than what is currently conserved *ex situ* in genebanks, depending on the crop, the production system and possibly other factors. Therefore, it would be important to inventory the on-farm component of crop genetic diversity to facilitate its conservation, management and use. Crop diversity in the field is, however, a moving target, since its existence over the years is only relatively stable in perennial crops such as fruit trees or permanent pastures. It is also dependent on personal choices made by the farmers from year to year in selecting seed material, and on the changing environment. Even though recognizable landraces may be generally retained over time (Maxted et al. 2009), the maintenance of up-to-date inventories of on-farm diversity might be difficult. The purposes of such inventories should be clarified and could differ by country and by types of material, as described in Section 2.2. It is not surprising that the GPA (FAO 2012) indicates significant gaps in the documentation on PGRFA, with the documentation of on-farm genetic resources being particularly inadequate.

Inventories of landraces have often been promoted, discussed and reported in Europe (Veteläinen et al. 2009; Negri et al. 2016). For landraces are the on-farm genetic material that is considered most

vulnerable and also the most promising in terms of reservoirs of useful traits (as well as components of cultural landscapes and champions of low-input agriculture and of new market opportunities).

With the understanding that different European countries may choose different approaches for the conservation and management of the existing on-farm genetic resources, as well as for the creation of corresponding on-farm inventories, compatible with country crop priorities, needs and resources, the creation of a European Inventory of On-farm Genetic Resources is deemed necessary when it responds to the following objectives, scope and methods:

Objectives:

a) Inventory the European on-farm diversity, within the scope defined below, in order to obtain snapshots of the situation at given intervals (e.g. every five years)

b) Identify valuable on-farm genetic resources that require *ex situ* complementary measures

c) Establish a knowledge base of guidelines and case studies for the assessment and monitoring of genetic erosion

d) Identify material defined by the respective National Focal Point as 'PGRFA naturally adapted to the local and regional conditions and under threat of genetic erosion', thereby eligible to be registered as 'Conservation varieties'. Similarly, identify material eligible to be considered for the other legal categories of 'Amateur varieties', 'Populations' and 'Mixtures' (see Annex, Section II.2)

e) Identify material that may be included in programmes or projects enhancing their use in meeting changing market demands

f) Contribute to documenting European on-farm genetic resources in compliance with the Second GPA, the ITPGRFA and the EU 2020 Biodiversity Strategy and facilitating interoperability among different information systems

g) Identify hotspots of on-farm diversity to support the creation of European agro-diversity sites (see 3.4 below)

h) Inform potential users about terms and conditions of access to on-farm managed genetic resources.

Scope:

a) Existing endangered genetic resources, with a focus on landraces and obsolete cultivars (as broadly defined in Chapter II of the Annex), as well as conservation varieties and other legal categories (see Section II.2 of the Annex)

b) Genetic resources that are continuously grown on sites or areas that can be precisely geographically positioned and identified as the sites of adaptation or adoption, as well as genetic resources corresponding to legal categories (see Section II.2 of the Annex)

c) Indicators of genetic erosion, as per Section 3.2 below

d) Local knowledge associated with the given genetic resources, which is useful for its unique identification, maintenance and value adding

e) Institutions or individuals that can be either formally or informally identified as the maintainers of a given genetic resource

f) Terms and conditions of access for direct use, breeding, research and education.

Methods:

a) European countries wishing to contribute to the European On-farm Inventory designate a National On-farm Inventory Focal Point through their ECPGR National Coordinator, with responsibility to make national data available according to an agreed data exchange format.

b) A list of descriptors should be agreed by the Focal Points, including a mandatory minimum set for data exchange. Descriptors developed by PGR Secure (Negri et al. 2012) can be the starting basis to reach an agreement. Specific descriptors should be agreed in order to inventory the material according to both biological and legal categories (see Annex, Sections

II.1 and II.2), as well as to cover the scope of the Inventory, as indicated above. Descriptors of genetic erosion (see 3.2 below) should also be included.

c) Each entry in the database should include the accession name of the given genetic resource and the corresponding cultivation site at a given time. A reference related to the grower(s) is also desirable.

d) The European On-farm Inventory should be completed as a concerted effort at given intervals (e.g. five years) under the coordination of an ECPGR or EU body.

e) As the Inventory also serves to monitor genetic erosion, each snapshot of genetic diversity data deployed on-farm should be archived in order to allow comparisons at time intervals.

f) Coordination with the activities of the FAO-Treaty Global Information System should be pursued.

g) Links and collaboration with inventories and databases maintained by seed savers' associations or farmers' associations involved in agrobiodiversity conservation should be sought.

h) Possible synergies and complementarity between the Inventory and EURISCO should be explored.

Funding:

a) National Inventory components should be funded through national funds, possibly complemented by additional regular or project funds (EC or others). Inclusion of on-farm data gathering among the activities eligible for the European Agricultural Fund for Rural Development (EAFRD) agri-environmental schemes could also be explored at the national level. Creation of a rolling European on-farm inventory at regular intervals would become more realistic if this task could be included in an EU Agrobiodiversity Strategy and become a legal obligation of the member states, similarly to the reporting requirements for the 'Habitats Directive' 92/43/CEE.

b) Some coordination components (e.g. agreement on data exchange standards) could be funded through the ECPGR budget (Activity Grant Scheme or other) or other project funds (EC or other). Fund raising jointly with FAO Treaty could also be explored.

3.2. Develop indicators for monitoring diversity and threat

PGRFA conservation, planning and decision-making require regular monitoring of the existing diversity of PGRFA, its distribution and evolution over time (FAO 2013). As indicated in the Second GPA, although modern molecular genetic techniques allow generating useful data, monitoring of genetic diversity remains a complex undertaking which requires practical and internationally accepted indicators of genetic diversity and genetic erosion.

The FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) has adopted in 2013 the indicators for monitoring the implementation of the second GPA and several of them have relevance for monitoring diversity. In particular, relevant indicators concern GPA Priority Activity 1 (Surveying and inventorying PGRFA), GPA Priority Activity 2 (Supporting on-farm management and improvement of PGRFA), GPA Priority Activity 15 (Constructing and strengthening comprehensive information systems for PGRFA) and GPA Priority Activity 16 (Developing and strengthening systems for monitoring and safeguarding genetic diversity and minimizing genetic erosion of PGRFA) (FAO 2013, 2014). Technical guidelines for national level conservation and use of landraces have been provided within the context of the FAO Commission on GRFA (Maxted et al. 2013; FAO 2014).

The above FAO indicators offer a very general indication of the status of genetic diversity in the field and do not allow systematic analyses at the species, variety, pedigree and allele levels. On the other hand, 'number of landraces' was validated by Ford-Lloyd et al. (2008) as a simple and effective proxy of the genetic diversity richness in farmers' fields and of its trend over time, provided regular surveys were undertaken. More detailed measures of inter-specific and intra-specific diversity were provided by other authors (Last et al. 2014), as well as the use of molecular markers to study varietal

richness, spatial evenness, between-variety and within-variety genetic diversity (Bonneuil et al. 2012). However, many proposed methodologies would be rather demanding and thus impractical for adoption on a large scale.

An important international forum working on biodiversity indicators is the CBD-mandated Biodiversity Indicators Partnership (http://www.bipindicators.net/), which is however so far falling short from providing useful examples of indicators for on-farm cultivated diversity, even less so internationally discussed and agreed.

