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European landraces: on-farm conservation, management and use

M. Veteläinen, V. Negri and N. Maxted (Eds)

European Cooperative Programme for Plant Genetic Resources

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European landraces: on-farm conservation, management and use

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Bioversity International is an independent international scientific organization that seeks to improve the well-being of present and future generations of people by enhancing conservation and the deployment of agricultural biodiversity on farms and in forests. It is one of 15 centres supported by the Consultative Group on International Agricultural Research (CGIAR), an association of public and private members who support efforts to mobilize cutting-edge science to reduce hunger and poverty, improve human nutrition and health, and protect the environment. Bioversity has its headquarters in Maccarese, near Rome, Italy, with offices in more than 20 other countries worldwide. The organization operates through four programmes: Diversity for Livelihoods, Understanding and Managing Biodiversity, Global Partnerships, and Commodities for Livelihoods.

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Cover illustration: Mr Raffaele Latassa harvesting seed of a local leafy kale (*Brassica oleracea*) at his garden in Bivongi, Calabria, Italy. Courtesy of © Lorenzo Maggioni, Bioversity International.

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Introduction to the Series

The Technical Bulletin series is targeted at scientists and technicians managing genetic resources collections. Each title will aim to provide guidance on choices while implementing conservation techniques and procedures and the experimentation required to adapt these to local operating conditions and target species. Techniques are discussed and, where relevant, options presented and suggestions made for experiments. The Technical Bulletins are authored by scientists working in the genetic resources area. Bioversity welcomes suggestions of topics for future volumes. In addition, Bioversity would encourage, and is prepared to support, the exchange of research findings obtained at the various genebanks and laboratories.

Contents

Foreword

The need to develop work on on-farm conservation of crop genetic diversity in the form of traditional crop varieties, or landraces (in the sense of Harlan) is emphasized in the Convention of Biological Diversity (CBD), Agenda 21, and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), all of which confirm on-farm conservation as an essential component of sustainable agriculture. The adoption of the CBD Programme of Work on Agricultural Biodiversity in 2000 (Decision V/5, annex 5) has substantially expanded the work on on-farm conservation throughout the world, including in Europe.

Efforts to measure landrace diversity within European production systems have shown that crop landraces are not only complex and highly varied in their genetic structure, but dynamic and evolving entities, characteristics that are now being recognized in designing policies to support their maintenance. Increasingly, attention is now being paid to how increasing the levels of genetic diversity within production systems can be a means of reducing risk to changes in pest and disease and precipitation regimes, particularly in light of the predicted effects of climate change.

Actions are being taken in Europe to make landraces more competitive with modern varieties. Interventions to increase competitiveness have included better characterization of local materials, improvement through breeding and processing, greater access to materials and information, increasing consumer demand, and more supportive policies and incentives.

One area of importance in the on-farm conservation of landraces has been the recognition of the central importance of maintaining local seed systems. Significant work has been undertaken to understand the value of local seed systems, including investigating ways that allow continual migration and selection of landrace populations to generate the qualities needed in local planting materials.

A second important element in European landrace conservation efforts has been the collaboration between partners from the formal and informal sectors, with the best results driven by a clear appreciation of the central role of the farmer in managing crop genetic diversity. These programmes have given importance to adopting working practices that are fully participatory and start from a desire to reflect farmers' needs and concerns in diversity management.

This Technical Bulletin provides a wealth of information on landrace inventories in Europe, on landrace management within a European context, and the promotion of landrace use, together with the development of European national policies to support the conservation and use of landraces in production systems for sustainable agriculture.

Devra Jarvis
Bioversity International

Section 1 - Introduction

1. European Landrace Conservation: an Introduction

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1.1 Establishing the context

European agriculture, like agriculture of other areas of the world, went through a significant change during the twentieth century. At the beginning of the last century the population was largely rural and agriculture was based on traditional systems, where most of the productive factors (seed included) came from the farm itself. At present, the percentage of the population involved in agriculture is less than 4% and agriculture is a sort of industrialized process based on productive factors which mostly come from outside the farm (machinery, fuel, chemicals and seeds of cultivars that were developed by smart breeding techniques). As for seed in particular, genetically uniform commercially bred cultivars now dominate agricultural production in Europe. They have generally replaced the more genetically variable crop varieties traditionally grown by European farmers, but have not completely wiped them out.

Traditional crop varieties, generally known as 'landraces', but also called 'farmer varieties', 'local varieties', or 'primitive varieties', have been continuously maintained by European people within their local biological, cultural and socio-economic context.

This volume, although far from giving an exhaustive picture, aims to acknowledge the existence of landraces in Europe, to point out their importance and to safeguard needs and show activities that can promote their wider use in agriculture.

In the past, at each harvest, farmers used to save a proportion of seed of their crops for sowing and cultivation, and these cycles had been repeated for millennia. As environments, as well as the people who live within them, are different in different agricultural areas, many landraces of a crop were developed within a certain region after domestication or introduction. In addition, farmers tended to

suit the intra-farm multiple eco-agricultural conditions by growing a diverse range of landraces per crop. Farmers selected different types, characterized by different ripening times, destination uses, local taste preferences, winter-hardiness and other characteristics, so that more than one landrace was often developed on their farms. This is reported for the areas of domestication as well as for the areas of secondary introduction of a crop (Brush 1992, 1995; Bellon and Brush 1994; Bellon 1996; Jarvis et al. 2008), although with differences linked to country and crop characteristics. For example, in Central Italy, where many landraces of different crops are still cultivated on the farm, each individual farmer often maintains several distinct landraces per vegetable crop (Negri and Tosti 2002; Negri 2003), while in Finland, where eco-agricultural conditions on an individual farm are more uniform, usually only one landrace is cultivated for household needs, especially in the case of cereals (Heinonen and Veteläinen 2007).

