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Farmer’s Pride

Networking, partnerships and tools to enhance in situ conservation of European plant genetic resources

In situ landrace propagation management and access guidelines

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Contents

Summary

Changes in global climatic patterns have significantly increased collective concern about the state of existing strategies to protect Plant Genetic Resources for food and agriculture. Concerning *in situ* conservation of landraces, few coordinated actions are in place at European level. In this context the Farmer's Pride Project aims to establish a network that effectively coordinates conservation actions to safeguard the wealth of Europe's crop wild relatives and *in situ* maintained landraces.

In situ conservation of landraces is currently seen as an effective means of answering present and future agricultural challenges; in fact, these materials can evolve in response to changing environmental conditions and different selective pressures. In this regard, landrace populations maintained *in situ* represent a living reservoir of adaptive traits that are of pivotal importance to safeguard the future of agriculture. Within the Farmer's Pride project this document intends to provide the community with guidelines and recommendations that can significantly help to maximise the level of *in situ* maintained diversity. The approach used is based on collection and analysis of diverse case studies of European *in situ* maintained landraces, together with a review of the existing literature on this topic.

By January 2020, a set of 105 case studies of *in situ* maintained landraces was successfully collected; the collection encompasses cases of 54 different species from 14 European countries. The dataset included open-field, garden and tree crops of which about half are cultivated in marginal areas. When management was analysed interesting evidence arose; in fact, different practices are applied for maintenance and propagation of landraces, according on their use, type, mating systems and applied propagation strategies.

Such results, together with an accurate literature review, allowed the identification of key management elements that are applied to landrace seed production and/or propagation. Clear guidelines to improve landrace propagation management were developed starting from the identified key elements.

The resulting document provides the user community with clear prescriptions to carry out, or develop, proper multiplication and diffusion strategies with the principal aim of maximising landrace diversity while keeping its identity. Cases where introduction of landraces into a completely new environment are needed are also considered. The elements used to build these recommendations were also retrieved through an accurate literature review.

1. General introduction

Collection, maintenance, and classification of plant genetic resources for food and agriculture (PGRFA) are vital processes underpinning the improvement of crop yields and sustaining our ability to feed the increasing human population (Godfray et al. 2010; Jarvis et al. 2010; Foley et al. 2011; Ortiz 2011; Khoury et al. 2014; Tilman and Clark 2014; Bellon et al. 2017, just to cite some of the many references). Currently, changes in global climatic patterns have significantly increased the collective concern about the strategies that have to be put in place to protect PGRFA (FAO 2010, 2012; Field et al. 2014). To date, *ex situ* collections have played a major role in providing germplasm for the plant breeding community, however, despite its undoubted value, *ex situ* conservation suffers a major drawback, in fact, these collections represent "frozen snapshots" of these materials at the moment they were collected (Brush 2004).

On the other hand, *in situ* conservation allows for the maintenance of species and their populations within their natural environments; the main rationale behind this type of conservation is its ability to allow species and their populations to evolve in response to changing selective pressures that occur naturally and/or are caused by farmers' management practices, as it occurs for landraces (Brush 2004; Gepts 2006). Farmer selective pressures can generally be associated with different agronomic practices, human preferences, uses in diverse socio-cultural sets. The exposure of landraces to changing selective pressures in different environments can favour new useful genetic variation that can significantly help address present and future agriculture challenges (Franks et al. 2007; Thormann et al. 2017; Raggi et al. 2019); as such, increased crop yield and nutritional value, resistance and/or tolerance to biotic and abiotic stresses are among the most desirable traits. All the same, the exposure to different selective pressures across generations and places in the past has maintained different traits in different populations of a certain crop (*i.e.* landraces). Therefore, *in situ* conservation is presently perceived as an effective and efficient means of answering present and future agricultural challenges.

Certainly, possible positive outcomes of *in situ* conservation depend on several variables that influence the level of conserved genetic diversity and its ability to generate resilient populations. Population size, different mating systems, different propagation practices, heritability of biotic and abiotic stress tolerance traits, gene-flow between different populations, intensity and principals of farmer selection are among the most significant forces driving landrace population adaptation and plasticity. Concerning crops, a consistent amount of diversity is still maintained by smallholder farmers in many low-income countries, often within crops' centres of origin where landraces still constitute a great portion of the cultivated materials (van de Wouw et al. 2010; Orozco-Ramírez et al. 2016). To the contrary, most European agricultural production nowadays relies on few species of which registered, uniform cultivars are the vast majority of the cultivated materials; though, landraces – together with some obsolete cultivars and other "non-conventional materials" – which are also cultivated and used across Europe (Negri et al. 2009a, ECPGR 2017).

The Convention on biological diversity (CBD) (1992) defines *in situ* conservation as "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties". While *in situ* conservation is often associated with wild biodiversity, actions focused on *in situ* conservation of landraces have been carried out in many countries (Negri et al. 2009b, 2013; ECPGR 2017). In the past, most actions arose locally or nationally and after a number of international documents and agreements (CBD 1992; FAO 2001, 2012). Nowadays, through the formalisation of the EU Biodiversity Strategy for 2030 (European Commission 2020), Europe is moving a step forward for a coordinated strategy to facilitate landrace conservation and sustainable use. Indeed, the document recognises the need to contrast the decline of genetic diversity "by facilitating the use of traditional varieties of crops" also through a revision of the European seed market legislation and of meeting the UN Sustainable Development Goals for 2030 (UN, 2015), particularly Target 2.5. (agricultural biodiversity maintenance and effective genetic conservation of PGRFA diversity).

1.1 Purpose, objectives and scope

These guidelines are a product of the project "Networking, partnerships and tools to enhance *in situ* conservation of European plant genetic resources" (Farmer's Pride), which is funded under European Union's Horizon 2020 Research and Innovation Programme on Societal Challenge 2 Food security, sustainable agriculture and forestry, marine and maritime and inland water research, under the specific call SFS-04 (GA 774271).

The principal aim of the project is to build an integrated multi-actor network of sites and stakeholders to sustain PGR *in situ* conservation that complements *ex situ* activities and enhances utilisation of plant genetic resources for food and agriculture (PGRFA) as a means of underpinning agriculture, food and nutritional security in Europe. Among its multiple tasks, the Farmer's Pride Project wants to provide the community recommendations and guidelines to favour a correct propagation management of different landrace populations according to their different mating system, population size, propagation strategy, use, farmer selective pressures, and by considering different socio-cultural situations.

The approach used to produce this document is based on the analysis of a large set of case studies of *in situ* (*i.e.* on-farm and in-garden) maintained landraces, collected across Europe. The information arising from the resulting evidence, together with an accurate scientific literature review, draws clear recommendations and guidelines that will help the user community (e.g. farmers and gardeners) to improve their landrace management practices. Therefore, the scope of this document is to extend the capacities of farmers to manage landrace diversity and distinct identity while at the same time securing and making available these materials to the user community (

Figure **1**).

Figure 1. Purpose of the *in situ* landrace propagation management and access guidelines.

1.2 Definitions

1.2.1 Landraces

According to existing literature, the term “landrace” refers to a broad range of definitions that have evolved over time (von Rümker 1908; Zeven 1998; Negri 2003; Camacho Villa et al. 2005; Tosti and Negri 2005) bringing us to the most recent definition that takes into account several aspects such as landraces’ heterogeneity, distinct identity, historical use, lack of formal improvement and association with local farming practices and culture (Negri et al. 2009a); such materials are actually defined as *sensu stricto* landraces or “true landraces”. On the other hand, it is also important to mention that not only *in situ* conserved true landraces, but also other materials are potentially relevant for preservation and maximisation of the level of *in situ* conserved diversity of crop species; such materials are:

- introduced landraces: landraces that have been introduced in a different region from the area in which its cultivation has been historically carried out;
- obsolete cultivars;
- conservation and amateur varieties as defined in the Commission Directives 2008/62/EC and 2009/145/EC (European Commission 2008, 2009);
- populations as defined in the Commission Implementing Decision of 18 March 2014 (European Commission 2014);

All the above-listed materials, together with true landraces, have been defined as landraces in a broad sense (*i.e. sensu lato* landraces) by the European Cooperative Program on Genetic Resources (ECPGR) in the “ECPGR concept for on-farm conservation and management of plant genetic resources for food and agriculture” (ECPGR 2017). All these materials together, hereafter defined “landraces”, are the object of this document.

1.2.2 Landrace maintainers

Regarding landrace on-farm conservation, literature almost always assumes that farmers are the only actors planting, cultivating and harvesting landraces. However, considering the common definition of farmers as “people cultivating a tract of land for the purpose of agricultural production” this would exclude other actors carrying out landrace cultivation for their home-consumption (*i.e.* gardeners). Indeed, a clear distinction between farmers and gardeners exists according to scale of production, cultivation techniques, crop species grown and their economic value, market and end-consumer. As such, farmers and gardeners (and growers) are not synonyms; however, both maintain distinct landrace diversity that must be considered when *in situ* conservation strategies are outlined. In this document, the two terms “maintainers” and “farmers” are both used to refer to a broad group of actors that carry out landrace *in situ* maintenance without any distinction. The document in Section 3 below, can also be useful to small seed companies that multiply landrace seed.

1.3 Structure of the document

Following this general introduction, the document is structured in the following main sections:

Case studies analysis (Section 2).

In this section of the document an analysis of 105 case studies of *in situ* maintained landraces across 14 European countries was carried out. Results give an overview of which species and type of materials are cultivated and in which locations they are cultivated, how landraces are managed with a specific focus on propagation methods, how landraces and their related products are marketed and which strategies were applied to favour landrace (and related products'), marketability. In addition, *in situ* accessibility to landrace propagation materials was analysed.

Recommendations for propagation management of managing landraces *in situ* (Section 3).

In this section, there are guidelines to improve propagation management of *in situ* maintained landraces. These recommendations are addressed to maintainers of landraces *in situ,* to help them improve their ability to properly manage landrace identity while conserving within population genetic diversity.

Recommendations for having access to *in situ* landrace propagation materials (Section 4).

In this section indications to promote access to *in situ* landrace propagation material are presented based on evidence retrieved from case studies and present seed market regulations.

Conclusions (Section 5).

2. Case studies analysis

2.1. Materials and methods

2.1.1 Case survey methodology

The case survey methodology represents a potentially powerful tool to identify and statistically test patterns of variation of different elements across multiple cases, provided the analysed sample is wide enough and is representative of different situations. This methodology is particularly relevant when an experimental design is not possible to be applied or otherwise can fail to capture situations that are relevant to certain managerial practice (Larsson 1993). This document takes advantage of the "case survey methodology" and uses it to gain information about *in situ* maintained landraces across Europe. This approach allowed quantitative analysis to be performed on a large set of different case studies that assemble information about different landraces across diverse socio-economic, pedo-climatic and cultural contexts in Europe.