With the establishment of a European Inventory, ECPGR could have a role in contributing to advance a standardized monitoring of diversity, while keeping in mind what has already been done. Although molecular data could also be used to generate a rational picture of the status and trends of diversity, it is currently financially and logistically impractical to call for systematic molecular surveying and monitoring of on-farm crop diversity in Europe. Simple indicators could however be easily derived from a European on-farm landrace Inventory. Existing more complex case studies may on the other hand be compiled and future studies promoted and monitored.

ECPGR activities can be articulated as follows:

Objectives:

a) Reach an agreement in Europe on simple and effective indicator(s) to be used for monitoring on-farm genetic diversity and trends;
b) Establish a knowledge base of case studies aiming to analyse genetic diversity and its trend in the field;
c) Monitor the relevant initiatives aiming at refining indicators of genetic diversity and trends at regional or global level.

Methods:

a) An ECPGR Task Force and/or the On-farm conservation and management Working Group should analyse existing options for indicators that are useful for monitoring genetic diversity and trends, and propose one or a few indicators that can be effectively and simply surveyed in Europe.
b) The Secretariat could work towards a bibliography of case studies on genetic erosion and monitoring of diversity in the field, as well as keep the Steering Committee informed about existing major initiatives to develop relevant indicators. Coordination with EEA, FAO and other actors' activities in this field should be sought for.

Funding:

a) ECPGR budget, subject to availability of necessary funding.

3.3. Promote good practices for on-farm management and conservation and adding value

There is no single way to promote and/or develop on-farm management and conservation, but rather an evolving set of approaches (Fasoula 1990, 1998, 2004, 2011, 2012, 2013; Fasoula and Fasoula 1997; Maxted et al. 2002; Jarvis et al. 2011, 2016; Maxted et al. 2013). Recently, draft technical guidelines for conservation and use of landraces have been proposed (FAO 2014). These guidelines include a range of approaches to consider at the national level. As part of the EC-funded project PGR Secure, national strategies on landrace *in situ* conservation have been developed in Europe by Finland, Italy and the UK, with different approaches (http://pgrsecure.org/).

Among the elements that can be found in the existing strategies and guidelines, the following can be listed as promoting good practices for on-farm management and conservation, including adding value:

- Establishment of an Inventory
- Analysis of gaps in *ex situ* collections
- Assessment of threats and prioritization of landraces and/or conservation sites
- Identification of landrace maintainers
- Raising of public awareness to promote use of landraces by farmers and consumers
- Facilitating registration into national (and European) lists
- Promotion of quality marks, typical products and local food chains
- Re-introduction of landraces and other germplasm from genebanks and other sources (community seedbanks)
- Introducing support schemes
- Promotion of research on genetic diversity and its trends, traditional knowledge and introduction into breeding programmes, including pre-breeding and participatory breeding
- Practicing prognostic breeding and using the associate indicators for accurate field phenotyping
- Increased coordination among public bodies and various stakeholders
- Multi-actor approaches to embedding diversity all along the food chain, involving both researchers and communities of practice.

National approaches to promote conservation and use of landraces can be modulated on the basis of individual country vision and objectives and drawing from existing examples. ECPGR can exercise the role of a hub, facilitating the exchange of national experiences, gathering and making available information on existing examples as well as developing elements for joint operation (e.g. European Inventory, see 3.1 above; network of conservation sites, see 3.4 below).

A fundamental principle for successful on-farm management is that it should be beneficial to the farmers and their communities. User guides and methodologies on how to approach dedicated marketing developments are often missing. An easily accessible collection of evidence-based practices of valorization of genetic resources and of value chain developments would be a useful reference point to identify applicable examples for local adaptation.

Objectives:

a) Provide an updated store of knowledge and evidence-based practices, gathering and making available relevant information related to successful experiences of conservation and sustainable use of landraces and other heterogeneous genetic resources in Europe.

Methods:

a) Compilation by ECPGR Secretariat and/or Grant Scheme Activity Partners of success stories to promote good and best practices related to sustainable conservation and use of landraces, according to the following categories:
    a. Case studies related to on-farm breeding
    b. Development of self-sustaining food chains based on valorization of landraces and other heterogeneous genetic resources
    c. Successful long-term funding schemes.
b) Publication or upload on the ECPGR website of the compiled information.

Funding:

a) ECPGR budget (Activity Grant Scheme or subject to availability of necessary funding) or other project funds (EC or other).

3.4. Establish European sites of on-farm cultivated plant diversity

In a number of countries, especially from southern Europe, on-farm conservation and management is predominantly dedicated to give value to site-specific landraces, including the entire agro-ecosystems in which they have historically developed. On-farm priority sites including populations of unique and significant landrace diversity located in areas where there is strong community support for on-farm maintenance, sharing high levels of genetic diversity, traditional value and threat of diversity loss could be designated at national and European levels as hotspots of on-farm diversity of cultivated plants (Most Appropriate Areas = MAPAs) as such following the Man and the Biosphere (MAB)-Plan – Biosphere Reserves Strategy of Sevilla (http://www.unesco.org/mab/doc/brs/Strategy.pdf). In fact, the Biosphere Reserves are intended to fulfil three complementary functions that pertain to agro-diversity hotspots: "*a conservation function, to preserve genetic resources, species, ecosystems and landscapes; a development function, to foster sustainable economic and human development, and a logistic support function, to support demonstration projects, environmental education and training, and research and monitoring related to local, national and global issues of conservation and sustainable development*". MAPAs of on-farm diversity of cultivated plants could be included as part of the FAO Globally Important Agricultural Heritage Systems (GIAHS) and complement the Natura 2000 network of wildlife sites. Such a network of MAPA sites should then facilitate the development of plans for *in situ* / on-farm conservation and their implementation. These sites would likely attract funds for research on diversity and monitoring its trends in response to climate change and farmers' management. Unique *in situ* materials in these sites would also be easily prioritized for *ex situ* back-up and provision of access to genetic resources.

Objectives:

a) Agree on criteria that can be used as a basis for nomination of most appropriate areas (MAPAs) containing unique landrace populations that are managed within an on-farm system
b) Identify MAPA sites to be recognized at the national and European levels
c) Promote planning and implementation of *in situ* / on-farm conservation activities at the genetic (adaptive trait), landrace, and on-farm system levels within the MAPAs.

Methods:

a) Through dedicated meeting(s) of interested country representatives, reach an agreement on the Terms of Reference for the creation of a European Network of MAPAs and the necessary steps for its implementation.

Funding:

a) ECPGR budget (Activity Grant Scheme or subject to availability of necessary funding) or other project funds (EC or other).

3.5. Propose legal and technical solutions to on-farm conservation obstacles

Issues of variable nature (ownership, access, availability, marketing, etc.) may sometimes generate difficulties to on-farm conservation and use of landraces and other heterogeneous genetic resources. For example, uncertainties regarding ownership of genetic resources may limit their access and use. Legislation regulating access may be so restrictive as to severely limit availability, or not clear enough as to create uncertainties regarding proper legal use. Availability of genetic resources may also be limited by insufficient information about the existence or the characteristics of the material or by lack of multiplication services. Marketing may be impeded by seed legislation or other disincentives of economic nature. In some cases, these types of issues might be positively addressed at the ECPGR level in order to find and propose generally applicable legal and/or technical solutions.

