European specific landrace conservation strategy for target crops (*Avena*, *Beta*, *Brassica* and *Medicago*)

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Cover Figure - Brassica Landraces in Italy (violet cauliflowers: courtesy F. Branca)

1. The need for landrace inventories of target crops (*Avena, Beta, Brassica* and *Medicago*)

The need for landrace (LR) inventories has been stresses by international policies and strategies for a sustainable use of Plant Genetic Resources for Food and Agriculture (PGRFA), beside by many papers specifically referring to Europe (Maxted *et al.*, 2009, 2012; Veteläinen *et al.*, 2009a, b, 2012). Following the CBD (1992), the 2nd GPA (FAO 2011) policy and strategy for *In Situ* Conservation and Management stresses that ''*The surveying and inventorying of PGRFA should be considered as the first step in the process of conservation and reducing the rate of biodiversity loss*''. In addition, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA, FAO 2001), of which many European countries and the EU are contracting parties of the ITPGRFA, recommends: "*Each contracting party should promote or support and appropriate farmers and local communities with efforts to manage and conserve on farm and their plant genetic resources for food and agriculture*'' (article 5c). The compilation of Plant Genetic Resource Inventories can also contribute to the achievement of the targets of the EU 2020 Biodiversity Strategy (the European Parliament Resolution, 2012) since, at present, there is no *in situ* (on farm systematic conservation of LR in Europe. *Avena, Beta, Brassica* and *Medicago* genera were chosen as focus crops due to their importance for European economy, representativeness of different type of crops (including both open field and garden crops, for human and animal consumption) and link with other PGR Secure workpackages.

2. Baseline European landrace inventories for target crops

Unfortunately lack of funds hampered the possibility of funding *in situ* LR inventorying across the entire Europe. Therefore, it was decided to focus on an inventory *in situ* (on-farm) extant landraces (LR) of target crops in Italy, Finland and UK.

In UK (Scotland) two LR of *Avena strigosa* Schreb., two of *A. sativa* L. and one of *Brassica oleracea* L. have been recorded in previous studies (Scholten *et al.*, 2009).

In Finland, one LR *B. rapa* ssp. *rapa L.* (turnip), two LR *B. napus* var. *nabobrassica L.* (swede), one A*vena. sativa* L. were recorded using the tools developed in the PGR Secure project. Two old *A. sativa* samples with long cultivation history were also recorded but not verified as LRs (as they might be obsolete cultivars). The data for Finland were extracted from the Finnish LR on-farm Inventory Data (Heinonen, unpublished) compiled during the PGR Secure project.

In Italy, one *A. sativa*, two *Beta vulgaris* L., one *B. napus* L., 27 *B. oleracea* L., 12 *B. rapa* L., and 45 *Medicago sativa* L. LR were officially recorded (see http://vnr.unipg.it/PGRSecure/start.html) using the tools developed in the PGR Secure project (i.e. D4.6 and D4.7, the 'Descriptors for web-enabled national *in situ* landrace inventories' and the 'MS database for *in situ* LR data recording', respectively both available from

www.pgrsecure.org LR help desk). Data for Italy were extracted from The First inventory of *In Situ* Maintained Landraces of Italy (Negri *et al.*, 2013) which was prepared in the frame of the PGR Secure project. However, it is known from recent bibliographic data and personal observation that for target crops other LR exist in Italy and Finland as well as in other European countries that have not been recorded in an inventory yet (see for example: Ciancaleoni *et al.*, 2014, 2014; Laghetti *et al.*, 2005; Reiner *et al.*, 2005; Silva Dias 2012; Thomas *et al.*, 2012, 2013; Schierscher-Viret *et al.*, 2009; Strajeru *et al.*, 2009).

3. Ecogeographic diversity data and analysis

Considering the scarcity of data an analysis of ecogeographic diversity was only possible for *B. oleracea, B. rapa* and *M. sativa*.