2.1.2 Collection of case studies

During 2019, Farmer's Pride Partners and Ambassadors (the latter helping in achieving Farmer's Pride aims), members of the ECPGR (European Cooperative Program on Plant Genetic Resources) On-farm working group, Universities, Non-Governmental Organisations (NGOs), national and local authorities, and private citizens across Europe were invited to provide a number of relevant case studies of on-farm/ in-garden maintained landraces representing successful (or potentially successful) examples of valorisation and/or use. The strategy used to collect case studies aimed at including *in situ* maintained resources of open-field, garden and tree crops, encompassing diverse countries, environmental conditions, management systems, multiplication procedures and diverse levels of relevance on the market (Raggi et al. 2020). In addition, some of the information used to compile the case studies were retrieved from the available literature (Bellon and Brush 1994; Tosti and Negri 2005; Tiranti and Negri 2007; Negri and Tiranti 2010a; Torricelli et al. 2013; Ciancaleoni et al. 2014; Raggi et al. 2016), the main goal being to collect as many case studies as possible. In order to standardise the collection of information, a template was developed and shared among potential contributors.

2.1.3 Data classification

To perform data analyses and visualisation, information of the case studies (entries) were classified into 23 categories (Table 1), describing basic characteristics and several cross-sectional themes about how, where, and why such resources are still kept, used and marketed. The categories were arranged in four thematic groups: i) general information, ii) management, iii) market and added values and iv) accessibility (Table 1).

Table 1. Data categorisation of 105 case studies of *in situ* maintained landraces.

Category	**Description**	**Possible values**
General information		
1. Species	Binomial name	Species name
2. Landrace type	Type of *in situ* conserved landrace	True landrace; introduced landrace; historical variety; selection from landrace; population**
3. Crop type	Whether cultivation occurs in gardens or open-field conditions. Fruit trees are also distinguished	Garden; open-field; fruit tree
4. Location	Country in which the resource is maintained *in situ*; latitude and longitude of the location in which the cultivation of the resource has been historically documented and carried out now	Country; latitude and longitude (decimal degrees)
5. Marginal area	Whether the cultivation mainly occurs in marginal areas	Yes/No
6. Edible/processed part	The part of the plant that is used and/or processed	Caryopsis, flower, fruit, leaves, plant, pod, root, seed, stem or tuber
7. Mating system	Mating system of the landrace species	Allogamous; autogamous
Landrace management		
8. Management system	Farming management system under which cultivation occurs	Low-input/organic; conventional
9. On-farm management plan	Existence of a formal on-farm management plan that sets standards for landrace propagation and management	Yes/No
10. Propagation*	Whether the propagation occurs sexually (via seed) or clonally	Sexual/clonal
11. Propagation organ*	Part of the plant used for propagation	Bulb, cloves, cuttings, offshoots of the main root, root, root sprouts, scion wood, seed or tuber
12. Multiplication actors*	Who multiplies the material?	A single farmer, Farmer's consortium, PDO consortium, private body, public body or seed company
13. Material exchange*	Multiplication material exchange among farmers/gardeners within the cultivation area	Yes/No
14. Material isolation*	Isolation strategy used for material multiplication	Spatial, temporal or mechanical
15. Selection*	Type of selected materials	Ears/kernel, fruit, mother plants; mother tree, parcel, pod, propagation organ, seed, mother plants and capsules, mother plants and fruits, mother plants and ear/kernel.

Market and added value		
16. Market extent	Extent of the landrace market	Local, national or international
17. Geographical designation	Type of geographical designation label	PDO, PGI and other national designations
18. Other labels or brands	Type of other label or brands	Commercial brand, quality label
19. Register	Type of register in which the landrace is listed	National register or other registers
20. Promotion	Extent of landrace promotion activities	Local, national or international
21. External support	Body or authority that financed activities that supported the landrace	Local authority, national authority, university, private initiative, NGO or Community Seed Bank
***4.* Accessibility**		
22. *Ex situ* backup	Existence of an *ex situ* backup	Yes/No
23. Access to the *in situ* resource	How the resource can be accessed	Conditioned, available

*This category refers to a specific aspect of propagation.

** Commission Implementing Decision of 18 March 2014 (European Commission 2014).

General information

This thematic group encompasses seven categories, including general information for data classification such as *species*, *mating system*, *crop type*, *edible/processed part*, *location* in which cultivation of the resource has been historically documented and is carried out now and whether the actual cultivation area can be classify as marginal or not. In addition, the category *Landrace type* classifies the entries according to their actual extent, meaning that in the dataset true landraces, introduced landraces and the other materials (Table 1) can be distinguished.

Management

This thematic group comprises eight categories, the majority of which directly refer to how each resource is managed in terms of seed production or vegetative propagation: *propagation*, *propagation organ*, *multiplication actors*, *material* exchange, *material isolation during multiplication* and *selection* (Table 1). In addition, the category *management system* refers to the farming system mainly used to cultivate the resource while the category *on-farm management plan* refers to the availability of official guidelines that farmers and users need to follow in order to maintain the resource on-farm, including all aspects related to seed production or vegetative propagation.

Market and added value

In this thematic group are all the categories that refer to the actual market extent of the product and all the approaches that are used, or were used in the past, to promote the resource or its related processed products. In this thematic group there are two specific categories that allow classification of the entries according to the presence of *Geographical designations* (e.g. EU's Protected Designation of Origin (PDO) or Protected Geographical Indication (PGI) and/or other similar EU or national geographical designations) or a quality designation, label or brand that is used to place the resource (or its derivatives) on the market. Notably, this thematic group also encompasses the category *external support,* which classifies the entries according to which local, national or regional authority-financed activities that supported the conservation, and use and market the resource.

Accessibility

Accessibility groups the two categories referring to the actual accessibility of the resource. The first category distinguishes entries for which an *ex situ* backup is available, while the other groups the accession for which alternative access to the resource can occur, grouping for example entries that can be accessed through seed/seedling markets as some resources might be registered as "conservation varieties" or "amateur varieties" (European Commission 2008, 2009) (see Annex I of this document).

2.2 Results

The collection of the case studies allowed the depiction of how landraces are managed, used and marketed across Europe. In the following paragraphs of the document, data from the case studies are summarised and analysed to give a brief perspective of the state of *in situ* conservation of landraces characterised by different use, mating systems, multiplication strategies and subjected to different selection criteria (where applicable). This landrace case studies collection is accessible in an *ad hoc* developed searchable database hosted by the website ECPGR Secretariat (https://www.ecpgr.cgiar.org/best-practice-evidence-based-database).

2.2.1 General information

By the end of January 2020, 105 case studies, reporting information on 53 different crop species, including entries from 14 European countries (Figure 2) were successfully collected. Because of its relevance, a case study from a non-European country was also retrieved from literature and included (Bellon and Brush 1994). Most of the entries are about *in situ* conservation of true landraces (74.3%, n=105). Regarding the crop type, most entries were classified as garden crops (58.1 %), followed by open-field crops (33.3%) and fruit trees (8.6%); most of the entries classified as garden crops belong to Southern European countries, while open-field and fruit trees are evenly distributed over the areas from which the case studies were collected; interestingly, in about half of the entries it emerges that the resources are conserved and used in marginal areas.

Both allogamous and autogamous crops have been described in the collection of case studies with a slightly prevalence of allogamous (54%) species over autogamous ones. A balanced dataset including the two reproduction strategies gives a comprehensive picture of different possible management approaches.

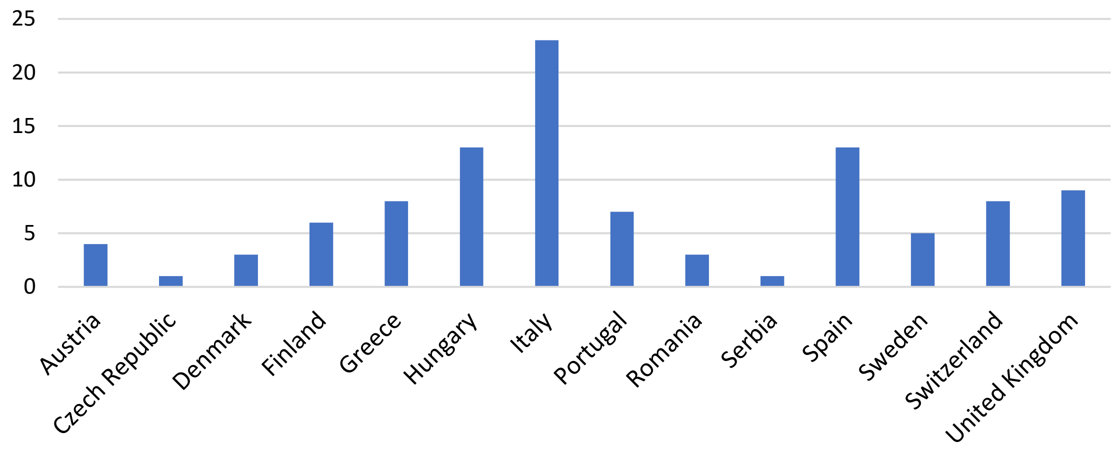

Figure 2. Distribution of the 105 collected case studies of *in situ* maintained landraces among the countries of origin.

2.2.2 Management

As mating system and multiplication procedures are the main factors affecting the level of on-farm maintained diversity, several fields were established to collect as much as possible information on how each resource is multiplied and managed. Concerning the management, most of the analysed landraces were cultivated under organic or low-input agronomic conditions (85%) and for most of them (70,5%) farmers *de facto* oversee the entire multiplication process.

Multiplication procedures

The vast majority of entries (83%) are propagated via seed, while only 17% clonally. Among the latter, all fruit trees are included (about half of the cases), while the other clonally propagated ones were classified as garden crops, including for example potato (*Solanum tuberosum* L.) and sweet potato (*Ipomea batatas* (L.) Lam.) that, in certain areas across Europe, are also cultivated as open-field crops. In asexually propagated crops, several organs are used to multiply the materials: all fruit trees are propagated by grafting cuttings onto rootstocks, however a single plum landrace (*Prunus persica* L., 'Mascina di Montepulciano') is propagated by directly using root sprouts (adventitious sprouts) that are separated from the mother plant by cutting a portion of the root (sucker division) and then planted without the use of rootstocks. Among others, it is interesting to mention the case of a Finnish horseradish landrace (*Armoracia rusticana* Gaertn., "Piparjuuri Vehmaa"), that also represents a case of neglected species; it is clonally propagated using offshoots of the main root as the production of seeds is scarce or absent. Another interesting case of clonal propagation is represented by the Swedish onion landrace "Leksand" (*Allium cepa* L.), that multiplied using bulbs due to a similar phenomenon of scarce seed production.