When landraces are used, between- and within-landrace diversity continues to evolve because of the natural and human selective pressures. However selection does not lead to genetic uniformity and each landrace in itself is highly genetically diverse (i.e. different genotypes constitute a landrace). Among- and within-landrace diversity had been the key to agriculture's food security for generations. The mix of landrace diversity has allowed (and still allows) farmers to service a diversity of needs and purposes and to obtain a harvest whether the year is dry or wet, or whether there is a pest or disease attack, as some genotypes will be affected each year but not all of them (Harlan 1992; Jarvis et al. 2008).

With the modernization of agriculture modern varieties were created, and as Esquinas-Alcazar (1993) wrote "*The heterogeneous varieties of the past have been and still are the plant breeder's raw material. They have been a fruitful, sometimes the sole, source of genes for pest and disease resistance, adaptation to difficult environments, and other agricultural traits like the dwarf-type in grains that have contributed to the green revolution in many parts of the world*".

The first 'modern' varieties were bred in maize and wheat (in the USA and Italy, respectively) in the early 1900s. Since then, breeding activities have increased, involved other species, and continued to take advantage of the progress made in genetics (see a critical review on the topic in Gepts (2002)). Modern varieties are bred to be genetically uniform (they are often pure lines or F1 hybrids) to maximize production ability under those inputs that make the environment best suited to the crop (irrigation, fertilization, pest control, etc.) as well as to meet the increasing demands of mechanized harvesting and handling, and meet supermarket quality controls. The high yielding modern varieties represent the

most spectacular success of genetics applied to agriculture and have contributed to alleviating the historic rural poverty. From the early 1900s to now, wheat productivity has increased from an average of 1.2 t ha^{-1} to 4 t ha^{-1} in Europe (and over 10 t ha^{-1} has been recorded in some countries) and about half of this increase is estimated to be due to breeding activities (Grigg 1994). It is also because of their good yielding performances (at least in some agro-ecosystems) that modern varieties have taken over from the genetically variable, often lower yielding, locally adapted strains or landraces in the fields of farmers. Thus uniformity replaced diversity, and is still replacing it.

This alarms both geneticists and breeders, since lack of diversity severely impairs the future improvement of crops and/or limits the possibilities for facing new production constraints. Breeding for uniformity is an Achilles' heel for the cultivars, in that if the disease or pest evolves to overcome the resistance bred into the cultivars, significant production loss results. Famously this battle was lost in the mid-1800s in Ireland. An infection of late potato blight (*Phytophthora infestans*) wiped out the potato crop, which led to the Great Potato Famine of 1845-49, and the starvation and emigration of millions. The existing varieties of potato at that time had no resistance to *P. infestans*, but resistance has subsequently been found in several wild potato species, particularly *Solanum demissum* from Mexico (Hawkes et al. 2000). If the plant breeder is to maintain the upper hand, he or she must maintain access to as wide a genepool as possible and attempt to avoid detrimental genetic uniformity, which is referred to as genetic vulnerability. This need of the breeder to utilize the broad genepool is essentially a paradox, which may be seen as a fundamental confrontation between conservation and development. Plant breeders develop better and higher yielding varieties which unwittingly cause the loss of genetic diversity; on the other hand these same plant breeders are dependent upon the availability of a broad genepool of diverse genetic material for success in their work. The loss of genetic diversity within crop plants, although not accurately documented, is believed to be extensive and therefore there has been increasing realization of the need actively to conserve the crop genepool.

Beside the obvious practical breeding and conservation consequences of the loss of landrace genetic diversity, scholars of human sciences are also alarmed because of the loss of crop-related culture. This culture can be of use not only in breeding activities, but also for developing further culture within the community (see for example Worede et al. 2000; Negri 2003; Torricelli et al., Chapter 18 in this volume). The disappearance of landraces not only means local genetic erosion but also 'local cultural erosion', by which both biological and cultural evolution is hampered.

Finally, the continued erosion of crop genetic diversity hampers agro-ecosystem functioning and its provision of services (i.e. pest and disease control, pollination, soil processes, biomass cover, carbon sequestration and prevention of soil erosion) (Cardinale et al. 2006; Hajjar et al. 2008) as well as potential innovation in sustainable agriculture (Jackson et al. 2007).

It is acknowledged that agro-biodiversity is a finite world resource that we know is being eroded or lost in part due to careless, unsustainable human practices. The Convention on Biological Diversity (CBD, 1992), the International Treaty on Plant Genetic Resources for Food and Agriculture (FAO, 2001) and the Global Plant Conservation Strategy (CBD, 2002a), recognized the requirement for the conservation of agro-biodiversity and called for conservationists to improve the efficiency and effectiveness of their conservation actions.

The Conference of the Parties (COP) to the Convention on Biological Diversity (CBD, 2002b) has established the 2010 Biodiversity Targets that draw attention to the need for conservation of the "*genetic diversity of crops, livestock, and harvested species of trees, fish and wildlife and other valuable species conserved … restore, maintain or reduce the decline of populations of species*" and committed the parties "*to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth*". Specifically in relation to plants, the Global Strategy of Plant Conservation (GSPC), which was adopted by CBD at its sixth COP, established the explicit target of "*70 per cent of the genetic diversity of crops and other major socio-economically valuable plant species conserved*" (www.biodiv.org/2010-target).

Following on from the GSPC, in the European forum, the European Plant Conservation Strategy (EPCS) was proposed and submitted to CBD SBSTTA by the Council of Europe and Planta Europa (2002) and has recently been updated for the next seven-year phase as the European Strategy for Plant Conservation 2008-2014 (ESPC) (Plant Europa 2008). The latter includes the target "*Prepare a European inventory of traditional, local crop landrace varieties*" which is to be achieved by 2014!

The International Treaty on Plant Genetic Resources for Food and Agriculture (FAO, 2001) is specifically focused on agro-biodiversity (www.fao.org/ag/cgrfa/itpgr), its objectives being the "*conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use*". Article 5 states that each Contracting Party shall: "*Survey and inventory plant genetic resources for food and agriculture, taking*

into account the status and degree of variation in existing populations, including those that are of potential use and, as feasible, assess any threats to them" … "*Promote or support, as appropriate, farmers' and local communities' efforts to manage and conserve on-farm their plant genetic resources for food and agriculture*".