Objectives:

a) Analyse existing issues related to ownership, access, availability and marketing that are generating obstacles to on-farm conservation and use of landraces and other genetic resources in Europe;
b) Develop solutions to existing issues that might offer reasonable compromises to appease the interests of the various stakeholders;
c) Exercise lobbying at the appropriate level to encourage implementation of the proposed solutions.

Methods:

a) Establish Task Forces of dedicated experts to study, analyse and propose solutions to issues of regional interest for which the ECPGR Steering Committee agrees to consolidate an ECPGR position;
b) Steering Committee endorses recommendations from the Task Forces and advises on suitable measures to encourage their implementation at the appropriate level.

Funding:

a) ECPGR budget (Activity Grant Scheme or subject to availability of necessary funding) or other project funds (EC or other).

4. Summary of priority actions

ECPGR on-farm conservation and management actions to be prioritized for the near future can be schematically summarized as follows:

a) Create European Inventory

- Develop a European Inventory of on-farm genetic diversity
- Coordinate activity to reach agreements on common descriptors, data exchange format and data flow mechanism

b) Develop indicators for monitoring diversity and level of threat

- Establish and operate a Task Force to propose indicators
- Establish a knowledge base of case studies on genetic erosion and monitoring of diversity in the field in Europe

c) Promote practices for on-farm management and conservation and adding value

- Establish the knowledge base of success stories and best practices in Europe about on-farm management and conservation and adding value through food chains

d) Establish European sites of on-farm diversity of cultivated plants

- Coordinate a sub-group of country representatives towards the creation of a European Network of sites of on-farm diversity of cultivated plants

e) Propose legal and technical solutions

- Establish and implement Task Forces of dedicated experts to study, analyse and propose solutions to issues hampering on-farm conservation and management, as well as its complementarity to *ex situ* conservation.

Annex

I. Legislation and policies

Various agreements and policy instruments refer to the conservation and sustainable utilization of PGRFA on-farm. In particular:

I.1. International level

a) *The Convention on Biological Diversity* (CBD 1992) is a legally binding agreement currently involving 196 Parties and including all the European countries. The CBD applies to all types of genetic resources, both wild and domesticated. Although its main focus is on issues that are usually under the mandate of the Ministries of Environment, it has also established a Programme of Work on Agricultural Biodiversity, last reviewed in 2008. This Programme aims to promote the positive effects and mitigate the negative impacts of agricultural systems and practices on biodiversity in agro-ecosystems, to promote the conservation and sustainable use of genetic resources of actual and potential value for food and agriculture and to promote the fair and equitable sharing of benefits arising from the use of genetic resources. At the tenth meeting of the Conference of the Parties, held in 2010 in Nagoya, Aichi Prefecture, Japan, a revised and updated Strategic Plan for Biodiversity for the 2011-2020 period was adopted, including the so-called Aichi Biodiversity Targets. Two of the Aichi Targets relate to agricultural biodiversity, aiming to reach by 2020 '*a sustainable management of areas under agriculture, […] ensuring conservation of biodiversity*' (Target 7), and that '*genetic diversity of cultivated plants […] and of wild relatives […] is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity*' (Target 13) (CBD 2010).

b) *The International Treaty on PGRFA* (ITPGRFA) (FAO 2001) is a legally binding agreement that entered into force in June 2004. The EU and other ECPGR countries are among the Contracting Parties, with the exception of Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Israel, Moldova, Russian Federation, Serbia and Ukraine. The Treaty's objectives, in harmony with the CBD, are the conservation and sustainable use of PGRFA and the fair and equitable sharing of the benefits arising out of their use, for sustainable agriculture and food security. The Treaty calls for an integrated approach to the exploration, conservation and sustainable use of PGRFA. With regard to on-farm genetic resources, attention is given to '*Survey and inventory PGRFA, taking into account the status and degree of variation in existing populations […] and assess any threats to them*' (Art. 5.a), as well as to '*Promote or support, as appropriate, farmers and local communities' efforts to manage and conserve on-farm their PGRFA*' (Art. 5c). Moreover, Art. 6 promotes the sustainable use of PGRFA with measures such as '*the development and maintenance of diverse farming systems*' (Art. 6.a), '*strengthening research which enhances and conserves biological diversity by maximizing intra- and inter-specific variation for the benefit of farmers…*' (Art. 6.b), '*promoting plant breeding efforts […] with the participation of farmers…*' (Art. 6.c), '*promoting the expanded use of local and locally adapted crops, varieties and underutilized species*' (Art. 6.e), '*supporting the wider use of diversity of varieties and species in on-farm management, conservation and sustainable use of crops and creating strong links to plant breeding and agricultural development*…' (Art. 6.f); '*reviewing and, as appropriate, adjusting breeding strategies and regulations concerning variety release and seed distribution*' (Art. 6.g). The Treaty also recognizes (Art. 9) the role and rights of farmers in conserving, using and improving agricultural genetic resources and sharing the related benefits.

c) *The Second Global Plan of Action for PGRFA* (GPA) (FAO 2012) was adopted by the FAO Council in November 2011, updating the Global Plan of Action adopted by 150 countries in 1996. The GPA is recognized as a supporting component of the International Treaty, assisting in priority setting, including the identification of funding priorities. The GPA is stressing the importance that *ex situ* and *in situ* conservation and sustainable use be coordinated in a complementary way at all levels. Specifically, conservation and development of PGRFA on-farm is valued to promote food security,

adaptability and resilience, particularly among communities that live in areas with low agricultural potential.

d) *The FAO Commission on GRFA* adopted in 2013 three targets for PGRFA (FAO 2013). According to the first target (Conservation of PGRFA), by 2020 an increasing proportion of the genetic diversity of cultivated plants and their wild relatives, as well as of wild food plant species is maintained *in situ*, on-farm and *ex situ* in a complementary manner. The rationale behind on-farm management of PGRFA alludes to the provision for the continued evolution and adaptation of these resources to changing environmental forces, and thus for the generation of new diversity that is important for future crop improvement.

e) The *Rio+20 declaration* on 'The future we want' (United Nations 2012) reaffirmed the need to improve food security, based on sustainable agricultural practices that preserve natural resources, including genetic diversity, by building on enhanced agricultural research and stronger international cooperation.