Selection

According to the collected data, selection for trueness to a specific ideotype is generally carried out for most records (70% of total). However, strong differences regarding the occurrence (or not) of selection practices exist among the seven identified crop categories (Table 2). In garden-clonal crops, both best mother plants and propagation organs are targets of selection. For all cases of clonally propagated fruit trees, scion wood or root sprouts are always collected, starting from best mother plants. In a case study of an Italian peach landrace it is clearly stated that multiple mother plants are used for clonal propagation to purposely maintain a certain level of diversity.

Table 2. Occurrence of selection (%), missing data on selection (%), and total number of observations in seven different crop categories grouped by crop type and mating system.

Crop category	Occurrence of selection (%)	Missing data (%)	Total number of observations
Garden-autogamous	87%	7%	30
Garden-allogamous	75%	21%	24
Garden-clonal	67%	11%	9
Open-field-autogamous	39%	17%	18
Open-field-allogamous	60%	27%	15
Open-field-clonal*	-	-	-
Tree-clonal	100%	0%	9

*no entry of the dataset can exclusively be attributed to this crop category, e.g. potatoes, sweet potatoes, horseradish and other similar clonally propagated species were reported under the category Garden-clonal.

As for sexually propagated crops, in the garden-autogamous category, selection mainly occurs by harvesting seed from mother plants resembling the ideotype (a practice reported for common bean, lettuce and tomato), fruits resembling the ideotype (tomato) or directly selecting best seed. The latter case mainly occurs when the seed itself is the edible part (*i.e.* common bean, cowpea). In garden-allogamous crops, selection procedures also regard mother plants (50%), fruits (25%) and seeds (12.5%).
In open-field-autogamous crops, according to the collected data, selection is not performed on about 44% of the analysed case studies; however, selection procedures were not always described in detail. In other cases, we recorded evidence of selection on seeds and mother plants. Interestingly, in a case study of Emmer wheat (*Triticum turgidum* L. subsp. d*icoccon,* "Farro di Monteleone di Spoleto") it is reported that only seeds harvested from plots located in a certain agro-environmental context are used for seed production (*i.e.* from the plots located at highest altitude).

In open-field allogamous crops, selection procedures were described in roughly half of the collected case studies. In maize, selection plays a major role in maintaining the ideotype, thus – when a detailed description was given – it is reported to occur on best mother plants, best ears and, in a single case, even best caryopses. This is a direct consequence of the genetic diversity structure of allogamous crops such as maize that, being highly heterozygous, can produce progenies that are phenotypically different from mother plants if no significant selection is applied. For most of the entries belonging to this category, spatial isolation was shown to be of great importance in helping actors in charge of seed production. On the other hand, it is noteworthy to mention that in other open-field allogamous crops, in particular forage species, no selection was reported. Isolation of mother plants during multiplication is important for both garden- and open-field-allogamous crops. From collected data, spatial isolation is by far the major isolation technique used for garden-allogamous crops (reported for celery, broccoli, turnips, onions, watermelons, and cardoons). Regarding open-field-allogamous, an actual temporal isolation was only reported in a maize landrace case study retrieved from literature (Bellon and Brush 1994); for the other maize records only spatial isolation was reported.

Unfortunately, little information on the genetic outcomes of the reported multiplication procedures was collected, while such information could provide evidence on how to maximize the level of on-farm/in-garden conserved genetic diversity to favour its maintenance and evolution. This opens space for future studies aimed specifically at addressing such effects of multiplication procedures.

Multiplication actors

As from data on multiplication actors – i.e. those effectively carrying out the entire multiplication process – farmers play a key role; indeed, in most of collected case studies (71%), farmers are in charge of multiplication and selection of propagation material, being *de facto* those controlling the resources and, to a certain extent, their diversity. However, in some successful cases, propagation, material selection and multiplication are carried out by farmers' consortia (8%) or other public or private bodies such as seed companies, NGOs or Universities (12%). Seed companies play only a marginal role in providing multiplication materials to farmers growing landraces (2%). Poor marketability, low market extent, lack of registration (*i.e.* resources registered as conservation or amateur varieties) and/or sometimes expansive multiplication procedure could be, among others, as the main causes behind the low interest of seed companies in entering landrace seed/seedling market.

Exchange of multiplication materials

Many authors reported that the level of multiplication material exchange among farmers using a certain landrace within the same area can condition level and structure of the conserved diversity (Tosti and Negri 2005; Negri and Tiranti 2010a; Torricelli et al. 2013). As from the results, 33% of the records reported material exchange among farmers; however, it should be noted that this data was missed for 33% of the entries. It is noteworthy to mention that, when material exchange among farmers was reported, no information on its consequences on the level of diversity (genetic and/or phenotypic) was provided with the exception of a few case studies retrieved from literature (Polegri and Negri 2010; Negri and Tiranti 2010; Torricelli et al. 2013).

Propagation management plan existence

For almost all the entries (94%) no formal management plan exists; even if informal propagation management systems were reported in a few case studies, based on the use of different approaches; in these cases, propagation systems use various approaches. It is worth mentioning that the systematic propagation approach used by the farmers cultivating the Italian maize (*Zea mays* L.) landrace "Nostrano di Storo": farmers (about 100) are grouped in a local cooperative that provides members with several services, including seed multiplication and distribution. As maize is an open-field, predominantly allogamous crop, its multiplication might be rather challenging if carried out only by single farmers. The cooperative of farmers cultivating "Nostrano di Storo" oversees the entire seed multiplication process.

Every year, some of the members – especially the ones holding long-time expertise – select a fraction of their fields in which they carry out manual harvest of the ears by discarding plants not corresponding to the 26 morphotypes constituting "Nostrano di Storo". In order to avoid cross-pollination with maize hybrid-varieties (or other varieties) the selected fields are likely to be surrounded by "Nostrano di Storo" or other crops. After harvest, the ears are carefully tied together and dried. When humidity of the kernel reaches ideal values, farmers and experts of the cooperative select ears according to their colour, size and number and appearance of the rows. Once the best ears are chosen, only the seeds located in the central part of the ear are selected. The procedure occurs every year in multiple locations. All the seeds are than bulked together and distributed to all the members of the cooperative. Such complex system of managing propagation ensures farmers to avoid undesired material contamination and to maintain the traditional morphotypes.

2.2.3 Market and added value

Market extent

As expected, most of the products from landraces are sold locally (54%, n=105). Interestingly, for about 21% of the entries, the extent of the market is national while only 4% are sold across national borders. A significant portion of the case studies reported that landraces are cultivated without a commercial purpose, and in fact are only produced to address domestic consumption needs (Figure 3).

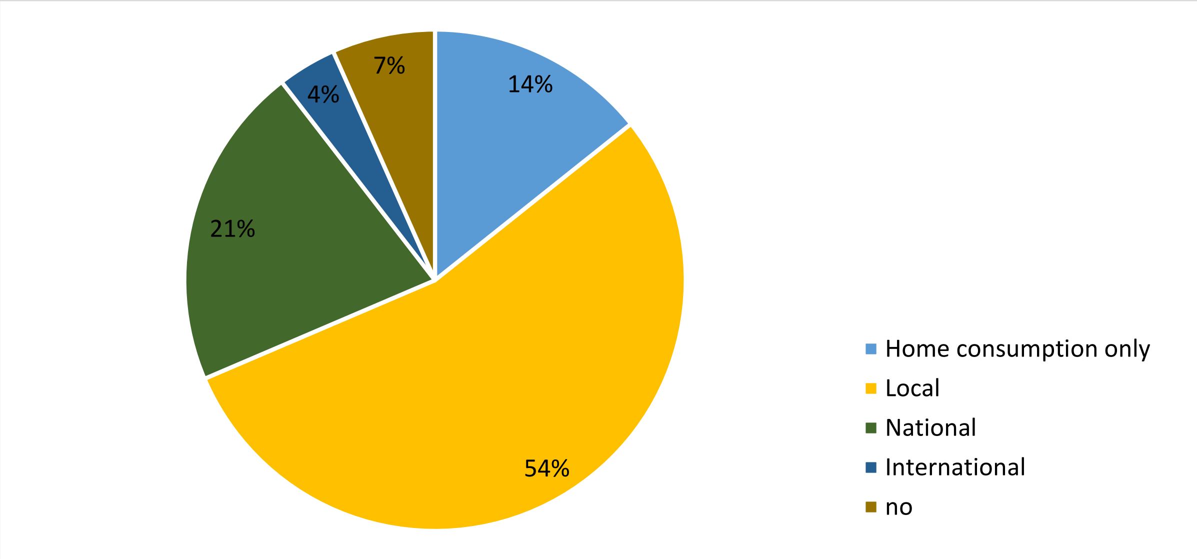

Figure 3. Market extent of 105 *in situ* maintained landraces. 'no' was assigned when no information was available on the market extent

Supporting actions that added value to landrace products

In order to foster conservation, use and market of a certain on-farm conserved landraces, external support appeared to be relevant. In fact, according to information retrieved from the case studies, such support led some to be able to obtain geographical designation, a quality label and/or other commercial brands/designations that helped their products to be placed on the market. In general, most of the analysed resources (77%) were the object of studies or of characterisation aimed at clearly distinguishing landraces from other commercial varieties by showing their peculiar, sometimes unique traits to potential users and consumers. As such, these activities strongly supported and promoted landraces on the market. Indeed, in this context, we recorded the existence of promotion activities for 72% of the resources of which local promotion represents more than half of the analysed cases.

These activities were carried out and/or led by the public sector (Universities, local/national authorities) or private bodies (NGO, local groups). Most of the case studies (82%) did not report any geographical designation associated with the resource. However, a European (10%, e.g. PDO or PGI) or national (8%) geographical designation was reported for other entries. Interestingly, 27% of the food products derived from the analysed cases hold other designations such as quality labels or even commercial brands; only a few entries (5%) hold both a geographical designation and another type of designation/brand at the same time.

From a deeper analysis of the case studies it appears that the use of geographical designations or other designations/brands is of major importance for the success of the product and the extent of its market, as many of this entries are characterised by a good commercial value and a significant market extent. It is also relevant that in most of the cases the acquisition of a designation results from promotional activities supported by various public or private bodies such as national/local authorities, universities, and NGOs.