Two LR *B. napus* ssp. *napobrassica* were found in the South-West (60.24 N and 22.22 E) and Southern Finland (61.29 N and 23.45 E), one LR *B. rapa* ssp. *rapa* in the Eastern Finland (62.47 N and 30.09 E) and one LR *A. sativa* in the South-East Finland (60.35 N and 27.42 E). The LR *B. rapa* ssp. *rapa* is registered as the conservation variety as well as the South-West Finland's LR *B. napus* ssp. *napobrassica* is registered to the National Variety list. Those are also cultivated also some other areas in Finland as introduced LR. The LR *B. rapa* ssp. *rapa* is a turnip of type of the slash-and-burn cultivation and this root vegetable has very long cultivation traditions in Finland. In general the cultivation altitude ranges up to 300 m asl.

In Italy, the *A. sativa* LR was found in Molise Region, the two *B. vulgaris* LR in Tuscany and Umbria Regions, respectively, the *B. napus* LR in Umbria Region, The *B. oleracea* LR in Friuli Venezia Giulia, Tuscany, Umbria, Molise and Lazio Regions, *B. rapa* in Umbria, Molise and Lazio Regions and the *M. sativa* LR in Umbria and Abruzzo Regions. For *B. oleracea,* which was found in plains and hilly sites, latitude ranged from 46.20 to 41.48 N, longitude from 14.05 to 10.52 E. For *B. rapa,* which was also mostly found in plains and hilly sites but for which two locations were recorded in mountain sites above 500 m asl, latitude ranged from 41.48 to 43.21 N, longitude from 12.04 to 14.88 E. Finally, for *M. sativa*, which was found from sea level up to 900 m asl, latitude ranged from 42.02 to 43.36 N, longitude from 12.34 to 14.47 E. Considering the high geographic diversity of the Italian territory, a high genetic diversity of these LR can be supposed. In particular, it is striking that *M. sativa* LR are found in such diverse locations.

Overall it can be noted that a higher number of LR was found in the Southern rather than in the Northern part of Europe but more study is required before firm conclusions can be drawn.

4. *In situ* versus *ex situ* gap analysis

In Finland all LRs of the target crops that were recorded *in situ* were also conserved *ex situ* at the Nordic genebank the Nordic Genetic Resource Center (NordGen). In total in the *ex situ* long term conservation there is five LR *B. napus* var. *napobrassica*, thirteen LR *A. sativa*, one LR *A. strigosa* and seven LR *B. rapa* ssp. *rapa* of Finnish origin.

In Italy, out of the 88 LR that were recorded *in situ* for the target crops only 44 (50%) are also conserved *ex situ*. 36 LR out of the latter 44 are conserved at the Department of Agricultural, Nutritional and Environmental Sciences, University of Perugia, the others in Regional gene banks. It should be noted on the matter that these gene banks, not receiving enough support have problems in managing these accessions and especially in multiplying and distributing germplasm when requested.

This emphasizes the need to implement and support effective *in situ* and *ex situ* complementary activities for the maintenance of genetic diversity and use by farmers/farmer organizations and breeders.

5. Identification and prioritization of *Avena, Beta, Brassica* and *Medicago* conservation areas

Also for the identification and prioritization of the target crop conservation areas, the scarcity of data that was possible to collect does not allow a sound assessment. However, it can be said that LR recorded in the most extreme environments, like the *M. sativa* from 900 m asl found in Abruzzo region, deserve the highest conservation attention also because that area is characterized by the presence of other LR of different and important cultivated species (*Triticum aestivum* L., *Phaseolus vulgaris* L., *Lycopersicum esculentum* L., *Lens culinaris* Med. etc), many natural resources that are used in agriculture (permanent pastures) and by the presence of many protected areas and National Parks.

Areas like that are hot spots of biodiversity and can be defined as Most Appropriate Areas for implementing or enhancing conservation activities (Negri *et al*., 2012).

6. European specific landrace conservation strategy for target crops (*Avena*, *Beta*, *Brassica* and *Medicago*)

6.1. Identification of future actions of primary importance

The issues to be considered towards a European strategic approach to conserving LR of *A. strigosa, A. sativa*, *Beta vulgaris*, *Brassica napus*, *B. oleracea*, *B. rapa* and *M. sativa* concern conservation, utilisation, policies, legislation, public awareness and education, socio-economy and cooperation.