If these targets are considered in conjunction with the first UN Millennium Development Goals (www.un.org/millenniumgoals/) of eradicating extreme poverty and hunger, then there is an obvious link between the conservation and use of socio-economically important plant species, commonly referred to as plant genetic resources. Plant genetic resources being the: "*genetic material of plants which is of value as a resource for the present and future generations of people*" (IPGRI, 1993).

In addition, the above-mentioned documents, as well as many others, aim to ensure better protection of local cultures and farmers' rights.

Those countries that are signatories to both the CBD and the International Treaty have an obligation and responsibility for the conservation of their potential or actual agro-biodiverse important species. Furthermore, if the CBD 2010 Biodiversity Target is to be met, along with the requirements of other relevant international, regional and national strategies and legislation, we need to be able to produce comprehensive inventories and systematically conserve landraces and other varieties *ex situ* in genebanks and *in situ* on-farm, as well as promoting their sustainable utilization.

1.2 Plant genetic resources and landrace conservation

Agro-biodiversity includes three levels of complexity arising from i) the combinations of biotic and abiotic elements that make up different agro-ecosystems, ii) the number of different species, and iii) the different combinations of genes within each species. We will focus on the inter- and intra-specific levels of complexity which relate to plant genetic resources for food and agriculture. Plant genetic resources for food and agriculture include modern cultivars, breeding lines and genetic stocks, obsolete cultivars, ecotypes, landraces and crop wild relatives (Figure 1.1) (Maxted et al. 2008). The first three of these components are largely being actively conserved already in Europe by plant breeders and gene bank networks. Therefore the components of European plant genetic resources that are most in current need of active conservation are crop wild relatives, ecotypes and extant landraces. While in recent years crop wild relative conservation has been the focus of several

initiatives (Heywood and Dulloo 2005; Maxted et al. 2008; Iriondo et al. 2008), landraces and ecotypes remain a component of agro-biodiversity which is highly threatened in Europe, and deserves immediate priority.

In situ and *ex situ* conservation are the two major strategies used in the conservation of plant genetic resources. There is an obvious fundamental difference between these two strategies: *ex situ* conservation involves the sampling, transfer and storage of a population of a certain species away from the original location where it was found (i.e. outside its natural habitat) whereas *in situ* conservation (i.e. the conservation of diversity in its natural habitat) involves the designation, management and monitoring of the population at the location where it is currently found and within the community to which it belongs (Maxted et al. 1997a). Historically, plant genetic resources have primarily been conserved using *ex situ* methods (see Frankel and Bennet 1970; Frankel 1973; Frankel and Hawkes 1975; Hawkes 1980; Brown et al. 1989; Guarino et al. 1995; Hawkes et al. 2000; Smith et al. 2003). More recently, *in situ* conservation has been proposed as being a better conservation strategy because, in contrast to *ex situ* conservation, it allows a complex of populations to be preserved and evolutionary processes to be continued.

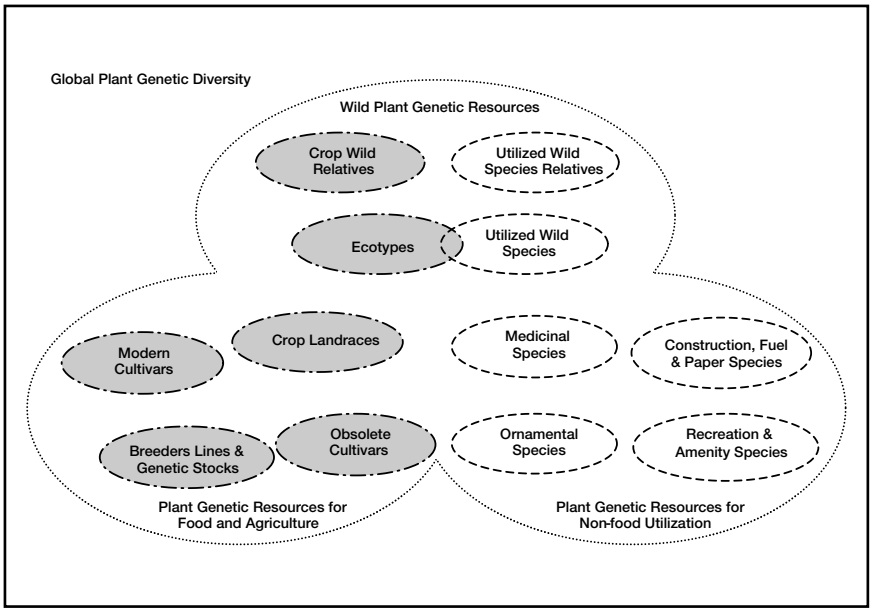

Figure 1.1. Global plant genetic diversity, plant genetic resources for food and agriculture are in shaded circles (modified from Maxted et al. 2008).

Each of the two basic strategies may be further subdivided into several specific techniques as indicated in Table 1.1. Article 9 of CBD (1992) stresses that the two conservation strategies should not be viewed as alternatives or in opposition to one another but rather should be practised as complementary approaches to conservation, each providing a safety back-up for the other. The goal of applying the two conservation strategies is ultimately to serve the present needs of plant breeders on one hand, and the need to maintain genetic resources that are always in tune with the environment to deal with future unpredictable changes on the other hand.

Although the full range of techniques are available, in practice to conserve landrace diversity, either *ex situ* seed storage or *in situ* on-farm conservation will be applied most often. Brush (2000), Hammer et al. (2003) and Maxted et al. (1997b, 2002) have from different perspectives attempted to clarify the methodological approaches to on-farm conservation. Maxted et al. (1997a) defined on-farm conservation as "*the sustainable management of genetic diversity of locally developed crop varieties (land races), with associated wild and weedy species or forms, by farmers within traditional agricultural, horticultural or agri-silvicultural systems*".