I.2. European level

a) The *EU Biodiversity Strategy to 2020*, adopted by the EU Parliament in April 2012, aims to halt biodiversity loss and the deterioration of ecosystem services. Under Strategy Target 3A (Increase the contribution of agriculture to maintaining and enhancing biodiversity), Action 10 encourages the European Commission (EC) and Member States to the '*uptake of agri-environmental measures to support genetic diversity in agriculture and explore the scope for developing a strategy for the conservation of genetic diversity*'. No significant progress towards Target 3A was reported by the EC to the European Parliament and the Council in its Mid-term review of the EU Biodiversity Strategy to 2020 (European Commission 2015a). In response to this mid-term report, the EU Parliament issued a resolution (European Parliament 2016) in which, among others, it is remarked that biodiversity loss refers not only to species and habitats but also to genetic diversity and the Commission is called on to develop a strategy for the conservation of genetic diversity. The need is also stressed to identify and establish indicators that unequivocally and scientifically measure the state of biodiversity. The need to promote the sustainable use of PGR and traditional agricultural varieties is also highlighted.

b) *The Common Agricultural Policy* (CAP) reform for 2014-2020 includes various instruments that can contribute to support biodiversity. In particular, the Rural Development Regulation (EU) No. 1305/2013 on support for rural development by 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*' (Article 28) (European Parliament and Council of the European Union 2013). Farmers are hereby rewarded for the preservation on the farm of plant genetic resources that are under threat of genetic erosion. Under a similar scheme during 2007-2013, genetic resources-related actions were programmed in 26 Member States, with 72 193 contracts and some € 266 million (EAFRD) and € 424.5 million total public expenditure paid out (European Commission 2015b).

c) *The Community Programme on the conservation, characterisation, evaluation and use of genetic resources in agriculture*, based on Council Regulation (EC) 870/2004 (Council of the European Union 2004), came to an end in 2012 and continuation of this type of action has been recommended to be further pursued under the Union's Research & Innovation Programme, allowing more practice oriented multi-actor formats (European Commission 2013).

d) *The EC research work programme Horizon 2020* for 2014-2015 (European Commission 2015c) assigned a budget of ca. € 32 million to successful proposals under topic SFS-7 'Genetic resources and agricultural diversity for food security, productivity and resilience' in Societal Challenge 2 (Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy). Calls for proposals focused on agricultural genetic resources are expected to continue in the work programme for 2016-2017 that includes one call for proposal for a Coordination and Support Action (SFS-04-2017) on 'New partnerships and tools to enhance European capacities for in situ conservation', with a budget of € 2 million (European Commission 2016a).

e) Regarding seed legislation, directives aiming to enhance *in situ* conservation and use of landraces and local varieties by facilitating their access to the market, were adopted in recent years by the European Commission, as follows:

- *Commission Directive 2008/62/EC* providing for certain derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties (European Commission 2008).
- *Commission Directive 2009/145/EC providing for certain derogations, for acceptance of vegetable landraces and varieties which have been traditionally grown in particular localities and regions and are threatened by genetic erosion and of vegetable varieties with no intrinsic value for commercial crop production but developed for growing under particular conditions and for marketing of seed of those landraces and varieties* (European Commission 2009).
- *Commission Directive 2010/60/EU providing for certain derogations for marketing of fodder plant seed mixtures intended for use in the preservation of the natural environment* (European Commission 2010).
- *Commission Implementing Decision C(2014) 1681 on the organization of a temporary experiment providing for certain derogations for the marketing of populations of the plant species wheat, barley, oats and maize pursuant to Council Directive 66/402/EEC* (European Commission 2014a).

I.3. Sub-regional and national differences in legislation and policy

It is possible to find very different scenarios across Europe regarding the continuing presence of variable genetic resources on the farms. In general terms, across the Iberian, Italian and Balkan peninsulas, as well as in Turkey and the Caucasus, the presence of landraces and fruit crops with a precise cultural and geographical link is still rather widespread. This is also true in marginal mountainous Alpine and Carpathian areas. Very localized occurrences of landraces can also be found in the United Kingdom and northern countries, especially in home gardens. For the most part of North and Central Europe, different types of variable genetic materials are occasionally grown, mainly based on introductions from different areas or re-introductions from genebanks. Consequently, legislations and policies at country level take different approaches.

A number of EU member countries have started to implement the EC directives on conservation varieties. By end of April 2016, 214 conservation varieties of agricultural plant species, 91 conservation varieties of vegetable species and 807 varieties developed for growing under particular conditions were listed in the common catalogue under the respective sections (European Commission 2016b, 2016c).

According to the Rural Development Plans (2014-2020) developed by the EU countries as part of the Common Agricultural Policy, a few countries have identified lists of varieties under threat of genetic erosion that are eligible to be subsidized if maintained on-farm as per Article 28 of Regulation (EU) No. 1305/2013 (European Parliament and Council of the European Union 2013). For example, Portugal will support the use of the three conservation varieties of cereals and forages that are registered in the National Catalogue and grown over a minimum area of 0.5 ha; Austria identified a list of 75 rare varieties of cereals, forages, legumes, vegetables and other crops; specific Italian regions such as Toscana and Veneto are supporting those varieties that have been registered in their regional inventories as linked to the local territory and under threat of genetic erosion.

National Strategies for landrace *in situ* conservation have been developed as part of the EC-funded project PGR Secure by Finland, Italy and the UK.

Very few projects for the conservation of traditional varieties of onion, emmer wheat and lentil were implemented in **Armenia** with state funding. Cultivation of old varieties without support from State authorities is in most cases not considered efficient. However, landraces of cereals and fruits are occasionally still cultivated in a few farms.

In **Azerbaijan**, on-farm management is a priority and the Genetic Resources Institute involves farmers in the evaluation and valorization of traditional varieties. Local varieties of cereals and

vegetables are still grown in diminishing percentages. Fruit traditional varieties are still abundant due to their quality and adaptation.

In **Belgium**, an on-farm repository orchard network has been developed since ten years with the objectives to firstly duplicate threatened fruit landraces and traditional cultivars from an *ex situ* collection, then to reintroduce local landraces in their region of origin and finally, to enhance users awareness about specific quality traits of such cultivars for niche markets. Over 60 partners are actively involved in the network represented by public administrations, environmental NGOs, Natural Parks and farmers. The network is composed of 63 ha of orchards planted by 4400 standard trees and 1500 different old cultivars and sub-types.

For genetic diversity conservation purposes, a subsidiary system has been introduced in **Finland** since the year 2000, aiming to enhance the cultivation of landraces and obsolete cultivars by offering farmers annual support based on a minimum contracted cultivated area.

In **France**, in 2012, two lists were created in the official catalogue of varieties (inscription to the catalogue is required for the varieties to be marketable): since then, 11 varieties have been listed as conservation varieties and 344 have been listed as varieties without intrinsic value. For all those varieties, the criteria for registration have been reduced, and registration costs were borne by the Ministry of Agriculture on the one hand and the Interprofessional Association for Seeds and Seedlings (GNIS) on the other. Moreover, Decree N°2015-1731 of December 2015 on PGRFA conservation establishes a framework for the recognition of a national collection and of collection managers: *in situ* conservation is identified as a key element of this system. Also in 2015, a multi-stakeholder consultative body on conservation of genetic resources issues was created: farmers, considered as on-farm managers, are represented in this body.

Georgia holds seven collections of local grape varieties. The largest collection of grapes and fruits was established in 2008 in Jighaura, which collected more than 460 local varieties of grapes and more than 300 local varieties of fruits, as well as forest tree species. The Scientific–Research Centre of Agriculture, holding the Jighaura collection, produces grafts of autochthonous varieties both for grapes and fruits and distributes those among farmers for their further conservation. The same Centre maintains the collection of local varieties of vegetables. The Agricultural University of Georgia holds the Gene bank of cereals, melons and technical crops The NGO “Elkana” works for the maintenance of cereal and legume landraces since the 1990s. In 2005 Georgia elaborated the “**National Biodiversity Strategy and Action Plan**”.

In **Germany** the general disappearance of traditional landraces from farmers’ fields makes the importance of on-farm management less obvious than in other countries, according to the National Programme for the Conservation and Sustainable Use of Plant Genetic Resources of Agricultural and Horticultural Crops (2012). However, on-farm management is considered significant for the conservation of diversity of crops that are not included in commercial breeding programmes, as well as to increase the diversity in agricultural production and thus the range of foods available and a diverse nutrition.