The promotion of use of variable materials in agriculture and in breeding is to be considered as the mean to *in situ* (on-farm) conservation.

To support conservation actions, research is also needed to improve our knowledge on present level of *in situ* (on-farm) diversity, population dynamics in relationships to factors such as migration, drift and human and environmental selection pressures, impact of climate change on diversity, and how variable populations should be managed to adapt, mitigate effects or be resilient to the climate change effects in the face of its potential impact, usefulness of variable materials in environmental friendly agronomic systems and in breeding, socio-economic factors driving *in situ* (on-farm) conservation.

Considering that lack of funds hampered the possibility of searching *in situ* LR across the entire Europe (and especially in those countries where they are most likely to be found still), the primary needs for a strategic approach to conservation of the target crop LR in Europe remain:

- to gather information on variable materials still maintained *in situ* (on-farm) that are known to exist, but have not been recorded yet;
- in addition, on the basis of the information gathered in this project, to back-up *in situ* (on-farm) conservation with *ex situ* conservation is also to be pursued immediately. Both LR that have been recorded *in situ* during PGR Secure that are not stored in gene banks yet and LR that are possibly still found on the farms (as from recent bibliographic information) should be actively collected and conserved *ex situ*.

These actions appear to be fully pertinent to the context of international policies and strategies for a sustainable use of Plant Genetic Resources for Food and Agriculture: the International Treaty (ITPGRFA, FAO 2001), the 2nd GPA (FAO 2011) policy and strategy for *In Situ* Conservation and Management and the EU 2020 Biodiversity Strategy (the European Parliament Resolution, 2012).

6.2. The compilation of country and European inventories of target crop landrace that are maintained *in situ* (on-farm)

A bottom up additive strategy

Considering the sovereignty of each country over its own genetic resources, a European inventory should be based on National inventories and each Nation's decision to contribute data which are needed to compile the European inventory with a bottom up strategy. Procedures and actors of this strategy are graphically presented in Figure 1 (bottom part) and can be summarized in the following steps:

a) Creation of official National inventories of (extant, re-introduced and introduced) LR.
b) Merging of each National inventory into a unique European inventory after a National filtering process that sees each country to decide on which of the above mentioned variable materials is to be considered worthwhile to be included.
c) Construction of a solid, efficient database for European *in situ* (on-farm) inventory information.

It would be initially necessary to stimulate each country's Government to construct its National inventory of on-farm maintained LR. This can be achieved through the ECPGR On-farm Working Group members (Fig.1, in italics). Gathering data for inventories should be mostly based on information provided by farmer/farmer networks, beside ECPGR WG members and other stakeholders. The inventories construction can take advantage of the information recording tools already purposely developed in this project (i.e. the 'Descriptors for web-enabled national *in situ* landrace inventories' and the 'MS database for *in situ* LR data recording', both available from www.pgrsecure.org LR help desk).

Once these National Inventories have been built up, and after a filtering process carried out by the National Inventory Focal Points in agreement with the National Coordinators, their data can be merged into a unique European inventory (Fig. 1, center), following the example of what has been done for the compilation of EURISCO (http://eurisco.ecpgr.org/). European data should be stored into a database that is linked to other formal (EURISCO, Central Crop Databases, genebanks databases) and to farmer/farmer organization network databases (Fig. 1, green diamond).