2.2.4 Accessibility

As from the results of the studied collection of case studies, 21% of the records are registered as “Conservation varieties” (90%), “Amateur varieties” (5%), “Registered populations” and (5%) (European Commission 2008, 2009, 2014), therefore in these cases seed is available on the market. As from some case studies, access to other entries is possible as seed is certainly available on the market (10% of the total), but it was not clearly declared under which legal framework such materials are commercialised. Concerning the other entries, the access to the on-farm/in-garden maintained resources is not clearly defined; in these cases, farmers or farmers’ consortia/organizations should be contacted directly in order to obtain propagation materials. In a number of case studies it is reported that seed can be accessed through local Community Seed Banks (CSBs). However, it is noteworthy to mention that, as from the gathered information, some farmers or farmers’ consortia/organizations appear to be reluctant to exchange or sell propagation material. Regarding this, it should be noted that ownership of genetic resources lie with farmers (*i.e.* those who have conserved and developed the resource across generations). On the other hand, it should also be considered that each country has sovereignty and responsibility over its own PGRs; in addition, according to different national rules, regions/landers can be in charge of managing such resources and consequently having a central role in deciding whether this material can be accessed or not and under which conditions the access can occur.

However, in 61% of the analysed case studies, the resource has already been deposited *ex situ* (i.e. in local, national or international genebank facilities). Access to this material can then occur under the international provisions set by the ITPGRFA and formalised as Standard Material Transfer Agreement (SMTA). Of course, this does not overcome the need to create a mechanism that facilitates and increases direct access to resources conserved on-farm/in-garden rather than *ex situ*. Considering that improving access to *in situ* maintained PGRFA is one of the main objectives of the Farmers’ Pride Project, a relevant coordination with Member States and/or national bodies holding rights on the *in situ* maintained resources is of pivotal importance to improve direct access to them.

2.3 Discussion

From the analysis of the 105 cases, some relevant aspects about the state of on-farm/in-garden management of PGRFA in Europe emerge. A relevant interest in the use of landraces still exists across Europe. It is noteworthy that, according to our data, these resources are mainly cultivated in marginal areas, mainly under low-input or organic conditions. In many of the analysed cases, on-farm conservation of landraces was favoured by numerous activities that were put in place by national, local or private bodies. Such entities had an important role in giving scientific and/or financial support for characterisation and subsequent valorisation. It should be noted that, for most of the analysed resources, several activities related to their valorisation have been/are in place, including the acquisition of geographical designation and/or of other brands that can help to increase their commercial value, making their cultivation attractive for new generations of farmers. These aspects are of great importance to guarantee long-term conservation through use of landraces. However, for most of the collected case studies, the extent of the market is local, while only a few examples of national or international markets have been described; such successful examples of valorisation could certainly be used as models for farmers (or farmers' consortia) interested in selling their products across or outside national borders. Even if product processing has not been specifically analysed in this study, we gathered clear evidence that product processing played a key role in enhancing market extent, product marketability and adding value (e.g. among others: barley "Orkney Bere", great headed garlic "Aglione della Val di Chiana", maize "Nostrano di Storo" and "Olotillo blanco").

Most of the collected case studies demonstrate that farmers (alone or grouped in consortia) are the main actors carrying out multiplication. Notably, the same crops, or crops belonging to the same category, are managed using slightly different multiplication strategies and selection methods that may affect their diversity. Even if diverse practices were observed, the analysed dataset allowed identification of the key propagation management elements that are relevant for different groups of crops also characterised by different mating systems.

Another interesting piece of evidence is that seed companies have a marginal role in carrying out multiplication of on-farm/in-garden *sensu lato* landraces. In this context, the European seed legislation framework offers opportunities to register these materials as "conservation varieties", "amateur varieties" or "registered populations"; as from the analysis of the case studies a small proportion of them take advantage of these potentially beneficial tools; in fact, registration might represent an important means to scale up conservation, use and market of a certain resource in a certain area. Lack of registration could be, among others, one of the main reasons explaining the lack of interest from seed companies in these resources. It is important to mention that the involvement of local seed companies in material multiplication would bring important technical advantages, especially when propagation is expensive due to technical aspects (e.g. plant isolation and seed processing).

Finally, as shown by the results of the case studies analysed, the presence of common management guidelines would help to maximise the level of on-farm/on-garden genetic diversity. The application of minimum standards for the management of material multiplication would not only maximise the level of conserved diversity, but can also help to preserve, to a certain extent, peculiar features that make a certain resource unique and attractive.

3. Recommendations for propagation and diffusion of landraces *in situ*

In this section of the document, guidelines to improve propagation management and diffusion of *in situ* maintained landraces are given. Propagation management recommendations are addressed to landrace *in situ* maintainers and constitute a tool to enhance multiplication strategies with a view to maximise the level of maintained diversity while retaining landrace identity. The subsection, related landrace diffusion, considers both the needs to enlarge the cultivation area of a landrace in the environment of adaptation and outside it. The elements considered to build the guidelines were retrieved through literature review and also considering the evidence arising from the analysis of the case studies presented in the previous section of this document (see 2. Case studies analysis).

3.1 Rationale

An increasing body of literature analyses how farmers can influence phenotypic and genetic diversity of different crops, characterised by different mating systems and evolutionary histories: maize (*Zea mays* L.) in Mexico (Perales et al. 2005; Orozco-Ramírez et al. 2016), potatoes (*Solanum tuberosum* L.) in Peru (Quiros et al. 1992; de Haan et al. 2013), rice (*Oryza sativa* L.) in China (Wang et al. 2016), barley (*Hordeum vulgare* L.) in Ethiopia (Samberg et al. 2013), cassava (*Manihot esculenta* Crantz) in Guyana (Elias et al. 2001), pearl millet (*Pennisetum glaucum* (L.) R.Br.) in Kenya (Labeyrie et al. 2014), sorghum (*Sorghum bicolor* (L.) Moench) in Cameroon (Barnaud et al. 2006) and common beans (*Phaseolus vulgaris* L.) in Italy (Negri and Tiranti 2010) are among the most relevant examples.

From all these literature records, it emerges that farmer seed management plays a strong role in shaping genetic diversity of crop genetic resources. This evidence highlights the importance of considering social, landscape and genetic data into the design of germplasm *in situ* conservation strategies and the role of farmers, in particular (Labeyrie et al. 2014, 2016; Bellon et al. 2017). Even if on-farm conservation relies on the existence of crop evolution under farmer management, there are few scientific studies to date on the genetic consequences that the different multiplication procedures produce on genetic diversity (Enjalbert et al. 2011). It is noteworthy that this lack of knowledge opens space for future studies aimed specifically at understanding how different management practices affect the diversity of different crops in different environmental and socio-cultural contexts. In fact, landraces and their maintainers constitute an important system of interaction between social and biological forces. For any landrace, maintainers – applying their knowledge, preferences, and practices – influence alleles that pass from one generation to the next one.

Understanding and maintaining these systems will certainly improve livelihoods and well-being while favouring equitable mechanisms that allow the society to access these resources and their variability will help to face the challenge posed by the on-going climate change scenario (Bellon et al. 2017).

3.2 Maintenance of landrace identity and within-landrace genetic diversity

Maintenance of landrace identity and diversity is of fundamental importance for landrace *in situ* conservation; maintaining identity implies that parental plants and their progeny should necessarily be characterised by the same phenotypic traits across time (i.e. generation by generation). Actually, possible loss of identity is not an issue that can always be easily overcome as its complexity depends on several factors; in fact, different species – or subspecies within the same species – are characterised by different outcrossing rates: some crop species are predominantly self-pollinating (*i.e.* autogamous), while others are predominantly cross-pollinating (*i.e.* allogamous). Thus, the latter are more prone than self-pollinating crops to receive pollen from other sexually compatible varieties, landraces or wild forms that are cultivated or are naturally present nearby. Therefore, undesired cross-pollinations can result in the progressive loss of landrace identity. In order to cope with this issue, there are several techniques and principles that must be applied to ensure maintenance of landrace identity. Among these, selection of mother plants and their isolation – whether spatial, temporal or mechanical – are the most effective and practicable for landrace maintainers.

On the other hand, maintaining within-landrace population diversity while keeping landrace identity raises the level of complexity even more. Many studies indicated that landrace populations – whether belonging to predominantly autogamous or allogamous species – retain remarkable levels of genetic diversity (Barnaud et al. 2006; Tiranti and Negri 2007; de Haan et al. 2013; Torricelli et al. 2013; Klaedtke et al. 2017). Maintaining such diversity is of pivotal importance to preserve landraces' adaptability potential since diversity is a means to overcome harsh conditions that on-farm maintained landrace populations can undergo across time and space.

To avoid the loss of useful genetic diversity from one generation to the following one, in general, it is recommended to use propagation material from the highest possible number of mother plants; however, the type of propagation (by seed or by scion), the reproductive system (i.e. autogamous or allogamous) and the quantity of propagation material needed condition the correct management of the multiplication/propagation process. Indeed, the way a certain landrace is propagated implies different principles that should be applied in order to preserve within-landrace population diversity.

In the case of clonally propagated landraces – potatoes or most fruit trees – a relatively high number of plants should always be used to produce clones meant to be grown in the same area. Such an approach allows to conserve possible adaptation features due to within-population genetic diversity or epigenetic effects (e.g. the presence of specific or unique epialleles) (McKey et al. 2010). It is also recommended that propagation material of clonally propagated landraces is always collected from mother plants in optimal phytosanitary conditions, to avoid diseases passing from mother plants to their clones. For seed propagated crops, the type of reproduction and the amount of seed needed should be carefully considered.

Regarding the correct *in situ* maintenance of open-field crops, such as landrace cereals and forages, a high number of mother plants is needed to produce seed for the following generation, then it is easy to preserve within-population genetic diversity; however, higher or lower care in avoiding undesired cross-pollinations should be applied in dependence of the reproduction system of the crop. In the case of landraces of open-field allogamous species (e.g. maize), seed should be collected from a high number of carefully selected mother plants (always true to type), being (spatially, mechanically or temporally) isolated from other sexually compatible plants that are present nearby. Indeed, some care is also needed for seed production of predominantly autogamous crops, but less effort is required.

In *in situ* maintenance of landrace garden crops a much lower number of seeds is generally needed; in this case, the maintenance of within-landrace diversity may be more difficult than in open–field crops since gardeners usually collect seed from a few plants and genetic drift[1] operates more intensively on populations of a limited number of plants. Spatial, mechanical or temporal isolation of mother plants is always recommended (although often not easy to be applied). In this group of crops the gardener's decision to maintain a higher or lower level of within-landrace diversity – by applying a higher or lower level of selection on possible mother plants – really plays a key role. Available literature shows that the conscious selection of different farmers cultivating the same landrace plays a major role in preserving its peculiar characteristics and structure (Lanteri et al. 2003; Tosti and Negri 2005; Negri and Tiranti 2010a; Torricelli et al. 2013; Ciancaleoni et al. 2014) so that within-landrace diversity is not only found in the same garden landrace, but also among different sub-populations of the same landrace grown in different home gardens.

In any case this also happens for open-field crops (Pusadee et al. 2009; Bellucci et al. 2013). This evidence suggests that, in order to maintain the highest possible level of within-landrace diversity, it is always recommended that a certain landrace is cultivated by different farmers and gardeners.