However, this concept has been based on the agricultural situations of developing or transitional economies where most crops were originally domesticated. On-farm conservation of landraces also occurs in areas where wild relatives are not present (as shown by many contributions in this volume). In this context also the meaning of 'traditional' needs to be clarified, does it mean 'ancient' (i.e. carried out without taking advantage of modern techniques and tools) or 'linked to a traditional context'? For countries such as Italy, on-farm conservation is not synonymous with 'ancient' agricultural techniques, rather the reverse is true. Here the principles of sustainable, organic agriculture and sometimes quality testing and certification of each productive step often drive production. Also here, about a third of landraces still extant are used in wide-scale production and are cultivated using high-input agronomic techniques or under highly skilled modern (sometimes organic) agricultural techniques (Negri 2003; Negri et al. 2007). However, in Finland and the UK, cereal and many other landraces are cultivated in a low-input context in marginal systems that rely on farmers' indigenous knowledge of the nature of the crop. Therefore, a more general definition of on-farm conservation should be reformulated as 'the management of genetic diversity of locally developed crop varieties (landraces) by farmers within their own agricultural, horticultural or agri-silvicultural systems'.

Table 1.1. Conservation strategies and techniques (Hawkes et al. 2000).

Strategies	Techniques	Definition
Ex situ conservation	Seed Storage	The collection of seed samples at one location and their transfer to a genebank for storage. The samples are usually dried to suitably low moisture content and then kept at sub-zero temperatures.
	In Vitro Storage	The collection and maintenance of explants (tissue samples) in a sterile, pathogen-free environment.
	Field Genebank	The collecting of seed or living material from one location and its transfer and planting at a second site. Large numbers of accessions of a few species are usually conserved.
	Botanic Garden/Arboretum	The collecting of seed or living material from one location and its transfer and maintenance at a second location as living plant collections of species in a garden or for tree species an arboretum. Small numbers of accessions of a large number of species are usually conserved.
	DNA / Pollen Storage	The collecting of DNA or pollen and storage in appropriate, usually refrigerated, conditions.
In situ conservation	Genetic Reserve	The location, management and monitoring of genetic diversity in natural wild populations within defined areas designated for active, long-term conservation.
	On-farm	The sustainable management of genetic diversity of locally developed traditional crop varieties with associated wild and weedy species or forms by farmers within traditional agricultural, horticultural or agri-silvicultural cultivation systems.

A prerequisite of any active conservation plan is the requirement for some form of inventory of what is to be conserved. Countries that have ratified the CBD and International Treaty and wish to meet the targets outlined above are obliged to make inventories of their biodiversity, design national conservation plans and monitor diversity to assess the efficiency of conservation actions. The production of national inventories of the wild components of biodiversity is well established, and botanists have been creating checklists and floras since the time of Theophrastus in the third century BC (Davis and Heywood 1973). There are fewer examples of inventories of the cultivated components of biodiversity. In addition, as far as is known, there are no comprehensive national inventories of crop landraces for any country inside or outside of Europe. Therefore the creation of national landrace inventories is critical and timely. How can we conserve landraces if we are unsure what we have and how can we reduce diversity loss if we have no inventory to allow comparison and assessment of change?

1.3 What is a landrace?

It is difficult to define precisely what constitutes a landrace. In fact Zeven (1998) goes so far as to conclude that definition of a landrace is not possible. However, if it were impossible to define a landrace then it would necessarily be impossible to recognize an entity for which there is an extensive literature, to build a national inventory and ultimately to conserve the diversity contained within it; therefore there was a pragmatic imperative to produce a definition as a precursor to the production of inventories, to conserve landraces' component elements and use that diversity. As for the definition of landrace, using a combination of several definitions and taking into account the discussions presented by previous authors (Anderson and Cutler 1942; Harlan 1975; Brush 1992, 1995; Papa 1996, 1999; Zeven 1998; Asfaw 2000; Friis-Hansen and Sthapit 2000; Negri 2003, 2005; Camacho Villa et al. 2005; Saxena and Singh 2006) the following definition was proposed at the second meeting of the On-Farm Conservation and Management Taskforce of the European Cooperative Group on Genetic Resources (Bioversity International) held in Stagerlitz (see www.ecpgr.cgiar.org/Networks/Insitu_onfarm/OnfarmTF_intro.htm):

> *"A landrace of a seed-propagated crop is a variable population, which is identifiable and usually has a local name. It lacks 'formal' crop improvement, is characterized by a specific adaptation to the environmental conditions of the area of cultivation (tolerant to the biotic and abiotic stresses of that area) and is closely associated with the uses, knowledge, habits, dialects, and celebrations of the people who developed and continue to grow it."*

This definition emphasizes the aspects of a long-standing, unbroken and active management of landraces in a specific human context and underlines that a landrace belongs to the people who developed it and feel themselves to be its owner. In this sense it answers the need for recognizing (and remunerating) the farmers' rights that has so often been highlighted in internationally binding documents.

However, there are some people who do not feel comfortable within the semantic limits of the above-mentioned definition. For example there are landraces that are autochthonous in one region and are being introduced into another region ['allochthonous landraces', following the definition given by Mayr (cited by Zeven 1998)]. These will become locally adapted with time, but could not be considered as landraces following the above-mentioned definition, because they do not belong to the people who developed

them. They are increasing in frequency as a result of reintroduction activities following the total loss of local landraces due to civil conflicts, extreme modernization of agriculture or the preference of those in the organic movement to grow traditional varieties whatever they are. Many would then like to consider these introduced populations as landraces *tout court* and their diversity as being at their full and unrestricted disposal. The implication on the farmers' rights issues of such thoughts must indeed be considered seriously.

Ultimately the definition of what constitutes a landrace is of great importance. Although the definition provided above could be properly used to prepare national inventories and conservation programmes for landraces, those actually applied are likely to be activity-specific and may depend on the resources available, the relative availability of landrace distributional data and the interests of the commissioning agency.