In **Greece**, the Ministry of Rural Development and Food started in 2000 the registration into national catalogues of the local genetic resources that are threatened by genetic erosion and the implementation of projects aiming to maintain the agricultural biodiversity, to promote the sustainable management of plant genetic resources and to enhance the cultivation of local varieties and the on-farm conservation of a wide range of crops from farmers. The rural development policy for Greece is implemented through the National Rural Development Programme with the financing support of the European Agricultural Fund for Rural Development.

Italy has developed specific ‘Guidelines for the Conservation of GRFA’, as part of its National Plan for Agrobiodiversity. Focus for on-farm conservation is hereby dedicated to ‘local varieties’ (landraces), which are defined on the basis of their long tradition of use and specific adaptation to a limited geographic area. The Italian law on agricultural biodiversity was approved in November 2015. This law focuses on the ‘local’ genetic resources under threat of genetic erosion, aiming to register into a national catalogue those resources that are distinctly identifiable and to maintain them under public responsibility and control, both *ex situ* and on-farm by local custodian farmers. The latter can be supported through an annual fund of **€** 500 000.

In the **Netherlands** a Community Biodiversity Development and Conservation Programme is concerned with the support of farming communities which maintain genetic diversity *in situ*, as complementary to *ex situ* genebank conservation. This programme regards farmers as the central stakeholders in on-farm management of agrobiodiversity.

The Nordic Genetic Resources Center (**NordGen**) promotes the use of old local varieties by providing small quantities of seed to hobby growers.

In **Portugal**, Decreto Lei 18/2014 identifies the promotion of the use and valorization of PGR, in particular of conservation varieties, through sustainable production methods or quality schemes in view to achieving economic size and enhancement of rural areas, as a task of the Directorate General for Agriculture and Rural Development.

The Portuguese Genebank (BPGV) has supported on-farm conservation, through the reintroduction of old landraces as well as providing small quantities of seed to farmers, especially cereals and grain legumes. These farmers, besides having the responsibility to keep those seeds in production, also have been able to valorize them in special markets (Barata et al. 2012).

Significant landraces' diversity is still recorded in Portugal, very localized in some regions. BPGV, together with the University of Birmingham, UK is preparing a complete landrace inventory of the Portuguese landraces, leading to the establishment of a national landrace conservation strategy for Portugal.

The **Romanian** genebank uses to support on-farm conservation by providing small quantities of seeds of grain legume and vegetable landraces to farmers who take the responsibility to keep these in cultivation.

In **Sweden**, on-farm management is occasionally carried out on a micro-scale by single individuals, but no particular areas of high diversity have been identified.

Several factors determining the continuing use in **Turkey** of traditional cultivars in specific contexts have been analysed through international projects. UNDP GEF/Small Grant Projects have been utilized to protect landraces and develop sustainable markets.

In the **UK**, a significant wealth of landrace diversity is still recorded, although very localized and at risk of extinction. Agri-environment schemes are supported for the maintenance, restoration and creation of species rich grasslands and of traditional orchards. A Landrace Protection Scheme in Scotland provides a safety net by storing and providing landrace seeds produced by growers.

II. Type of materials grown on-farm

A wide range of plant materials can be considered as deserving to be the object of on-farm conservation and management. Their specific value should be analysed and understood in order to orient conservationists and policy-makers in selecting their conservation priorities and fine-tuning their policy instruments. Different biological categories can be identified. Additionally, European and national legislations have also created 'legal categories', which may or may not overlap with the biological ones. Registered cultivars that are listed in National and European Common Catalogues of agricultural and horticultural crops form a category that is both biological and legal. In fact these materials, which are legally marketable, are distinct, stable and uniform and in the case of agricultural crops they have demonstrated a Value for Cultivation and Use. They are available from the market, while farmers' saved seed can be re-used, compatibly with national adoption and interpretation of UPOV conventions.

The following list of categories tries to identify all the other materials that exist in the field and contribute to on-farm biodiversity (biological categories) as well as the corresponding categories that have been defined by legislation (legal categories).

II.1. Biological categories

Landraces

These are crop populations with a very specific link to a geographic location where they have been developed and have adapted under cultivation. Several definitions have been provided (Anderson and Cutler 1942; Harlan 1975; Brush 1992, 1995; Papa 1996; Zeven 1998; Asfaw 2000; Friis-Hansen and Sthapit 2000; Negri 2003, 2005; Camacho Villa et al. 2005; Saxena and Singh 2006; Mendes Moreira et al. 2008; Polegri and Negri 2010). A comprehensive definition from Negri et al. (2009) summarizes and extends the existing ones: *'Landraces are variable populations, which are identifiable, usually have a local name, (generally) lack formal crop improvement, are commonly characterized by a specific adaptation to the environmental conditions of the cultivation area (tolerant to the biotic and abiotic stresses of that area) and are closely associated with uses, knowledge, habits, dialects and celebrations of the people who have developed and continue to grow it'*. In short, *sensu stricto* landraces are extant landraces that have continuously maintained their link with the original territory where they have developed their distinctive characteristics.

Also clonally propagated crops (e.g. vines, olive trees, fruit trees, garlic, artichokes, etc.) often possess some within-cultivar genetic variability (clonal polymorphism) (Tignon et al. 2001; Cipriani et al. 2002; Fornek et al. 2003; Halapija Kazija et al. 2013) and therefore certain populations may fit with the above definition of landraces.

As landraces are by definition dependent for their survival on a specific interaction between traditionally grown plant material and the human and physical environment that has shaped them, they are often under threat of extinction. This is owing to the tendency of modern agriculture to use seed of commercial varieties and owing to the changing structure of society, which tends to reduce the number of farmers maintaining a link with old traditions. On the other hand, the high intrinsic diversity and the continuing evolution of landraces under their specific managed environment makes them particularly valuable as genetic resources deserving high conservation priority, together with the agro-ecosystem that has generated them. They also often have a specific historical value as well as contribute to the overall sense of identity of people living in a specific territory.

The term 'landraces' is often used as a synonym of other terminologies (and vice-versa), such as 'farmers' varieties', 'heirloom varieties', 'traditional varieties', 'folk varieties', 'heritage varieties', 'old varieties', etc. These terms are intended to cover all the products of breeding or selection carried out by farmers, either deliberately or not, continuously over many generations (FAO 1998). All these materials, that have been created by farmers, and are recognized by farmers for their characteristics, are lumped in this concept into the term 'landraces'. Some of these 'landraces' might have been introduced for cultivation into different areas from their area of origin, or may have been re-introduced in the same area where they had previously originated and then had been abandoned. Therefore these materials may harbour different levels of genetic variability (owing for example to bottleneck effects or stronger farmer's selection), and have different levels of adaptation (owing to a short time exposure to a new environment) and identity values (owing to absent or broken tradition of cultivation). Thus, '*sensu stricto'* landraces should be distinguished from 're-introduced' and 'introduced' landraces, as well as from less heterogeneous farmer's varieties.