3.3 Crop categories and key factors affecting landrace propagation management

3.3.1 Crop categories by propagation

Due to the effects that mating systems (i.e. the way a certain species naturally reproduces) and propagation strategies (i.e. the way farmers reproduce a landrace of a certain species) have on *in situ* maintained diversity of open-field, garden and fruit tree landraces, crop species were classified into six different categories accordingly defined (Table 3). The rationale behind this categorisation harnesses on two respective grounds.

- Garden and open-field landraces are generally characterised by quite different census (i.e. number of cultivated plants) and are cultivated in different agronomic contexts; these two aspects determine the application of different management strategies and farmer selective pressures. The same applies to fruit tree landraces.
- Different mating systems (i.e. autogamy vs. allogamy) or clonal propagation strongly affect landrace diversity and the strategies applied to maintain landrace identity; species characterised by different mating systems should follow different multiplication principles.

[1] Genetic drift (also known as Sewall Wright effect) takes place when the occurrence of variant forms of a gene, called alleles, increases and decreases by chance over time. In small-sized populations, infrequent alleles face great chance of being lost.

Due to the strong consequences of clonal (asexual) reproduction on the management of genetic diversity, both garden- and open-field- clonal crops are presented together.

Table 3. Crop categories and examples of species belonging to each category

Crop category	Crop common names
Sexually propagated	
Garden autogamous	common bean; cowpea; tomato; lettuce; eggplant; pepper; pea; lima bean; faba bean, seed poppy.
Garden allogamous	celery; broccoli; collard; faba bean; turnip; turnip greens cabbage; cardoon; watermelon; zucchini; onion; asparagus; runner bean; swede.
Open-field autogamous	soft wheat; durum wheat; emmer wheat; einkorn wheat; barley; spelt; lopsided oat; grass pea; field pea; pea; spanish vetchling; lentil.
Open-field allogamous	maize; rye; fodder beet; chicory; red clover; white clover; timothy grass.
Asexually propagated	
Garden and open-field clonal	potato*; sweet potato; potato onion*; garlic; great headed garlic; horseradish; jerusalem artichoke.
Tree clonal	apple; pear; peach; plum; common grape vine.

*Landraces of this species are commonly propagated clonally.

3.3.2 Key propagation management elements

According to evidences arising from literature (Cerretelli and Vazzana 2002), from the analysis of the case studies presented in the previous section of this document (see 2. Case studies analysis) and after discussion with Farmer's Pride Partners involved in the related task during the Workshop 2 (Santorini, Greece, October 2019), ten "key propagation management elements" were identified. They are mainly aimed at maintaining the ideotype of the landrace as well as its intrinsic genetic diversity. These elements encompass fundamentals of plant material multiplication, including isolation, selection, circulation/exchange of the material among users, population size, number of users and the extent of the cultivated area (Table 4).

Table 4. Ten key propagation management elements.

Key propagation management elements	Description
Selection	
Of mother plants	Seed or propagation materials are collected from mother plants corresponding to the ideotype.
Of fruits	Seed is selected from fruits better resembling the fruit ideotype.
Of seed	Seed is selected when corresponding to the seed ideotype.
Isolation	
Spatial	Isolation technique based on distancing that is used to reduce/avoid undesired cross-pollinations with other varieties/landraces of the same species.
Mechanical	Isolation technique used to avoid undesired cross-pollinations generally used when spatial or temporal isolation cannot be applied. This approach often involves isolating a plot with anti-insect nets. It can also be applied by removing the plants of other varieties/landraces that are nearby.
Temporal	Isolation technique used to reduce/avoid undesired cross-pollinations with other varieties/landraces that takes advantage of the knowledge of different flowering times.
Plants	
Number of cultivated plants	Cultivation of adequate number of plants avoids undesired effects due to genetic drift.
Cultivated area	Whether the landrace is cultivated in a sufficiently wide area, ensuring that an adequate number of plants grow, avoiding effects due to possible genetic drift.
Farmers	
Material exchange	Material exchange among farmers can affect the level and the structure of the conserved diversity.
Number cultivating the resource	Whether enough actors use and propagate the landrace. This aspect relates to the level of conserved diversity.

Since the 10 identified elements can have different impacts on different *in situ* maintained landraces, their relevance for each of the six identified crop categories was defined by the attribution of a score from 1 = not relevant to 5 = mandatory (Table 5). These scores must be considered as a general indication since differences, among species within the same category, can also be rather high in relation to the considered management elements.

Table 5. Relevance of 'key propagation management elements' according to the defined crop categories. 1=not relevant; 2=can be relevant; 3=relevant; 4=recommended and 5=mandatory

Key propagation management elements	Garden-autogamous	Garden-allogamous	Open-field-autogamous	Open-field-allogamous	Garden- and open-field clonal	Tree-clonal
Selection						
Of mother plants	3	**5**	2	**5**	**5**	**5**
Of fruits	4	2	4	3	1	1
Of seeds	**5**	2	4	3	1	1
Isolation						
Spatial	3	**5**	3	**5**	1	1
Mechanical	1	4	1	2	1	1
Temporal	2	3	2	3	1	1
Plants						
Number of cultivated plants	4	3	**5**	**5**	4	2
Cultivated area	2	2	4	4	2	2
Farmers						
Material exchange	3	2	2	2	4	3
Number cultivating the resource	4	2	2	2	2	3

According to the scores reported in Table 5, the following key propagation management element/s results are particularly relevant (*i.e.* score =5) for each identified crop category as follows:

- Garden-autogamous: selection of seed;
- Garden-allogamous: spatial isolation, selection of mother plants;
- Open-field-autogamous: number of cultivated plants;
- Open-field-allogamous: spatial isolation, selection of mother plants and number of cultivated plants;
- Garden and open-field-clonal: selection of mother plants;
- Tree clonal: selection of mother plants.

3.4 Landrace multiplication guidelines

In the following paragraphs, multiplication management guidelines are given by each crop category, keeping in mind the evidence that emerged from the analysis of the 10 key propagation management elements, and relying on the available bibliographic and empirical evidence. However, these guidelines are not to be considered strictly mandatory, since, as shown in the section above, landraces of the same crop species can be propagated by different farmers using quite different propagation methods. In addition, it should be noted that outcrossing rates can vary a lot, depending on the (*sensu lato*) environmental conditions, in both (predominantly) autogamous and allogamous crops.

3.4.1 Sexually propagated landraces

For each group of sexually propagated landraces (*i.e.* Garden-autogamous, Garden-allogamous, Open-field-autogamous, Open-field-allogamous), outcrossing rates, the recommended minimum distances (from the landrace to other sexually compatible materials potentially present nearby) and the minimum number of mother plants to be used for seed multiplication are reported. For open-field crops, the minimum number of mother plants is expressed as “minimum cultivated area” devoted to seed multiplication.

Regarding the recommended minimum isolation distances to be applied for seed production, such distances are lower for open-field crop species than for garden crops, which is mainly due to two factors: i) the wide cultivation area, that characterises open-field conditions, reduces possible undesired cross pollinations and ii) in open-field conditions, the seed for the following season is commonly harvested from the most spatially isolated portions of the fields (e.g. from the middle).

In general, for sexually propagated landraces, the reproduction of a relatively high number of plants per generation can contribute to minimising the negative effects due to genetic drift (e.g. random fluctuation of allele frequencies from one generation to the next one) resulting in a correct management of the within-landrace genetic diversity.

Therefore, hereafter the suggested minimum number of plants or cultivation area, that is intended to keep within-landrace diversity to a safe level, is reported; a higher number of plants or wider cultivated areas would serve this purpose even better. As for the number of seeds to be collected from each plant of course it strictly depends on the quantity of seed needed for the next cultivation; precise indications cannot be given.

Garden-autogamous

Many species commonly cultivated in-garden belong to this group (e.g. tomatoes, eggplants [aubergines] and common beans). Even if self-pollination is predominant for crops belonging to this category, the cross-pollination rate can be quite different for each species (Table 6), depending on diverse floral morphologies (even within the same species), the presence of pollinators and environmental conditions meant *sensu lato* that there was a need to include farmer choices in managing the garden. It is important to mention that, even if spatial isolation does not play a key role in managing propagation of garden-autogamous crops, that minimum recommended distances must be applied to prevent possible cross-pollination with other sexually-compatible materials cultivated nearby (Table 6).

Table 6. Multiplication management guidelines for a proper *in situ* maintenance of garden-autogamous landraces of different species. Outcrossing rate, recommended minimum distance from other sexually compatible plants and range of minimum recommended number of plants from which to collect seed are reported.

Name, scientific	Name, common	Outcrossing rate (%)	Recommended minimum distance (m)	Range of minimum recommended plants (n)	References
Capsicum annuum L.	Pepper	2-90	50	4-15	Franceschetti 1971; Tanksley 1984; Pickersgill 1997; Cerretelli and Vazzana 2002; Lanteri et al. 2003
Lactuca sativa L.	Lettuce	1-5	3	10-15	Cerretelli and Vazzana 2002; Hooftman et al. 2008
Phaseolus vulgaris L.	Common bean	1-80	50	15-30	Ibarra-Perez et al. 1997; Cerretelli and Vazzana 2002
Pisum sativum L.*	Pea	5-30	20	15-30	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018
Solanum lycopersicum L.	Tomato	2-5	50	4-15	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018
Solanum melongena L.	Eggplant	1-4	100	4-15	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018
Vicia faba L.*	Faba bean	4-84	300	10-25	Cerretelli and Vazzana 2002; Holden and Bond 1960; Link et al. 1994a; Suso and Moreno 1999; Suso et al. 2001; 2008; Gasim et al. 2004

* commonly cultivated also as open-field crop

The occurrence of cross-pollination can increase the level of within-population diversity but, at the same time, it can reduce landrace identity. Then farmer selection for trueness to their own type is recommended, as it is commonly reported. Farmer selection also favours a progressive adaptation of the landrace to specific conditions of each field that can also be quite different. It has been demonstrated that in predominantly self-pollinating landraces, within-population diversity can be rather high (Tosti and Negri 2005; Tiranti and Negri 2007; Negri and Tiranti 2010a; Klaedtke et al. 2017). Scientific evidences also showed that different farmer selection procedures – coupled with micro-environmental selective effects – can structure a predominantly autogamous landrace as a meta-population in which a substantial differentiation may be maintained at the subpopulation level (Tosti and Negri 2005; Tiranti and Negri 2007). In other words, even if cultivating the same landrace, after a sufficient number of generations, different farmers grow significantly different subpopulations of the same landrace. In order to maximise the level of conserved diversity, conservation should consider this possible scenario where all different sub-populations should be conserved. Having a strong effect on landrace genetic structure, seed exchange among different farmers should be tracked and controlled.