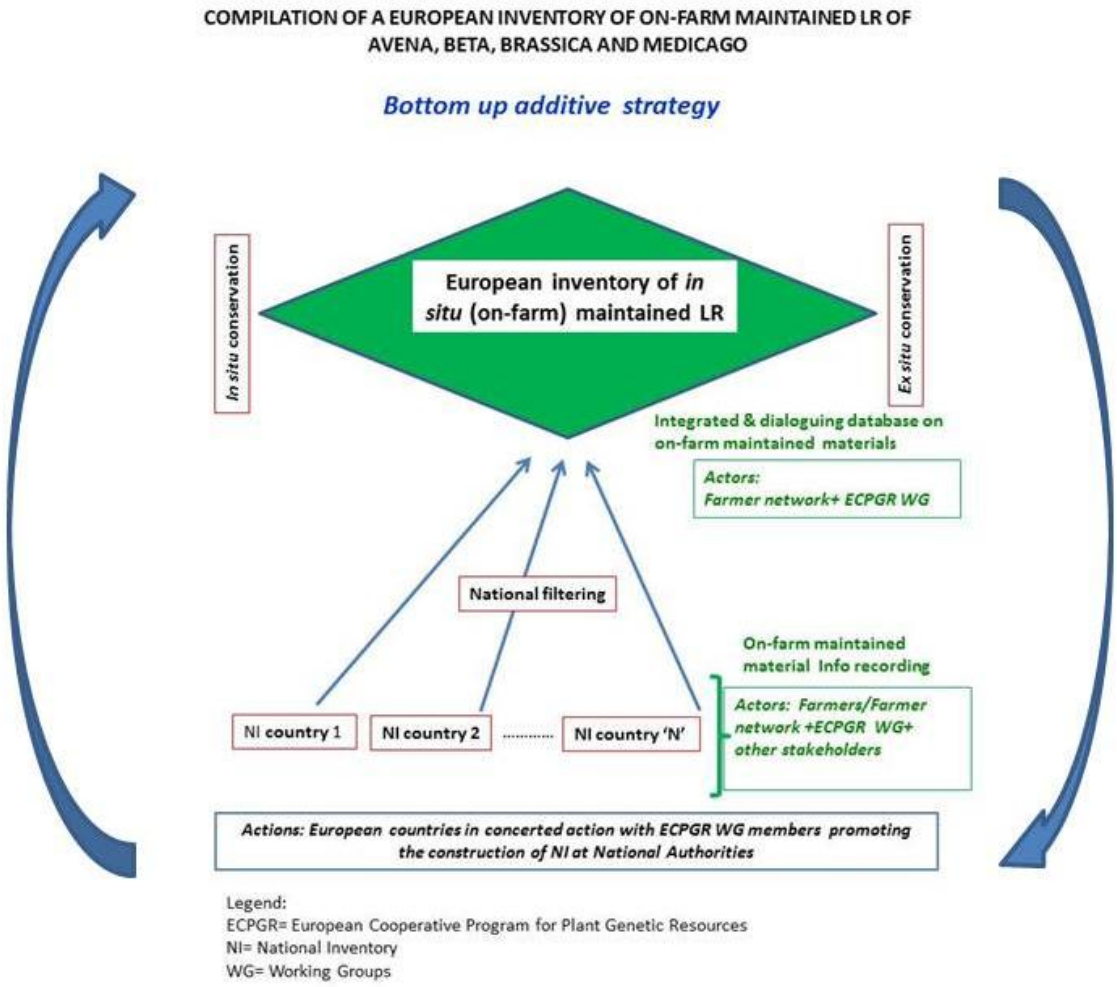

Figure 1. The compilation of a European inventory of on-farm maintained LR of *Avena, Beta, Brassica* and *Medicago* following a bottom up approach. Actors are identified by italics, information gathering and management by green text and arrows indicate periodic reworking.

Using a similar approach some Italian Regions have developed an operative Regional law to protect agro-biodiversity (Emilia Romagna, Tuscany, Umbria, Marche and Lazio) and inventory their LR diversity. It is useful to note that these inventories are already used in Italian Regions to fund (through the European Agricultural Fund for Rural Development, EAFRD) activities aimed to protect, monitor and enhance utility of Genetic Resources for Food and Agriculture *in situ* (on-farm) and specifically to:

- support *in situ* and on farms conservation of protected genetic resources, i.e. their cultivation within the area where they have been selected;
- where possible, favour the reintroduction or extension of culture of protected genetic resources;
- assign to farmers, under the strict control of the Region, the multiplication of genetic resources that they themselves have conserved up to present day, by providing them the necessary assistance to enhance the techniques for the multiplication and propagation of material;
- control the exchange of the propagation material produced and make it available both to the farmers that apply for it for cultivation and for scientific purposes such as genetic selection and improvement;
- apply cultivation models, studied on the basis of those adopted by tradition, that should exalt the quality and productivity of the protected genetic resources;

- coordinate the subjects included in the Network in order to promote the economic and cultural enhancement of the genetic resources that are protected by law, through the establishment of protection associations, consortia or protected trademarks and their involvement in food fairs.