1.4 Nomenclatural versus genetic distinction

One of the possible limitations of many landrace genetic erosion studies is that researchers often identify landraces using purely the name given to the landrace by the farmer; it being assumed that if two landraces have different names they are in fact different, they are internally consistent and distinct from each other. However, it is known that farmers may use the same name for landraces that are genetically distinct and use different names for a single landrace. For example a landrace may be named, as often happens, after a cooking quality (e.g. sweet-grain, fast-cooking, fill-belly) in a local language so the name serves a descriptive not a distinction or unique identification role. Thus the drawback of such nomenclatural-based evidence is subjective and liable to misinterpretation and a reduction in the number of nomenclatural landraces when assessing genetic erosion may not provide an accurate estimate of loss of genetic diversity.

Studies carried out comparing genetic with nomenclatural diversity for landraces to find out how well they generally correspond have been inconsistent. Harlan (1992) provided evidence that genetic diversity is correlated with landrace nomenclature and this is certainly true for both autogamous and allogamous crops owing to the different selection pressures landraces experience in adapting to different environments (*sensu lato*, i.e. including selection pressures operated by man) over time. While Huamán and Spooner (2002) and de Haan et al. (2007) found only partial correlation between potato landrace names

and genetic diversity in South America, Majaju and Chakauya (2008) found good correlation in sorghum landraces from the semi-arid areas of Zimbabwe. Evidence from Italy showed that cowpea (*Vigna unguiculata* L.), common bean (*Phaseolus vulgaris* L.) and celery (*Apium graveolens* L.) landraces, each clearly designated by a particular common name (i.e. Fagiolina del Trasimeno, Fagiolo a Pisello and Sedano Nero di Trevi), which were studied for several morpho-physiological and genetic traits, appeared to be structured populations with a substantial genetic differentiation of subpopulations (i.e. farmer populations) (Tosti and Negri 2005; Tiranti and Negri 2007; Negri et al. in press). Nomenclatural diversity itself can also be wide, for example, a potato landrace grown in Norway, Finland, Sweden and Iceland can have up to 18 documented names as recorded by the Nordic Gene Bank when receiving samples for conservation (Veteläinen and Bennvid 2001).

The fact that the names by which landraces are known may or may not be correlated with actual genetic distinction for crop groups means that ideally the relationship should be investigated prior to making the assumption of correlation. This is the ideal, but seldom are sufficient resources available to implement the ideal, therefore in the absence of any information to the contrary, it is often pragmatically assumed that landrace names do identify distinct entities.

1.5 Threats to landrace diversity

1.5.1 Estimates of landrace loss

While we know a significant amount about the loss of botanical diversity – 21% of European vascular plant species (Euro+Med PlantBase - www.euromed.org.uk - Euro+Med PlantBase 2005) were classified as threatened using the 1994 IUCN Red List Categories and Criteria, and 50% of Europe's 4,700 vascular plant endemics are considered to be threatened to some degree (www.redlist.org) – there are few data available to assess landrace extinction or genetic erosion (genetic erosion being a permanent reduction in richness or evenness of common local alleles or the loss of combinations of alleles over time in a defined area, Maxted and Guarino 2006). It should also be noted that the data that are available have not often been quantified rigorously. Objective evidence is largely absent and thus assessment is anecdotal (FAO 1999) or is based on nomenclature, as is the case for potato landraces present on the Chilean island of Chiloe over the last 80 years (Ochoa 1975), see Table 1.2.

Table 1.2. Recorded potato landraces on Chilean island of Chiloe (Ochoa 1975).

Year	Landrace numbers
1928	200
1938	200
1948	100
1958	≈ 80
1969	35-40

In the East Shewa district of Ethiopia farmers identified 26 tetraploid wheat landraces which were once widely grown in the area and of these only six were currently available, a 77% loss of diversity (Tsegaye and Berg 2007). Also in Ethiopia, Teklu and Hammer (2006) reported *Triticum polonicum* and *T. turgidum* cultivation had decreased dramatically and was now very localized, indicating severe threat of extinction, as well as genetic erosion of 100% in both *T. durum* and *T. dicoccon* in Tulo district, genetic erosion of 85.7, 100 and 77.8%, respectively for *T. durum*, *T. turgidum* and *T. dicoccon* in Chiro district, and in Harar Zuriya district genetic erosion of 88.9% for *T. durum* and 100% in both *T. turgidum* and *T. dicoccon*. While in Europe, Hammer et al. (1996) found that there was about 70% genetic erosion of landraces in Southern Italy over a period of thirty years, and Negri (2003) found a similar loss of diversity in the Mt. Amiata area of Tuscany in only four years.

These studies show that landraces are highly threatened, if not the most threatened element of plant genetic resources.

1.5.2 Causes of landrace loss

Continued landrace loss in Europe is due to several factors, underlying which is the profound transformation of productive systems and socio-economic context which occurred in the twentieth century, already mentioned above (for further details see Grigg 1994; Negri 2005).

They first include the diffusion of modern cultivars which, being more productive, under high inputs at least, rapidly substituted landraces when agriculture became a market-oriented activity and the need to relieve rural people from famine was still keenly felt. This is also recorded among the factors contributing to landrace loss in other countries outside Europe, such as Ethiopia (Tsegaye and Berg 2007). The consequence has been an increased reliance on monocultures based on a few cultivars.

In Europe landrace diversity is also threatened by the inadvertent consequences of the variety and seed certification system associated