Garden-allogamous

Garden-allogamous crops include all cross-pollinating species that are commonly cultivated in-garden. Cross-pollination is generally guaranteed by specific flower morphologies that favour the attraction of pollinators, high pollen mobility and/or genetic mechanisms such as self-incompatibility and male sterility. For this crop category, selection plays a major role in maintaining the ideotype, thus, selection must occur by collecting seed from the best mother plants. Isolation of the proper mother plants is also recommended. Among all possible isolation strategies, spatial isolation should always be applied as it provides a means to avoid undesired cross-pollinations following minimum recommended distances (Table 7).

Table 7. Multiplication management guidelines for a proper *in situ* maintenance of garden-allogamous landraces of different species. Outcrossing rate, recommended minimum distance from other sexually compatible plants and range of minimum recommended number of plants from which to collect seed are reported.

Name, scientific	Name(s), common	Outcrossing rate (%)	Minimum recommended distance (m)	Range of minimum recommended plants (n)	References
Allium cepa L.	Onion	70-100	1,000	10-15	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018; van der Meer and van Bennekom 1968,1972;
Apium graveolens L.	Celery	47-87	500	3-10	Cerretelli and Vazzana 2002; Castellini 2005; Torricelli et al. 2013; Lorenzetti et al. 2018; Orton and Arus 1984; *
Asparagus officinalis L.	Asparagus	100	3,000	15-20	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018;
Beta vulgaris L.	Beet	100	500-1,000	3-10	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018; *
Brassica oleracea L.	Broccoli, cabbage, collard	80-100	600-1,500	3-10	Cerretelli and Vazzana 2002; Ciancaleoni et al. 2014; Lorenzetti et al. 2018; Qi et al 1995;
Brassica rapa L.	Turnip, turnip greens, napa, choy	100	1,000	5-20	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018;

Citrullus lanatus (Thunb.) Matsum & Nakai	Watermelon	65-77	1,000	3-15	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018; Ferreira et al 2000; 2002; *
Cucumis sativus L.	Cucumber	5-87	100	3-15	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018;Wehner and Jenkins 1985; *
Cucurbita spp.	Pumpkin, zucchini	75-100	1,000	3-15	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018;Enriquez et al. 2018; *
Daucus carota L.	Carrot	98-100	1,000	5-10	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018; Koul et al 1989;
Foeniculum vulgaris L.	Fennel	Up to 100**	800	5-10	Cerretelli and Vazzana 2002; Gross et al. 2008; Salami et al. 2016;
Phaseolus coccineus L.	Runner bean	19-60	500	10-25	Cerretelli and Vazzana 2002; Spataro et al 2011; Mercati et al 2015
Spinacea oleracea L.	Spinach	100	1,000	30	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018; ***
Vicia faba L.	Faba bean	4-84	300	10-25	Cerretelli and Vazzana 2002; Lorenzetti et al. 2018 Holden and Bond 1960; Link et al. 1994a; Suso and Moreno 1999; Suso et al. 2001; 2008; Gasim et al. 2004;

*Also personal communication of V. Negri (University of Perugia, Italy). **The outcrossing rate of this species is highly variable. ***Also personal communication of C. Kik (Centre for Genetic Resources, Wageningen University and Research, the Netherlands).

Alternatively, when a low number of mother plants is selected, mechanical isolation can also be considered (e.g. as for broccoli or celery). There are evidences that even if a low number of mother plants is selected each generation, as happens in species that produce a high number of seed per plant like celery and broccoli, a rather high level of genetic diversity can be maintained (Torricelli et al. 2013; Ciancaleoni et al. 2014).

Open-field-autogamous

This category includes all self-pollinating species open-field grown among which there are cereals and some legumes of great economic importance. Even in this category of crops cross-pollination may occur, but at low rates (Table 8). Cross-pollination rates also depend on some characteristics of the environment where the landrace is cultivated. Accordingly, for this crop category, no isolation is generally applied; spatial isolation – that can mostly be achieved with minimal costs – can help to maintain landrace identity and, consequently, its peculiar characteristics. Minimum recommended distances for some of the major crops belonging to this category are reported in Table 8.

Table 8. Multiplication management guidelines for a proper *in situ* maintenance of open-field autogamous landraces of different species. Outcrossing rate, recommended minimum distance from other sexually compatible plants, range of minimum cultivated area along with the minimum area (%) devoted to landrace multiplication.

Name, scientific	Name, common	Outcrossing rate (%)	Minimum recommended distance (m)	Minimum recommended cultivated area (m^2)	Minimum area devoted to landrace multiplication (%)*	References
Avena sativa L.	Oats	0.5-2.4	4-8	3,000	4-10	Grindeland and Frohberg 1966; Mipaaf 1971; Lorenzetti et al. 2018;**
Hordeum vulgare L.	Barley	1.6-4.3	4-8	3,000	4-10	Mipaaf 1971; Tsegaye 1996
Lens culinaris Medik.	Lentil	2.2-6.6	15-20	1,500	10-15	Erskine and Muehlbauer 1991; Cerretelli and Vazzana 2002
Triticum aestivum L. subsp. *aestivum*	Soft wheat	1-4	4-8	3,000	4-10	Mipaaf 1971; Lorenzetti et al. 2018
Triticum monococcum L. subsp. *monococcum*	Einkorn wheat	1-4	4-8	3,000	5-10	Mipaaf 1971; Lorenzetti et al. 2018
Triticum turgidum L. subsp. *durum*	Durum wheat	1-4	4-8	3,000	4-10	Mipaaf 1971; Lorenzetti et al. 2018

*The suggested percentage is intended to obtain an amount of seed that is sufficient for the landrace cultivation on the same area (m^2) in the following growing season. **Also A. Katsiotis (Cyprus University of Technology) personal communication.

Selection is recommended to maintain landrace identity, good agronomic performances – in terms of yield and other peculiar characteristics of the resource – and good phytosanitary conditions of the propagation material. Depending on the edible/processed part, selection can be carried out on fruits (caryopses for cereals) or seeds especially for legume crops such as lentils. Interestingly, the selection of the best caryopses harvested on the best plots, rather than selecting the best plants scattered over a wide cultivation area, was reported for cereals in some of the analysed case studies (Figure 4).

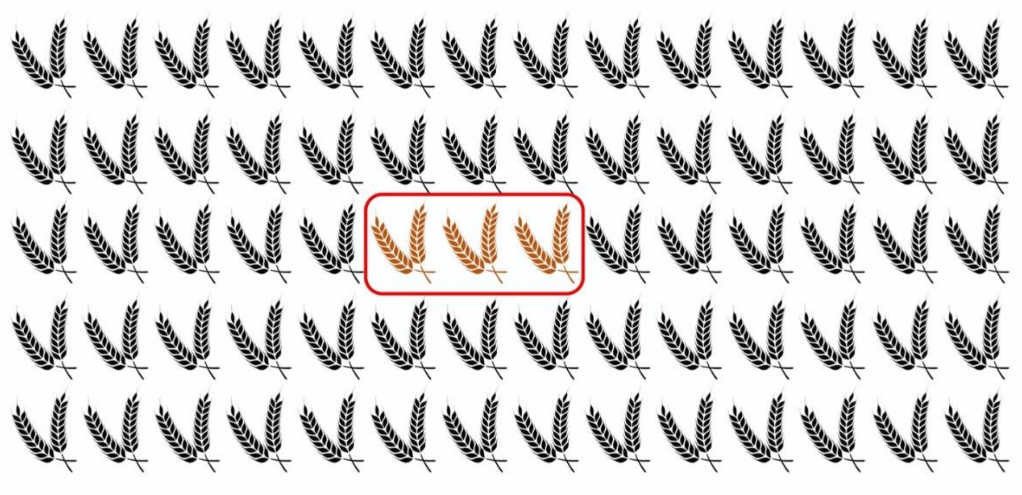

Figure 4. Seed for the next generation is collected from all the plants (orange) growing in the inner part of the field devoted to landrace multiplication (delimited by a red line).

Considering species propagated via seed, open-field-autogamous are those requiring relatively lower efforts when compared to other crop categories. Generally, for open-field crops, it is not useful to recommend a specific number of plants to be used for seed production but a percentage of the total number of the grown plants. However, for cereals like wheat it has been suggested that a minimum of 30,000 plants should be multiplied to reduce possible undesired effects due to genetic drift that could negatively affect the level of within-landrace maintained diversity (Enjalbert et al. 1999; Goldringer et al. 2006).

Open-field-allogamous

In open-field allogamous species, pollen mobility must be carefully considered to attain proper plant isolation; in fact pollen mobility can be highly different in different species or groups of species. When compared to other methods, spatial isolation is the best practice to avoid undesired cross-pollinations, in fact, the application of other isolation techniques (e.g. mechanical) to an open-field crop implies high costs. Recommended minimum isolation distances for propagation of landraces belonging to different open-field allogamous species are reported in Table 9. As shown in the case studies, temporal isolation can also be considered, in particular in certain agro-environmental situations (Bellon and Brush 1994). Since flowering is affected by different environmental factors, a minimum temporal separation of flowering of about four weeks – between the landrace and other materials cultivated nearby – is highly recommended to avoid undesired cross-pollination events (Cerretelli and Vazzana 2002).

As for garden-allogamous crops, seed collection from the best mother plants is a key procedure to maintain landrace identity and its peculiar characteristics: this is of fundamental importance for maize landraces where the selection of individual mother plants is possible (Box 1), while this selection level cannot be generally applied to other species in this category (i.e. forage crops). In order to maximise the level of retained diversity while maintaining landrace identity, seeds should always be selected from a high number of mother plants resembling the ideotype (Serpolay-Besson et al. 2014; Mendes-Moreira et al. 2014).

Also, for this group of crops it is not useful to recommend a specific number of plants to be used for seed production, but a percentage of the total number of plants grown. A schematic representation of this selection process for maize is presented in Figure 5.

Box 1 The Italian maize (*Zea mays* L.) landrace "Nostrano di Storo"

The maize landrace "Nostrano di Storo" is cultivated in the "Chiese" valley (Province of Trento, Italy). Within the cultivation area, more than 100 farmers are grouped in a cooperative that provides members with multiple services, including seed multiplication. In fact, the cooperative oversees the entire seed multiplication process: every year, some of the members (especially the ones holding long-time expertise) select a fraction of their fields in which they carry out manual harvest of the ears by discarding plants not corresponding to the 26 morphotypes constituting the landrace "Nostrano di Storo".

To avoid possible cross-pollination with maize hybrid-varieties (or other varieties) the selected fields are likely to be surrounded by "Nostrano di Storo" itself or different crop species, ensuring proper isolation distances. After harvest, the ears are carefully tied together and dried. When kernel humidity reaches ideal values, farmers and experts of the cooperative select the ears according to colour, size, appearance, and number of rows. Once the best ears are chosen, only seeds located in the central part of the ear are kept. The seeds are than bulked together and distributed to all members. Such systematic management of seed production ensures preservation of landrace identity along with within-landrace genetic diversity.