A top down strategy

However, considering the facts that i) to compile National inventories cannot be immediately feasible for all European countries, ii) different areas of Europe have different level of on-farm maintained diversity (i.e. different numbers of LR) the possibility to take an overview from an European perspective should also be taken into account with a 'top down' approach (Figure 2). This would also require an initial informative dataset on diversity maintained i*n situ* (on-farm). This can be developed by retrieving available bibliographic information and database data by the ECPGR WG members and other stakeholders, and subsequently by checking actual existence in the field. From the initial informative dataset, variable materials maintained *in situ* (on-farm) that are of priority importance for Europe and worldwide will be subsequently identified. Criteria to identify materials of priority importance for Europe and worldwide need to be discussed and agreed first. It must be finally noted that both strategies would require a periodic reworking because *in situ* (on-farm) inventories deal with very dynamic situations (growers come and go, new variable population arise meanwhile, so that situations can change rapidly) and research is continuously piling on new data on LR diversity maintained in the field and its utility.

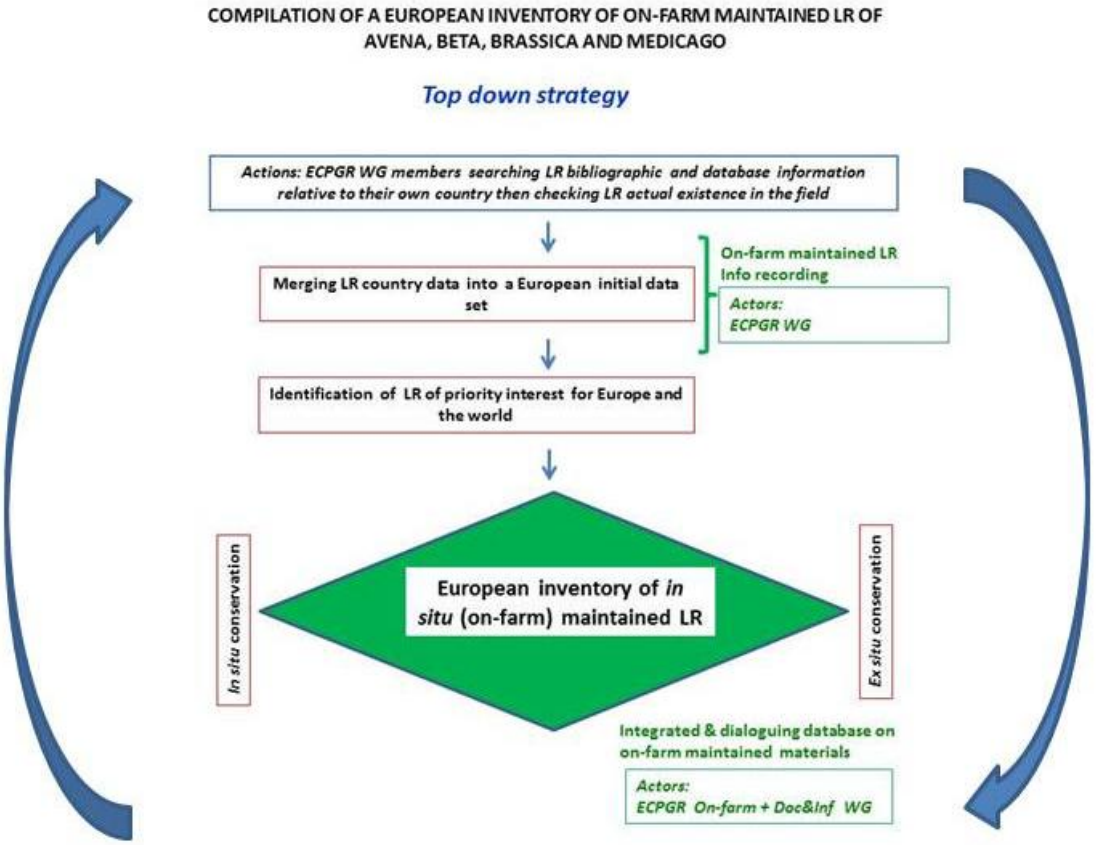

Figure 2. The compilation of a European inventory of on-farm maintained LR of *Avena, Beta, Brassica* and *Medicago* following a top down approach. Actors are mentioned in italics. What is related to information gathering and management is reported in green. Arrows show periodic reworking.

The European inventory will need an informative basis for promoting *ex situ* and *in situ* (on-farm) conservation actions. No action plan for *in situ* maintained materials can be developed to answer the 2nd GPA (FAO 2011), the ITPGRFA (FAO 2001) and the EU 2020 Biodiversity Strategy (the European Parliament Resolution 2012), if there is not any informative base. The same considerations hold true for the development of plans for *in situ* conservation and their implementation at Nation level. These plans should rely on different elements (depending on the country and country area), but the information collected will assure the possibility of:

- collecting materials not already present in *ex situ* collections. On the matter it is worthwhile to recall that the gap analysis mentioned in section 3 showed that many *in situ* maintained LR (50%) are not conserved in genebanks,
- promoting the use LR in agriculture in such also achieving their *in situ* (on-farm) conservation. This can be done by enhancing economic and cultural motivations to maintain them, for example:
    - enhancing the value of LR products by the use of mark labelling (i.e. Protected Designation of Origin, Geographic Designation of Origin, Traditional Specialty, certified product from Organic Agriculture, etc.). Many products from LR, already take advantage of this possibility,
    - developing of local food supply systems based on LR, in the EU this is presently facilitated by the adoption of the new Common Agricultural Policy. There are several examples in Europe based on variable materials like campaigns that promote the commercialization of food from 'nearby' farms in local markets, grouping consumers for obtaining reductions to the prices, offering agri-touristic services, serving local food in restaurants,
    - enhancing the use of LR in environmentally and economically sustainable farming systems, which presently answer the needs of farmers (like organic farmers) and the consumer demand for a sustainable production systems,
    - developing food chains based on LR,
    - enhancing the use of LR in community and home gardens,
    - enhancing the cultural anchorage of a certain community to the variable material it developed,
- promoting the use of LR in breeding and participatory breeding by exploiting their genetic diversity,
- promoting research on LR for
    - within- and among- genetic diversity level, for traits conferring
        - resistance/tolerance to biotic stresses
        - resistance/tolerance to abiotic stresses
        - quality,
    - *in situ* (on-farm) genetic diversity evolution under changed climatic conditions,
    - level of genetic diversity that can be maintained under
        - different agro-ecosystems,
        - different management systems (e.g. environmental friendly agronomic systems vs 'conventional' agronomic systems),
    - socio-economic factors that drive conservation, in such answering unsolved research questions (Veteläinen *et al.*, 2009a),
- developing the research needed to identify agro-biodiversity hot spots (Most Appropriate Areas for conservation activities) and compile their European inventory.

The development of European inventory also

- allow to assess overall progress implementation and related follow-up processes of the 2nd GPA (FAO 2011) following the criteria and indicators set by Commission on Genetic Resources for Food and Agriculture in draft formats (CGRFA-14/13/Inf.9 Rev.1) (i.e. most of indicators and question

mentioned in there are included in the 'Descriptors for web-enabled national *in situ* landrace inventories').
- facilitate the cooperation among European countries,
- facilitate the cooperation among the formal sector and the networks of farmers and farmer organizations.

Finally, it will be a useful example to develop

- *in situ* conservation actions at the global level.