with the establishment of plant breeders' rights, which remunerate seed companies for the costly process of creating modern cultivars. To be sold commercially, all major agricultural and vegetable crops grown in Europe need to be registered in the National Catalogues and then in the European Common Catalogue for agricultural and vegetable varieties, introduced in 1970 (Hutchinson in Hawkes 1978; Velvé 1992; Stickland 1998), following precise regulations. To be accepted onto the National List a variety has to meet the 'DUS' criteria: it has to be distinct (in character from any other variety in the 'community'), unique (plants are similar or genetically identical in character) and stable (remains true to its defined characteristics after successive multiplications or propagations). The European and subsequent national legislation was intended to standardize crop names and protect both consumers and breeders, but has had the unintended consequence of drastically reducing the numbers of cultivars grown – there is a cost to DUS testing – and impinging on the ability of farmers to grow older varieties or landraces not present on the list. Although it is generally illegal to sell seed that is not on the national list, it is common for farmers to exchange their farm-reproduced seed. In addition, several European seed exchange networks, such as Garden Organic (www.gardenorganic.org.uk), Irish Seed Savers (www.irishseedsavers.ie), Arche Noah (www.arche-noah.at) and ProSpecieRara (www.ProSpecieRara.ch) have found ways around the legislation in order to ensure the conservation of heritage varieties, but these organizations have primarily focused on vegetable or fruit landraces, not on larger-scale field crops. But even for these, Velvé (1992) estimates that 1500 vegetable varieties representing 23 crops were immediately lost due to the requirement to register varieties prior to sale in the European Community. Although it is hoped that at least some of these varieties were placed in formal or informal sector genebanks or are still held by national variety statutory testing centres across Europe, it is unquestionable that a significant loss of European agro-biodiversity occurred, and much of the diversity has been lost in the form of traditional landraces, because of a sort of systematic eradication by government policy (Maxted 2006). The European crop seed market is currently regulated by diverse European directives for agricultural crops, but in partial recognition of the threat to and critical need to maintain agrobiodiversity, the European Commission has recently presented a new EU directive 'Commission Directive 2008/62/EG of 20 June 2008'. The Directive has the objective "*to ensure* in situ *conservation and the sustainable use of plant genetic resources, landraces and varieties which are naturally adapted to local and regional conditions and threatened by genetic erosion*

(conservation varieties) should be grown and marketed even where they do not comply with the general requirements as regards the acceptance of varieties and the marketing of seed and seed potatoes." However, being mainly concerned with seed trading, it is unlikely that the Directive will be of great help in preserving all the diversity maintained up to now in Europe. In addition, the national implementation of Directive 2008/62/EG remains a matter of active discussion across Europe and the 'loose' wording of the Directive may result in quite different national interpretations (see Lorenzetti and Negri, Chapter 31 this volume).

Last, but not least, the constant reduction in rural populations, the constant simplification of productive processes due to high manpower costs, the ageing of the maintainers, the unsuccessful farmer generation switchovers and passage of information from one generation to the next are serious threats for the on-farm maintenance of landraces (Negri 2003; Heinonen and Veteläinen 2007).

1.5.3 Estimates of genetic erosion among and within landraces

Le Clerc et al. (2005) quantified the genetic diversity among 133 modern and traditional maize cultivars grown in France during the last five decades using 51 SSR. A total of 239 alleles were generated and although the earliest decade (that when landrace populations were present) had the highest genetic diversity, the later three decades had similar values. The analysis between decades represented only 10% of the total molecular variation, but was significant in decade-by-decade comparisons, except for the last two decades. The results show that genetic diversity has been reduced by about 10% in the maize cultivars bred before 1976 compared with those bred after 1985. They concluded that the very low differentiation (GST = 0.21%) observed among cultivars of the last two decades should alert French maize breeders to the need to enlarge the genetic basis in their variety breeding programmes. Also, Ishikawal et al. (2006) highlighted the loss of genetic diversity in traditional upland rice germplasm in northern Thailand, due to the replacement of a large number of traditional varieties with a smaller number of modern varieties, but also because of gene flow from distinct cultivars to landraces. Gene diversity is higher in Thailand compared with Laos, due to the higher frequencies of Indica strains and heterozygotes, but now nearly half of local Indica strains carry the cultivar Japonica plastid and cytoplasm. These local nuclear–cytoplasm substituted strains and heterozygotes in northern-Thailand were probably generated by natural hybridization, where the local Japonica strains acted as the maternal donor, but

they have resulted in unintentional genetic pollution and erosion of native landrace diversity. The evolution of flint maize landraces from central Italy since the introduction of dent hybrid varieties in the 1950s was also assessed by using SRR (Bitocchi et al. 2009). It was shown that the maize landraces collected in the last 5–10 years have evolved directly from the flint landrace gene pool cultivated in central Italy before the introduction of modern hybrids, but with the significant contribution of introgression from hybrid varieties. No evidence of genetic erosion of the maize landraces was observed, suggesting that *in situ* conservation of landraces is an efficient strategy for preserving genetic diversity.

It should be noted that the trend towards reliance on a small number of pure lines and improved varieties does not always result in a narrowing of the crop genetic bases in some species; two studies of European winter wheat do not show a significant loss of diversity among varieties over time (Khlestkina et al. 2004; Huang et al. 2007). However it should also be noted that these authors compared the diversity in cultivars over time and did not make a comparison between cultivation of cultivars and the full range of landraces historically cultivated. However, Prashanth et al. (2002) showed that the process of breeding modern cultivars did not appear to cause significant genetic erosion in landraces of rice in India, and Ford-Lloyd et al. (2008) were unable to detect a significant reduction of available genetic diversity over time in rice landraces collected throughout South and Southeast Asia. The latter study also found a strong link between numbers of landraces collected (and therefore extant) and genetic diversity; hence, numbers of landraces present was found to be a clear indicator of a healthy level of genetic diversity.

1.6 Actions needed

Landraces are the most threatened element of plant genetic resources and remain an urgent priority for conservation action for the following reasons:

Landrace diversity is directly threatened by replacement by modern varieties and specifically in Europe through the application of variety and seed certification legislation.

Although we have no idea how many traditional seed-saved varieties remain extant, we do know widely from anecdotal evidence that landrace maintainers, almost invariably elderly, are dwindling in number each year, and the landraces are going with them (Negri 2003; Scholten et al. 2008; Smekalova, Chapter 13 this volume) so that the rate of local genetic and cultural erosion is very high.

The proportion of the total landrace diversity that is currently used by farmers or breeders is not systematically conserved *ex situ* in genebanks (where almost random, rather than systematic, collections of landraces are held). Furthermore, in Europe, and especially in the North of Europe, there is only a handful of working *in situ* on-farm landrace conservation projects that are actively maintaining landrace diversity. Maxted (2006) has also argued that their conservation falls outside the remit of conventional conservation agencies.