Obsolete cultivars

Many cultivars (possibly derived or developed historically from landraces through formal improvement) were once registered on national seed and variety lists and were cultivated commercially, but are presently obsolete, either dropped or not from the lists, having been replaced in use by newer commercial varieties. They are no longer widely marketed though they may continue to be marketed in restricted areas where they possess historic or traditional value. These generally hold a limited level of genetic diversity within cultivar. Conservation of this material in genebanks can therefore be effective. However, where seed-propagated obsolete cultivars continue to be cultivated and their seed saved under on-farm management, their intrinsic diversity will evolve over time.

Other heterogeneous populations

Heterogeneous populations, other than landraces, is a term used here to indicate all those cultivated varieties that, being constituted by several genotypes, are susceptible to change in genotypic composition with time and under the pressure of different factors. They may include several types of materials purposely developed by farmers, farmer organizations and/or by breeders, including through participatory plant breeding. These materials contribute to diversity in the fields and may either be left to evolve on-farm or require re-planting of the original seed. Whether the seed of these materials can be legally marketed or not has to be verified on a case by case basis. The following types of material can be listed in this group:

- Mixtures of registered varieties
- Large mixtures of a wide range of germplasm, including wild relatives, landraces from several countries and modern breeding material, used as 'evolutionary populations' (Ceccarelli 2012)
- Multiline varieties (composed of up to 10 lines that are isogenic for almost all agronomic traits, but only genetically dissimilar in resistance against one particular disease; for example, the Dutch wheat variety 'Tumult' (Lammerts van Bueren 2002)
- Line mixture varieties (lines which are carefully selected for mixing ability on the basis of phenotypic uniformity for a number of traits but which are genetically different) (Lammerts van Bueren 2002)
- Composite cross populations (populations of segregating individuals derived from intercrossing a number of parents and then exposed to natural selection in each subsequent generation = evolutionary population breeding)
- Synthetic populations (for example 'Fandango', that includes 75 maize inbred lines and has been cultivated since 1985 in Sousa Valley (Portugal) under participatory plant breeding; Mendes Moreira et al. 2009).

II.2. Legal categories

It is important to clarify whether plant genetic resources as defined above in different categories are legally eligible to be grown, exchanged and/or whether their seed can be sold in the market.

No legal restrictions exist to the possibility of growing any plant material belonging to the above-mentioned biological categories (apart from possible phytosanitary restrictions and crop-specific rules such as those governing the planting of vines in the EU). Limitations may be related to ease of access, lack of multiplication and low agronomic or commercial value of the genetic resources for direct growing.

The exchange of seed or propagating material that is not intended for commercial purposes is also allowed in the EU, although different interpretations of the seed directives have been made in individual member countries at this regard. On the other hand, marketing of seed and propagating material is strictly regulated in the EU and limited to plant material that is included in the EU Common Catalogue. As registered material needs to be distinct, uniform and stable, most heterogeneous genetic resources which may be the focus of attention in terms of on-farm conservation and management would not qualify for registration. However, derogations to the strict rules for marketing of seed of specific genetic resources were recently made as described below.

Conservation varieties

Commission Directives 2008/62/EC (European Commission 2008) and 2009/145/EC (European Commission 2009) establish the requirements of plant material of agricultural species (i.e. most of open field crops like cereals and potatoes) or vegetables that can be referred as 'conservation varieties' and thereby accepted with certain derogations for inclusion (i.e. registration) in the Common Catalogue and for the marketing of their seed. These materials should be either 'landraces' (defined in the same Directives as 'a set of populations or clones of a plant species which are naturally adapted to the environmental conditions of their region'), or 'varieties which are naturally adapted to the local and regional conditions' (in the case of agricultural plants), or 'varieties which have been traditionally grown in particular localities or regions' (in the case of vegetables). The Directives' definitions of 'landraces' and of 'naturally adapted (or traditionally grown) varieties' are rather vague, make no clear

reference to the level of intrinsic genetic diversity but only to 'adaptation' or to 'local' and 'regional' conditions or to 'traditional growing'. As there is no prescription on how adaptation can be measured, as well as the geographic extension of a 'region' is not defined, ample discretion is left to the member countries to give an interpretation of these requirements. As regards distinctness, stability and uniformity, member states are also allowed to adopt their own provisions, although within certain limits. However, in order to be registered as a 'conservation variety', the above-mentioned landraces and varieties need to 'present an interest for the conservation of plant genetic resources' and specifically be 'threatened by genetic erosion'. This last parameter is defined as 'the loss of genetic diversity between and within populations or varieties of the same species over time, or reduction of the genetic basis of a species due to human intervention or environmental change'.

In practical terms, landraces can be registered as conservation varieties, as long as they can be distinguished from others and have a history of cultivation in a certain geographical area (as a proxy of 'natural adaptation' or of 'traditional growth'). A threat to their genetic integrity must also be documented. Registration of 'conservation varieties' in the Common Catalogue allows the marketing of their propagating material with some geographic and quantitative restrictions.

Vegetable varieties with no intrinsic value for commercial production (Amateur varieties)

These are the varieties cited in Commission Directive 2009/145/EC (European Commission 2009) that provides derogations for acceptance (i.e. for the registration) in the Common Catalogue and the marketing of their seed of *vegetable varieties* (i.e. of those vegetables covered by Commission Directive 2002/55/EC (European Commission 2002) *with no intrinsic value for commercial crop production but developed for growing under particular conditions*. In practice, these are varieties intended for amateur gardening. In this case there is no relation with a threat to genetic erosion and/or with a history of cultivation in a precise geographical area. Requirements of distinctness, stability and uniformity are relaxed in the same way as for conservation varieties. Marketing restrictions are not geographic in this case, but only quantitative and the seed should be sold in small packages. Amateur varieties can be old or modern and can be the result of farmers' selection or professional breeding.

Populations of the plant species wheat, barley, oats and maize

Commission Implementing Decision of 18 March 2014 (European Commission 2014a) organized a temporary experiment providing certain derogations for the marketing of cereal populations. The rationale here is the intention to allow marketing of populations that do not fulfil the variety definition as regards uniformity, under the assumption that such diverse populations could be beneficial in conditions of low-input agriculture for example to reduce the spread of diseases. Eligible populations need to be identifiable on the basis of i) the varieties used in the crossing for the creation of the population, ii) the breeding schemes, iii) the region of production, iv) the degree of heterogeneity and v) their important characteristics.

Mixtures of forage species for use in the preservation of the natural environment

These are a combination of populations of different species. They may be employed when maintaining/restoring an environment and provide a good example of integrating farming with nature conservation activities. Derogations to seed commercialization of forage mixtures for this purpose are foreseen in the EU Directive 2010/60/EU.

III. Different management approaches and their objectives

There are different approaches in Europe to use and manage diverse materials on-farm, depending on the diversity richness in the country, type of material, type of crops, actors involved and their objectives. Examples of approaches and the related objectives are listed below:

a) Family production

A high proportion of the landraces still cultivated in Europe is maintained for prevalently self-consumption on a family farm or garden, owing to adaptation to a specific location which ensures

good productivity and/or for traditional use by that family. Farm-saved seed or propagating material is selected in order to maintain a crop ideotype, but also, in some cases, new off-types emerging from casual crosses are maintained. This approach is therefore generally conservative, but with a certain degree of dynamism, since the landraces may evolve in response to unpredictable events (climate change, farmer's choices, casual crosses, etc.).

b) *Special products for niche or secured market production*

Landraces or other diverse materials are marketed locally or more widely as specialty products having peculiar traits and/or a link with local history, culture and tradition. Often a label helps identify the added value of the product, which may also consist in its contribution to biodiversity conservation. Certain forms of production (i.e. organic) may add attractive components to the package for given consumers. This type of production is usually managed by local farmers or their associations who benefit from better prices derived from the added value guaranteed by the label and appreciated by the consumers. The products are often associated with the touristic package of a certain place. Examples also exist of local consortia of stakeholders curating the entire value chain, including multiplication of the starting genetic material, quality standard check, extension service, link with cultural tradition, marketing strategy and sale of the product.