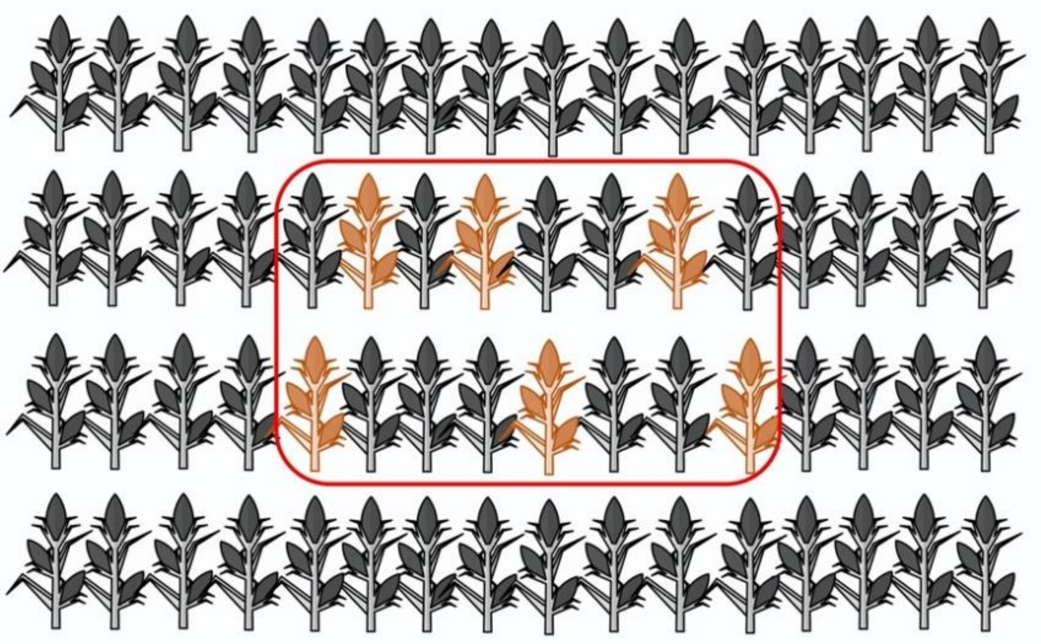

Figure 5. Scheme representing possible actuation of selection of a maize landrace. Seed collection from the best mother plants (orange) grown in the area devoted to landrace multiplication (delimited by a red line) and placed in the inner part of the fields.

Table 9. Multiplication management guidelines for a proper *in situ* maintenance of open-field allogamous landraces of different species. Outcrossing rate, recommended minimum distance from other sexually compatible plants, range of minimum cultivated area along with the minimum area (%) devoted to landrace multiplication.

Name, scientific	Name, common	Outcrossing rate (average %)	Minimum recommended distance (m)	Minimum recommended cultivated area (m^2)	Minimum area devoted to landrace multiplication (%)*	References
Dactylis glomerata L.	Cock's-foot	100	200	2,000	10-15	Mipaaf 1971; Lorenzetti et al. 2018
Lolium perenne L.	Ryegrass	100	200	2,000	10-15	Mipaaf 1971; Lorenzetti et al. 2018
Medicago sativa L.	Alfalfa	80	200	2,000	5-10	Mipaaf 1971; Lorenzetti et al. 2018
Phleum pratense L.	Timothy-grass	100	200	2,000	5-10	Mipaaf 1971; Lorenzetti et al. 2018
Secale cereale L.	Rye	50	300	2,000	5-10	Mipaaf 1971; Lorenzetti et al. 2018
Trifolium pratense L.	Red clover	60-80	200	2,000	10-15	Mipaaf 1971; Lorenzetti et al. 2018
Trifolium repens L.	White clover	100	200	2,000	10-15	Mipaaf 1971; Lorenzetti et al. 2018
Zea mays L.	Maize	95	200	1500	1-3	Mipaaf 1971; Lorenzetti et al. 2018, **

*The suggested percentage is intended to obtain an amount of seed that is sufficient for the landrace cultivation on the same area (m^2) in the following growing season. ** Also 'Mais di Storo' case study.

3.4.2 Asexually propagated landraces

When compared with sexually propagated, maintaining identity and possible genetic diversity requires less effort in landraces of asexually propagated crop species. For the category "garden- and open-field clonal" outcrossing rates, and minimum number of mother plants to be used for vegetative propagation are reported. Since it is quite common that few individual trees are maintained *in situ* – or in some cases only a single tree only – no minimum requirements are given for this category.

Garden- and open-field clonal

For this crop category, the most relevant management practice is a wise selection of mother plants from which propagation materials are collected. To obtain vigorous and healthy clones, it is always recommended that propagation material is obtained starting from multiple mother plants in optimal physiologic and phytosanitary conditions. The minimum recommended number of mother plants for clone production is reported in Table 10. Since a low within-landrace diversity is expected for landraces belonging to this group of crops, material exchange among farmers should always occur; in addition, cultivation of a high number of plants can contribute to maintain a proper level of landrace diversity *in* *situ* (McKey et al. 2010). It is also relevant to mention that mother plants historically grown in certain pedo-climatic conditions should always be used to produce clones to be grown in the same area. Such an approach would allow it to be possible to conserve adaptation features due to epigenetic effects (e.g. specific or unique epialleles) (McKey et al. 2010).

Table 10. Multiplication management guidelines for a proper *in situ* maintenance of garden- and open-field clonal landraces of different species. Range of minimum plants from which propagation material should be selected.

Name, scientific	Name, common	Range of minimum recommended number of plants from which to collect propagation material	References
Allium sativum L.	Garlic	15-20	McKey et al. 2010*
Allium ampeloprasum L.	Great headed garlic	15-20	McKey et al. 2010*
Armoracia rusticana Gaertn.	Horseradish	20-30	McKey et al. 2010*
Cynara cardunculus L.	Artichoke	10-20	McKey et al. 2010*
Helianthus tuberosum L.	Jerusalem artichoke	20-30	McKey et al. 2010*
Ipomea batatas (L.) Lam.	Sweet potato	20-30	Diniz et al. 2006**
Solanum tuberosum L.	Potato	20-30	Diniz et al. 2006

*Following the principals in McKey et al. 2010. ** Adapted from Diniz et al. 2006.

Tree-clonal

The accurate selection of mother trees is the key management element to carry out a proper propagation of tree-clonal crops. In fact, propagation organs must only be obtained from mother plants unambiguously identified (i.e. true to type) as the corresponding landrace. Also the phytosanitary conditions of such plants must be carefully monitored as different pathogens (viruses, bacteria and fungi) can be easily spread through asexual propagation; when mother plants show any disease symptom or sign, micro-propagation of primary meristems must be considered for the production of pathogen free new landrace clones. Moreover, even if more than one true to type landrace individual is known, it is highly recommended to obtain propagation material from the maximum possible number of individuals. The application of such a principle can maximise the level of conserved diversity (Figure 6). Clones from a single plant should only be produced when no other true to type individuals of the same landrace are known. In fact, a large cooperative of northern Italy, specialised in the propagation of fruit tree landraces, reported that, when possible, clones are obtained from several mother plants in order to preserve and propagate (at least part of) the existing clonal diversity.

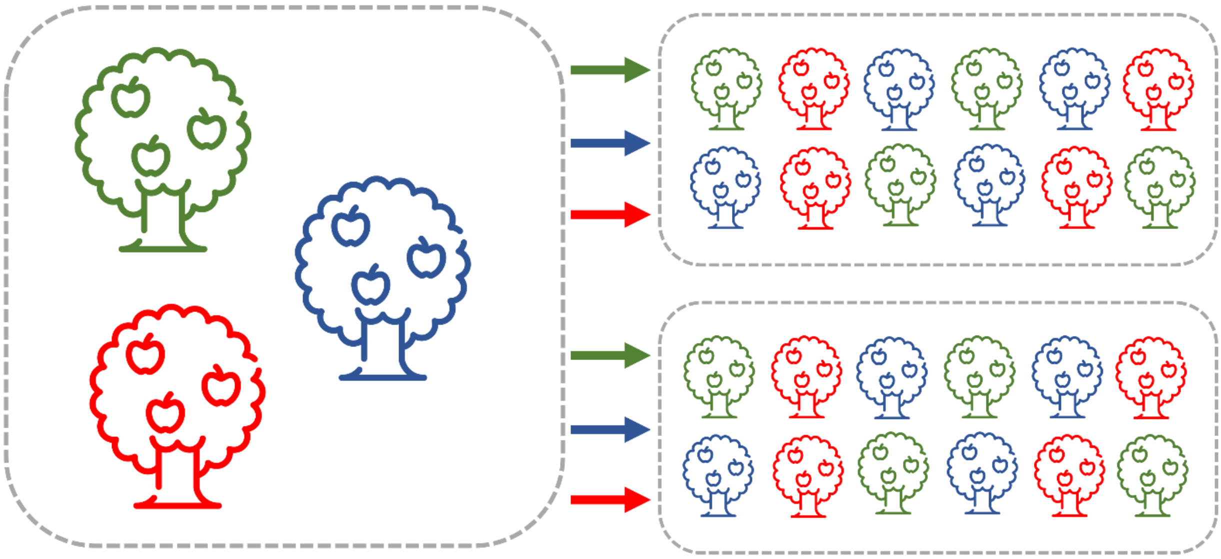

Figure 6. **Scheme representing possible actuation of the diffusion of a clonally propagated fruit tree landrace. In the scheme, three different individual mother trees, true to type (green, red, and blue, left side) represent the existing clonal diversity. The three mother-trees are used to produce clones to be planted in new orchards (right side).**

Also in this case, clones, historically grown in certain pedo-climatic conditions should always be used to produce clones to be used in the same area, or at least in areas characterised by same pedo-climatic characteristics.

3.5 Guidelines for a management plan of landrace diffusion in the adaptation area

As noted in the first section of this document (2. Case studies analysis), no formal multiplication management plan exists for most of the *in situ*-maintained landraces across Europe. However, it emerges that some informal, but well-detailed management procedures are applied for seed multiplication of some *in situ* maintained landraces, as in the case of the Italian *Nostrano di Storo* maize landrace (Box 1).
In this section (3. Recommendations for managing landraces *in situ*) guidelines and principles for the multiplication of landraces belonging to the six defined crop categories (i.e. Garden-autogamous, Garden-allogamous, Open-field-autogamous, Open-field-allogamous, Garden- and open-field-clonal and Tree-clonal) have been discussed; minimum requirements to ensure preservation of landrace identity and within landrace genetic diversity are also given. This set of information should be used as a starting point to draw a proper management plan for seed multiplication of different garden and open-field, autogamous or allogamous landraces as well as for managing clonal propagation in different crops.