In times of ecosystem instability and climate change, broader gene pool diversity will be required by breeders, and landraces hold the necessary diversity (Esquinas-Alcazar 1993; Hammer and Diederichsen, Chapter 2 this volume), as demonstrated by the review of pea landrace diversity in Sweden (Lorion et al. 2005; Weibull et al. Chapter 14 this volume), without having the associated disadvantages of undesirable traits associated with crop wild relatives.

Unless action is taken immediately, losses of landraces will continue and complete extinction is the only possible conclusion. As a consequence, urgent action is required to inventory, rescue and preserve the wealth of European landrace diversity. The first logical step appears to be to compile inventories, later threat assessment and prioritization for conservation should be carried out.

For general biodiversity threat assessment and prioritization, the standardized system of applying the IUCN Red List categories (IUCN 2001) is commonly used. The IUCN threat assessment is data-driven on the basis of different criteria under which a taxon may be listed, each with distinct data requirements. However, these criteria are mainly addressed to entire taxa as the goal of the threat assessment is to conserve entire taxa. On the contrary, landraces are not distinct taxa, but variable populations of a crop taxon, and the goal of landrace conservation is to conserve the full range of genetic diversity within the landrace, not just the representation of the landrace *per se*. These differences mean that the application of IUCN Red List categories in the traditional sense would not prove effective for assessing threats to landraces. However, the ethos used to design the IUCN Red List categories could be used to propose a set of categories and criteria for landrace threat assessment. Joshi et al. (2004) proposed such a system for use in assessing the threat to landraces on the basis of landrace population, ecological, social, modernization and use criteria. In this volume (Chapter 10) Porfiri et al. also propose a methodology to assess the threat to landraces. There is clearly scope for development and broader application of such potentially useful techniques.

1.7 Why a fresh initiative in European landrace conservation and use?

It has been argued above that Europe's remaining landrace diversity is a particularly critical resource in the current time of climate change and growing ecosystem instability and that this resource is currently being eroded by careless, unsustainable human actions, yet it is this resource that will underpin the future food security and well-being of European consumers. Therefore, it is timely to provide an overview of European landrace diversity, conservation and use (Section 1, Chapters 1 and 2), a general introduction to methodology of creating landrace inventories and how such inventories have been prepared in various European countries (Section 2, Chapters 3 to 15), exemplar case studies of landrace *in situ* and *ex situ* conservation (Section 3, Chapters 16 to 25), exemplar case studies of landrace use (Section 4, Chapters 26 to 30), the European and national policy context for landrace conservation and use (Section 5, Chapters 31 to 33), and finally a concluding section discussing the findings of the exercise and suggesting a more systematic approach to securing European landrace diversity, its conservation and use (Section 6, Chapter 34). The chapters presented contain numerous ideas for inventorying, conserving and using landrace diversity and as such each specific chapter is of interest in its own right, but the chapters have been written to try to bring out the methodologies applied so that as well as being specific records they can also help the development of generic protocols that may be applied more widely. Having outlined the dual specific and generic nature of this exercise, it must be stressed that no single approach is recommended for the inventorying, conservation or use of European landraces, and that each application is likely to be distinct: but it is hoped that the exemplar studies reported will encourage other countries within Europe to conserve this critical resource before our landrace diversity is reduced to an ethnographic artefact.

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2. Evolution, Status and Perspectives for Landraces in Europe

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2.1 Introduction

"*An autochthonous landrace is a variety with a high capacity to tolerate biotic and abiotic stress resulting in high yield stability and an intermediate yield level under a low input agricultural system*" (Mansholt 1909, emend. Zeven 1998). Landraces were originally described for agricultural crops (Rümker 1908; Mansholt 1909; Kiessling 1912; Tschermak 1912; Schindler 1918) but later the concept was also applied to horticultural crops such as vegetables (Hammer 1997), medicinal and aromatic plants (Heeger 1956), fruit trees and grapes (Bisson, 1989). Today the term landrace also includes ornamental garden plants. Landraces represent a specific evolutionary stage of crop plants. Zeven (1998) after Mayr (1937) proposed two types of landraces – (1) autochthonous landraces, cultivated for more than a century in a specific region (e.g. 'Quarantino' maize in Italy, though maize is an introduced crop there); and (2) allochthonous landraces, introduced from another region and locally adapted (e.g. 'Kent Wild White Clover', grown in some hilly areas of Scotland, Camacho Villa et al. 2005). As a third type, the so-called Creole landraces have been defined (Bellon and Brush 1994) as material derived from a bred cultivar (e.g. 'Square Head Master Wheat', continuously grown since 1930 near Suffolk, UK, see Camacho Villa et al. 2005).

About 10 000 years ago, wild progenitors gave rise to the first primitive varieties (Baur 1914) or primitive forms (Hawkes 1983). Initially, these primitive varieties must have been genetically quite narrow, due to the founder effect (Mayr 1942). However, other populations of the wild progenitor may have subsequently been domesticated, and the genetic flow between crop wild relative and cultivated species may have widened the genetic base over time, resulting in diverse landraces (Zohary 1999). Possibly, domestication was a gradual process, taking a long period of time and accumulating the traits resulting in the domestication syndrome in crop plants, which adapted them to the needs of farmers (Hammer 1984; Tanno and Willcox 2006).

Tanksley and McCouch (1997) emphasized that narrowing of the genetic base (genetic bottlenecks) occurred firstly when changing the wild species into a domesticated species and secondly when landraces were replaced by modern cultivars (Figure 2.1). Tanksley and McCouch overlooked, however, that not only genetic bottlenecking (founder effect), but also widening of the genetic base has happened, and the true picture might be closer to the pulsation of diversity over time shown in Figure 2.2. The evolutionary processes under domestication are highly dynamic, resulting in reticular phylogenetic backgrounds of cultivated species (Hammer 1981). These processes continue today. In some countries, primitive varieties still coexist with the more advanced landraces. In Europe, however, they are rarely preserved except in genebank collections. Dehiscent flax or cereals with easily shattering seeds represent examples of such primitive varieties. For practical reasons, primitive varieties are distinguished as a different category from landraces. However, many fluctuations from one category to the other exist.