This approach tends to ensure the genetic conservation of specific populations, whenever the label and/or the production protocols are linked to the obligation to use defined genotypes or combinations thereof.

c) *Educational activities*

Increasingly, open air museums of agriculture and botanical gardens use plant traditional varieties as a demonstration of historic agriculture and for various educational activities. The main objective here is neither conservation nor development, but raising public awareness of PGRFA diversity.

d) *Specialist companies producing and selling landraces*

There are a growing number of small seed companies focusing on commercializing amateur varieties, conservation varieties, landraces and obsolete cultivars, provided they are legally marketable in the respective countries. Special trademarks such as 'Green cultural heritage' can also be applied. This approach benefits from the opportunity to market less uniform materials than those that are strictly distinct, uniform, stable and with certified value for cultivation. This approach facilitates the conservation of material that is well described and has a clear denomination (in the case of conservation varieties and amateur varieties) and which has been declared at threat of genetic erosion (in the case of conservation varieties).

e) *Provision of financial support*

A number of EU countries are using Rural Development Funds provided by the EU to compensate farmers who are cultivating specific varieties considered under threat of genetic erosion. Other funding schemes may be set up with public funds at different levels. Financial support may be dedicated to protection of landraces that are strictly linked to relatively narrow geographical areas, or they may not set any geographic limitation within the country. This approach is mainly dedicated to conservation on farm of well-defined landraces.

f) *Development of alternative farming systems based on diversity*

Organic and low-input farming is increasing across Europe. In these farming systems the use of obsolete cultivars, landraces and heterogeneous materials is increasing, since high productivity is not the main target and farmers believe diversity provides a buffer against agro-environment constraints (i.e. climate extremes, soil and pest variability). Consequently farmers' requests for seed of such materials are increasing. The conservation objective of specific genotypes is in this case less emphasized than the use of diverse material. This context facilitates the creation of new combinations and selection of new materials that are suitable for the specific purpose.

g) *Development of local food supply systems (including community and home gardens)*

The full range of available diverse materials is increasingly the subject of local food supply system development. Farmer or community organizations may promote campaigns to sell vegetables in the same area where they are produced ('Zero kilometre food'), including part of urban and peri-urban agriculture. Diversity of products (local landraces or varieties introduced even from

other regions of Europe) can be an element associated to this type of campaigns. This approach may encompass several objectives: to maintain the characteristics of the material used (as in the conservation varieties), to change it depending on the need, to adapt it to new conditions (as in the case of new introductions) or to suit the needs or fancies of the main end-users (as in community and home gardens).

h) *Participatory breeding and evolutionary populations*

The need or the aspiration to develop new materials for specific, usually organic/low-input, farming systems and well adapted to the growing locations can be satisfied through participatory breeding processes and/or the development of constantly adapting evolutionary populations. Such an approach is based on different types of materials and it aims at retaining or developing a direct link between materials and the local environment as well as between materials and the society which cultivates and uses them. This dynamic approach tends to create new diversity and improved materials through a process where the farmer is the main driver of the genetic change. Products from this process can be either uniform and stable or largely heterogeneous new genetic resources, depending on the specific aims.

IV. Actors and stakeholders

On-farm conservation and management involves a range of different stakeholders (i.e. farmers, amateur gardeners, farmer/gardener networks, diversity seed companies, commercial seed companies, breeders, retailers, distribution chains, local communities and associations, public authorities and the European Union) which are active also at national and sub-national levels and sometimes operate in an integrated manner.

a) *Single farmers*

These are the main actors that have maintained landraces and other heterogeneous materials in the fields, especially but not exclusively in the southern part of Europe. As a consequence, most of the unknown and so far untapped genetic resources like landraces are held in their fields.

b) *Amateur gardeners*

Individuals sometimes maintain landraces and other heterogeneous materials in their gardens for family use. Maintenance of specific genotypes can be linked to traditional use, but long-term survival *in situ* is fragile, depending on the continuation of the family tradition over time. Specific cases of amateur gardeners who may maintain traditional varieties are found in convents or monasteries.

c) *Gardeners networks*

Networks of gardeners, such as ProSpecieRara (Switzerland), Arche Noah (Austria), Garden Organic Heritage Seed Library (UK) and Colher para Semear (Portugal) maintain and propagate seeds for use by their members. These networks consist mostly of amateur gardeners who do not have a commercial interest. Some of the members are specialized in seed production of the network varieties, which are sold through seed catalogues. Among the objectives of these networks there is the ambition to maintain landraces and other heterogeneous materials available for the general public. Sometimes they are linked to national genebanks and they multiply genebank material for the broader public or for their members. Some networks invest in breeding programmes, particularly for neglected crops or crops with special taste or cooking characteristics. These kinds of networks are mostly established in the northern and eastern countries.

d) *Farmers networks*

These are farmer communities (e.g. Réseau Semences Paysannes (France), Rete Semi Rurali (Italy) and Red de Semillas (Spain)) caring for a specific set of local landraces. Propagation and conservation is closely linked to commercial production by selling the product directly from the farms or from local markets. Seeds are rarely sold but may be exchanged between farmers within the same community. Farmer networks mutually exchange cultivation, seed propagation, selection and value enhancement knowledge. Some farmer networks collaborate with local

genebanks to propagate and bulk-up varieties and cooperate with institutional authorities. Farmer networks are mostly established in southern regions of Europe.

e) *'Diversity seed' companies interacting with farmer / gardener networks*

Many seed savers or farmer networks specialize in producing seeds for commercial purposes. Seeds are commonly sold using a network brand and a central catalogue, e.g. Dreschflegel in Germany or Le Biau Germe in France. These networks can be relatively small and localized, or larger organic seed companies such as Sativa Rheinau AG or Bingenheimer Saatgut. These companies often promote seed that is labelled as organically produced or as rare varieties (such as the ProSpecieRara label). Cultivars developed for special purposes (amateur varieties) are often offered, as well as other varieties from the national or European catalogues. These companies promote the use of diversity in farms and gardens and can also be involved in plant breeding.

f) *Commercial seed companies*

In the case of vegetable crops, for which a specific EU seed regulation exists (Council Directive 2002/55/EC of 13 June 2002 [Council of the European Union 2002]), (typically) small seed companies sell on the local seed market varieties which are (or are essentially derived from) local landraces, under the local name, as belonging to the EU 'standard seed' category.

g) *Commercial breeders*

Commercial plant breeders consider landraces as an important source for new genetic resources. Biotic and abiotic stress resistance and tolerance are especially target traits. In addition, landraces may be of interest when breeding for efficient nutrient uptake and utilization. Breeders hold private collections of variable materials from multiple sources and origins, including breeding lines under development. These materials are usually maintained for the short term, multiplied, evaluated and used for crosses and selection.