7. Better Integration Between the Formal Sector and Farmers/Farmer Networks (Answering The Needs Of Farmers/Farmer Networks)

As mentioned above, to enhance the cultivation of LR on the farms/in gardens, both for local and wider markets and family use, and their use in breeding and participatory breeding, are among the common needs and elements for a strategic and cooperative approach to *in situ* (on-farm) conservation, since the farmers are the main actors in conservation. Viewing to ensure the good condition of the habitats that are home to the agro-biodiversity we wish to preserve in Europe, to maintain a close relationship between local actors and direct managers of the land and the formal sector should be encouraged, paying attention to the needs of the former.

To this end the formal sector (like the ECPGR WG members, individually and in a cooperative manner) can provide support:

- to make LR stored in genebank available to a wider extent for initial introduction and reintroduction or,
- to make information related to them available to a wider extent and facilitate its exchange,
- to give technical support to *in situ* (on-farm) activities,
- to assist and favour the registration of the materials for on-farm conservation as 'conservation varieties'. As discussed in Spataro and Negri (2013), the latter can help in maintaining LR on the farms.

8. The Need to Promote Awareness and Raise Additional Funding for *In Situ* (On-Farm) Conservation in Europe

PGR activities are presently mainly focused on *ex situ* conservation in Europe. Lack of consistent and continuous funding is at present the primary constrain towards a *in situ* (on-farm) European approach to conservation. The European Commission (EC) appears to be as the primary organism where to lobby for promoting awareness on conservation and rising funds for specific regional *in situ* (on-farm) research and dissemination activities (Horizon 2020, AGRIGENRES context, if eventually refunded). For example further developing infrastructure and methods on conservation and sustainable use of PGR *in situ* (on-farm) could

be suggested as a topic within the Societal Challenge - Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy frame.

However, it is recognized that short-term research funding is not entirely suitable to sustain long-term *in situ* (on-farm) activities, thus there is a need to explore simultaneously the interest of European Agencies, like the European Environment Agency (EEA), of the Institute for Environment and Sustainability (IES, one of the European Commission's Joint Research Centres), of the Technical Centre for Agricultural and Rural Cooperation (CTA) to provide the policy and context, governance and ultimately fund specific *in situ* (on-farm) conservation. Although it is recognized that these European agencies have primarily an environmental remit and therefore discussion directly with EC Agriculture should also be a high priority. In particular, research needs funds to assess present LR diversity, population dynamics and impact of climate change on LR diversity, proper ways of LR managing to favour their future adaptation, to identify agro-biodiversity rich areas, to assess LR utility in environmental friendly agronomic systems.

As for the practical side of the matter, at EU level, policy measures in favour of wildlife conservation in farmlands and support schemes for semi-natural grasslands, landraces of farm animals and other incentive measures aiming at preserving biodiversity are already foreseen in the CAP. Specific forms of support for the farmers willing to facilitate the survival of LR taxa with appropriate management should also be foreseen as a form of compensation to farmers for the delivery of public goods such as the maintenance of important PGR that continue to evolve *in situ*. The increasing farmer interest in nature conservation, the development of recreational activities, and the need to develop 'alternative farm enterprises' that can give additional income to farmers (Sokos et al 2013 and references therein) could facilitate the application of such measures. To this end, the status of "Farm Maintaining Plant Genetic Resources" could be suggested to the European Commission and attributed to farms really involved in CWR and LR *in situ* conservation.

EU member states should take better advantage of the EAFRD funds for protecting LR and improving the diversification of the rural economy by using variable materials. Examples of effective uses of EAFRD funds exist (see the Italian Region experiences that are reported above) that could be followed. In addition, it can be noted that EAFRD also funds cooperative work among EU countries for rural development. Of this specific frame of funding EU countries could take advantage for the compilation of European inventories.

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10. Most Used Acronyms

CBD: Convention on Biological Diversity

ECPGR: European Cooperative Programme for Plant Genetic Resources

EU: European Union

EC: European Commission

EAFRD: European Agricultural Fund for Rural Development

GPA: Global Plan of Action

ITPGRFA: International Treaty on Plant Genetic Resources for Food and Agriculture (International Treaty)

LR: Landrace/s

PGRFA: Plant Genetic Resources for Food and Agriculture

WG: Working Group/s