Further indications can be given on how to diffuse a landrace cultivation within its adaptation area, when it runs the risk of disappearing. This is particularly relevant when a landrace is cultivated by a few farmers or a single farmer and there is then the need to pass the landrace itself from hand to hand within its adaptation area. Figure 7 summarises how this process can be carried out: a single farmer donates his/her seed to neighbouring farmers who are willing to cultivate the landrace and the latter, in turn, donate their own propagated material to their neighbours and so on, so to favour a progressive diffusion and adaptation of the landrace in its original area of cultivation.

The number of seeds to be used for this action of landrace diffusion from a farmer to another, depends of course on the species, as mentioned above, and it can be recommended that the seed sample is a representative sample of the multiplication material of the farmer donating materials. It should also be recommended that not only seeds, but also skills are passed from one farmer to another. Some further indications can be found in the Italian *Linee guida per la conservazione e la caratterizzazione della biodiversità vegetale di interesse per l'agricoltura* (Guidelines For Conservation and Characterisation of Agricultural Biodiversity) (INEA 2013).

In many on-farm systems local seed exchange is already a regular component of the system, however, seed exchange to sites outside the adaptation area should be avoided as it inevitably results in genetic modification of the original landrace genetic profile (i.e. loss of identity) and potential loss of genetic diversity.

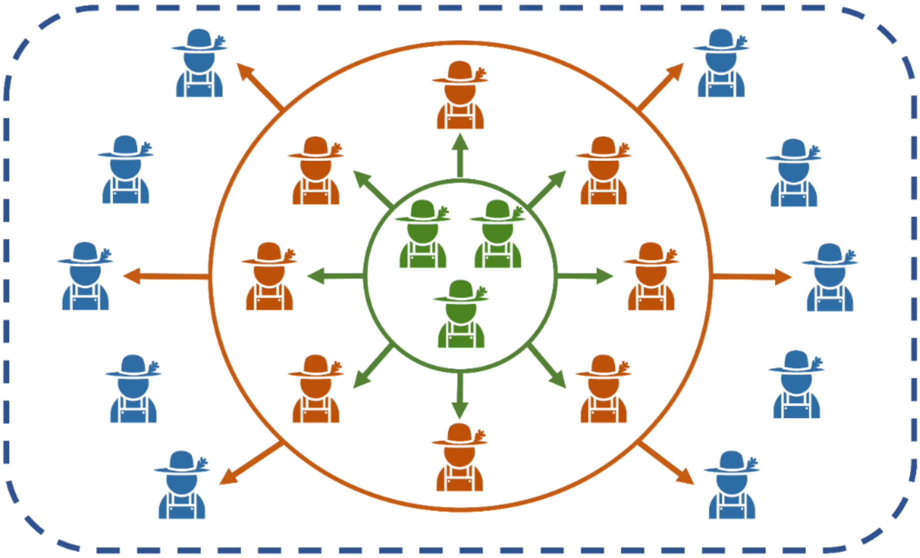

Figure 7. Scheme representing possible actuation of diffusion of a landrace within its adaptation area (dotted blue line). Single farmers that initially keep the resource (central nucleus in green) donate propagation material to neighbouring farmers (dark orange) that wish to cultivate and multiply the resource continuously over time. The latter in turn do the same with their neighbours (blue).

3.6 Guidelines for a management plan of landrace diffusion outside the adaptation area

When the introduction of a landrace into a different cultivation area is envisaged, recommendations are different and mostly concern the sample of seed (or other propagation material) that should be used for the introduction. In this case, considering that the environment will probably be different from the original one, it is recommended that the multiplication material, and seeds especially, do not come from a single farmer, but from as many farmers as possible. In fact, as already stated in the present section of this document, each landrace is often made up of different subpopulations, each of them, in turn, characterised by different allele frequencies as well as alleles.

It can also be suggested for new introductions, that a pool of landraces from different areas is used with possibly the most similar environmental conditions to the proposed introduction environment, instead of a single landrace. In fact, the use of a wider allele pool can favour adaptation into the new area, where selection pressures are different from the original ones: some alleles will be favoured, but others will be eliminated by selection. The rationale for this procedure lies in the fact that, at present, very little information on adaptive advantages of single alleles in a crop, and in relation to selective pressures of a certain environment, is available.

Of course, this procedure implies that some time is needed to reach full adaptation of introduced material to the new environmental and farming conditions.

4. Recommendations for having access to *in situ* landrace propagation materials

The analysis of case studies showed that the accessibility of propagation material of landraces maintained *in situ* is mostly conditioned by the willingness of farmers to share propagation materials, which does not appear to be granted. This is amply justified by the fact that many farmers make part of their income from cultivating unique landraces and are *de facto* owners of the landrace (FAO, 2001). Quite often, farmers or farmers' consortia/organisations should be contacted directly and asked to obtain propagation materials. Only in a few cases it is reported that landrace propagation materials can be easily accessed through local Community Seed Banks (CSBs) as for the Mátrafüred, Fadd and Máriapócs tomato and the Markóci bean from Hungary.

However, most of the entries are reported to be deposited *ex situ* and might be accessible from public genebanks under the criteria set by the International Treaty of on PGRFA, through the so-called Standard Material Transfer Agreement (SMTA) that ensures farmers' rights (access to *ex situ* accessions). It should be noted though that each country has sovereignty and responsibility over its own PGRs; according to different rules, National and/or Regions/Landers decide whether *in situ* landraces can be accessed or not and under which conditions. To provide access to landrace seed via local or national *ex situ* facilities is then readily possible, but at the same time a controversial option. Strategies that can favour direct access to *in situ* conserved resources (i.e. direct exchange between keepers and other stakeholders) appear to be needed that consider country legislation. They must certainly ensure all farmers' rights, which were established by the International Treaty of PGRFA. This approach might ensure the access to *in situ* resources among keepers and other stakeholders, rather than access to old-stock accessions.

The analysis of case studies also showed that seed companies generally have a marginal role in producing landrace propagation material, possibly due to a restricted market for landraces and problems related to registration of the landraces within the context of the present seed regulations. On the contrary, the involvement of local seed companies could bring important technical advantages, especially when propagation is rather expensive due to technical aspects of seed production or plant propagation. In this context, it should be noted that the European seed legislation framework offers several possibilities to register landraces as "conservation varieties" or "amateur varieties" and other heterogeneous materials as "registered populations" (European Commission, 2008, 2009, 2014). These opportunities should be better used to favour *in situ* maintenance of landrace diversity (Spataro and Negri, 2013). As from the analysis of the case studies, a small proportion of landraces take advantage of these potentially beneficial tools. Registration might represent an important means to scale up conservation, use and market of a certain landrace in a certain area provided it is granted with no (or little) registration costs by the country. To promote access to *in situ* maintained landraces then, it can also be recommended that countries put in place measures to facilitate their seed registration.

Finally, it is to be noted that the situation is under development since European Biodiversity Strategy (2020) considers to facilitate the use of “traditional varieties of crops” also through a revision of the European seed market legislation.

5. Conclusions

Landrace diversity is of undoubted value for the present and the future of agriculture. The recommendations presented in these last sections of the document are addressed to those who keep maintaining landraces or are interested in starting landrace cultivation. A proper *in situ* maintenance of landraces, also taking in mind their identity, lays foundation on the need to ensure their continued evolution across time.

All the recommendations presented here must not be considered as mandatory, since in some cases they may not be exactly applied, instead they are aimed to inspire correct principles to be applied when cultivating, propagating and diffusing landraces.

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Annex I

Accessibility

The European legislative framework: a brief overview

Accessibility of *in situ* maintained landraces represents a great challenge due to some limitations arising from the current European legislative framework. In 1998, the European Union first introduced the issue of *in situ* conservation of plant genetic resources into its seed legislation, aiming to establish specific conditions under which "seed may be marketed in relation to the conservation *in situ* and the sustainable use of plant genetic resources"(European Community 1998). This Directive was not binding, leaving each member state free to decide whether or not they want to impose specific conditions on the marketing of *in situ* maintained resources. After long negotiations about mechanisms to be used to implement the directive the EU finally published Directives and Decisions on the matter, in particular:

- **Directive 2008 /62/CE of 20 June 2008** (European Commission 2008)

  Besides providing the definitions of "conservation *in situ',* "genetic erosion" and "landrace", this directive defines criteria and requirements for the acceptance of landraces and varieties as conservation varieties, with particular regard to the historical linkage to their region of origin, and establishes rules for the marketing, certification and official post controls; it also establishes quantitative restrictions of the seed marketed yearly for each conservation variety (Spataro and Negri 2013).
- **Directive 2009 /145/EC of 26 November 2009** (European Commission 2009)

  This directive is divided into two parts:
  - The first part defines requirements for acceptance to registration, marketing conditions, denomination, certification, and controls of conservation varieties.
  - The second part is addressed to the vegetable varieties with no intrinsic value for commercial crop production, otherwise known as "amateur" varieties, where disposals about these resources are less restrictive than those established for conservation varieties. In fact, no region of origin, nor geographic restrictions for their marketing, are established.

  It is to be noted that the definition of "conservation variety" given in both 2008/62/EC and 2009/145/CE makes old conventional varieties – deleted from the Common Catalogue for a period of at least two years – eligible to be registered as conservation varieties (Spataro and Negri 2013).
- **Directive 2010 /60/EU of 30 August 2010** (European Commission 2010)

  This Directive focuses on fodder "preservation mixture" for the purpose of recreating and preserving natural habitats. Indeed, it favours preservation of ecotypes in their relative adaptation environments.

- **Implementing Decision 2014/150/EU of 18 March 2014**

  This Implementing Decision introduces derogations for the marketing of populations of wheat, barley, oats, and maize. This de facto allows commercialisation of heterogeneous populations that could not meet the Distinctness Uniformity Stability (DUS) criteria required by the European seed legislation.

The "informal seed system" in Europe

Since the early 1980s, many initiatives around the world favoured the establishment of "Community Seed Banks" (CSBs) as fundamental units of the so-called "informal system". Their general objectives are to safeguard agrobiodiversity and favour access/exchange of traditional plant materials within certain areas. The principals behind the activities of CSBs rely on the facts that the seed of not registered landraces is not easily found and accessed, some farmers wish to be free from what they feel being the unfair conditions posed by the seed companies or have the simple desire of preserving local biodiversity. Nowadays, many European CSBs operate as regional or national networks favouring access and exchange of underutilised plant materials to the user community. Currently, many CSBs and networks are legally formalised as foundations. Such entities are important frames that constitute different regional platforms fostering and favouring landrace access to the user community.

Other initiative for the wide diffusion of PGRFA are those of the different "Seed savers" which often do not have a proper CBS, but exchange several types of materials to affiliates, including landraces.