h) *Local communities*

No-profit local communities organized in associations or consortia may support the cultivation of landrace materials that are strictly linked to a certain territory and have historical or cultural value. Annual fairs are organized and prizes awarded to the best grower (e.g. the Portuguese competition for the 'Sousa Valley Best Ear' (Mendes-Moreira et al. 2014).). Local landrace products are sold to people visiting the fairs. Examples of this type are the celery landrace named 'Sedano Nero di Trevi' in Italy (Torricelli et al. 2013) or the plum cultivar 'Požegača' in South East Europe (Halapija Kazija et al. 2013).

i) *Public authorities*

National authorities co-fund activities for the on-farm conservation of obsolete cultivars and neglected species under the umbrella of the Rural Development Fund. In some cases, also public authorities such as Regions, Provinces, Municipalities or Parks promote on-farm conservation activities with their own provisions.

j) *Consumers*

Consumer's choices can be critical to influence production patterns. A strong demand for diversified food may act as a driver to encourage farmers to look for diversified seed, including landraces, conservation varieties and other heterogeneous materials.

k) *European Union*

The EU has provided relevant documents and policy-supportive measures that promote on-farm conservation and management by developing specific seed legislation as well as the Community Programme on conservation, characterization, evaluation and use of genetic resources (Council Regulation (EC) No 870/2004 [Council of the European Union 2004]), which was terminated in 2012. In 2014, DG AGRI launched a Preparatory action on EU plant and animal genetic resources to deliver inputs on how to improve communication, knowledge exchange and networking among all the actors potentially interested in activities related to the conservation of genetic resources in agriculture and to find ways towards a sustainable and economically viable use of these resources. This action has delivered its recommendations in June 2016. At the same time, the Union Research and Innovation Policy Horizon 2020 has included actions on investigating and investing in agricultural genetic resources-related research. A Report from the

Commission to the Parliament (European Commission 2013) recommends a better coordination of genetic resources conservation efforts through sustainable use and effective interplay among the relevant actors. The available instruments that are indicated to achieve this goal are the possibilities offered by the Rural Development Programmes, the European Innovation Partnership instruments as well as by Horizon 2020.

V. Inventories of on-farm data in Europe

In most cases existing examples of landrace inventories are compilations of names of the landraces derived either from farmer interviews, genebanks or seed catalogues or from historical documents. These inventories do not document the on-farm situation. One exception is the recent Italian *in situ* landrace inventory (Negri et al. 2013) which links every landrace in the catalogue to a defined farmer. On the other hand, the vegetable inventory of England and Wales, compiled in 2009, focuses on defined maintainers of the landraces, which are either true *in situ* occurrences or institutions multiplying the seed *ex situ*. These two inventories (from Italy and the UK) provide a snapshot of the situation at a given point in time and no mechanism to keep them constantly up to date has been formalized in the respective countries. Another example of *in situ* inventory is the national survey carried out in Germany in 2007-2009, that covers the exact proportions of the grapevine varieties in the historically mixed vineyards of the various wine regions. The survey allowed the identification of several historical varieties, including a number that had been considered extinct. The database establishes a link between *in situ* occurrences and sites of *ex situ* conservation in genebanks. A German cereal landrace inventory also exists, showing where and on which area endangered cereal varieties are grown, from a list of about 70 varieties that are multiplied and distributed by the Centre for the Conservation of Plant Genetic Resources, based in Münster. Another example in Belgium is the survey organized in 2014 by Natural Parks to identify old fruit tree cultivars still cultivated in old standard tree pastured orchards. More than 1000 trees have been evaluated and samples of fruits were collected for cultivar identification.

VI. Identification of funding opportunities for implementation of ECPGR activities (EU and others)

In the European context, the obvious donor is the EC which should be considered as the primary body for providing resources for **regional** on-farm conservation and management activities. In practice, the EC is already committed to preserving agro-diversity at the **national level** through the Common Agricultural Policy (CAP). Indeed, Rural Development Regulation (EU) No. 1305/2013 on support for rural development by EAFRD may provide '*support for the conservation and for the sustainable use and development of genetic resources in agriculture*' (Article 28) (European Parliament and Council of the European Union 2013). As detailed in Commission Delegated Regulation (EU) No 807/2014 of 11 March 2014, supplementing Regulation No. 1305/2013 (European Commission 2014b), eligible actions for funding include not only (Article 7) support *to preserve plant genetic resources naturally adapted to the local and regional conditions and under threat of genetic erosion*, but also (Article 8.2):

a) *Targeted actions promoting the* in situ *and* ex situ *conservation, characterisation, collection and utilisation of genetic resources in agriculture, including web-based inventories of genetic resources currently conserved in situ, including on-farm and of ex situ collections and databases.*

b) *Concerted actions promoting the exchange of information for the conservation, characterisation, collection and utilisation of genetic resources in Union agriculture, among competent organisations in the Member States.*

c) *Accompanying actions such as information, dissemination and advisory actions involving non-governmental organisations and other relevant stakeholder, training courses and preparation of technical reports.*

It is therefore apparent that EAFRD has offered several opportunities to the EU member countries for national level support to on-farm conservation during the period 2014-2020, even though only very few countries have included the above-mentioned activities within their National Rural Development

Programmes. A strengthened link between ECPGR National Coordinators and their respective Rural Development Managing Authorities is recommended to overcome such missed opportunities.

As EAFRD only provides funds to implement measures defined by national rural development implementation plans, actions at regional level, such as those outlined in the present concept, are not covered by any permanent funding scheme.

Regional actions outlined in the present concept require funding beyond the budget capacity of ECPGR, unless the overall ECPGR budget is increased by the member countries or specific actions can be funded through voluntary contributions by any ECPGR member country.

Implementation of the above activities can be covered only to a limited extent by the current ECPGR budget level. Additional funding could be obtained through EC funding schemes such as those offered by Horizon 2020. Funding opportunities can be monitored at http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/index.html. However, H2020 applications only respond to published calls and so there is a critical need for more effective and coordinated lobbying to ensure PGR issues are included in published calls. Currently the opportunities are few and those that are funded may not accord with ECPGR agreed priorities, particularly in the funding of too specific projects that do not move forward the strategic agenda.

Other opportunities for funding may arise from any decision deriving from the EU Preparatory action on genetic resources (http://www.geneticresources.eu/).

Activities of other funding agencies and institutions concerned with conservation and use of PGRFA should be monitored and opportunities explored to carry out joint initiatives or fund raising. The following entities can be listed: FAO International Treaty for PGRFA, Global Environment Facility (GEF), International Union for Conservation of Nature (IUCN), Conservation International, the European Environment Agency (EEA), the Institute for Environment and Sustainability (one of the EC's Joint Research Centres) and the Technical Centre for Agricultural and Rural Cooperation (CTA).

A source of permanent funding would be necessary in order to ensure adequate coordination and implementation of longer-term initiatives such as a European Inventory of on-farm landraces, genetic diversity monitoring, coordination of a Network of sites of on-farm diversity of cultivated plants, etc. A possible link to the Common Agricultural Policy (CAP) could potentially provide such stability and would be appropriate.

Unless the ECPGR member countries agree to increase their direct investment in ECPGR, the most effective driver for the implementation of the present concept could be the establishment of a permanent commitment by the EC in support of ECPGR activities. Attainment of such a scenario may depend on effective lobbying of EU member country representatives with the European Commission and/or the Parliament.

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