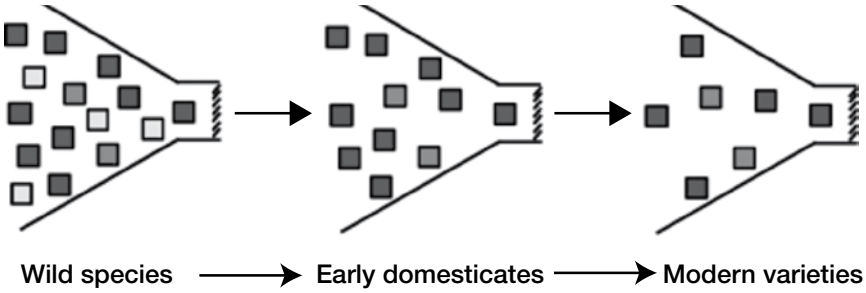

Figure 2.1. Genetic bottlenecks during domestication and modern breeding (Tanksley and McCouch 1997).

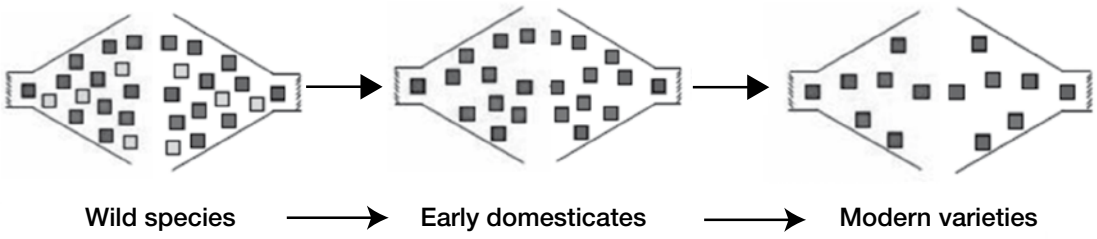

Figure 2.2. Genetic bottlenecking followed by subsequent widening of the genetic base during crop domestication and breeding.

The perception of landraces and a loose concept of what they are emerged only after the first breeders' varieties (cultivars) came into being with the development of professional plant breeding in the 19th century. In some European countries intensive breeding of crops started some 150 years ago. Soon after, the usefulness of landraces as basic material for the selection of breeders' varieties was discussed (Proskowetz 1890; Schindler 1890). The first definition of the term 'landrace' was provided by Rümker (1908). Zeven (1998) claimed that the term landrace is indefinable. This proposal was proven as being untenable by Camacho Villa et al. (2005). Instead, they developed the following working definition: Landraces are dynamic populations of cultivated plants with historical origins, distinct identities and lack formal crop improvement. They are often genetically diverse, locally adapted and associated with traditional farming systems (Camacho Villa et al. 2005). Breeders' varieties (cultivars) were developed from landraces. This proceeded rather slowly at the beginning. Only step by step the breeders' varieties obtained a wider distribution and finally they displaced the traditional landraces in many of their areas of distribution.

2.2 History of landraces in Europe and their conservation

Agriculture entered Europe (Greece) about 8000 years ago coming from the Near East (Hammer 1997) and reached most parts of the continent in the next 3000 years. The term 'Neolithic Revolution' has been coined for this process (Childe 1925). Early-introduced crops (archaeophytes) include mainly cereals, pulses and flax (Zohary 1999). Later on, vegetables, aromatic plants and fruit trees were also introduced (mostly archaeophytes). Neophytes (e.g. maize, tomatoes and potatoes) appeared after the European detection of America about 500 years ago (Hammer and Perrino 1997). Of course, wild endemic European species have also been domesticated, turning them into crop plants (autochthonous elements). Crops of all these groups have reached the state of landraces and may be considered as 'local', i.e. grown in an area for more than 30 years (Louette et al. 1997).

The first activity of the newly arising systematic plant breeding in the 19th century was the selection of improved varieties from populations of landraces. E. von Proskowetz, for example, started with line selection from spring barleys of the Hana region in Moravia around 1870. 'Chevalier' barleys, which were leading in Europe at that time, were superseded by the spring barleys which von Proskowetz selected (Lehmann 1981). On the basis of these results, von Proskowetz (1890) and Schindler (1890) concluded

that landraces (German *Landrassen*) are useful. But they also drew attention to their (expected) gradual disappearance and proposed that landraces should be collected, exactly described and their descriptions compiled in a catalogue. They also proposed to establish collections for carrying out systematic character analysis. With these proposals they had already outlined the objectives of modern genebank activities: collection, exploration, documentation and conservation (Lehmann 1981). Following this early proposal, the value of landraces as basic material for plant breeding was stressed repeatedly in the early 20th century (Nilsson-Ehle 1911; Baur 1914; Tschermak 1915; Schindler 1918). Vavilov (1935) reported that all modern breeding efforts in Europe started with selecting from landraces and emphasized that the landraces' diversity was the most important resource for crop improvement.

The period 1909-1952 (after Zeven 1998) can be seen as an age of growing awareness of the importance of landraces. Specialized collections of living plant material of crop plants were established in Europe. One of the first was the Bureau of Applied Botany founded in St. Petersburg (Russia) in 1894. R. Regel, the director of this institution from 1905 till 1920, managed to establish a collection of 9000 seed and spike samples of cereals and 900 seed samples of industrial plants, mostly landraces from the Russian Empire (Regel 1915; see also Lehmann 1981; Loskutov 1999). In 1920, N.I. Vavilov succeeded R. Regel in the directorship of this institution, which in 1924 became the All-Union Institute of Applied Botany and New Crops (later, the N.I. Vavilov All-Union Institute of Plant Industry - VIR). Under the directorship of N.I. Vavilov, the staff of this institution devoted themselves to collecting and exploring crop plants of many parts of the world as a basis for developing new cultivars for agriculture and horticulture in the Soviet Union. Between 1920 and 1940, 140 expeditions in the Soviet Union and 40 expeditions to 64 foreign countries were organized. Accordingly the collections increased rapidly and had in 1940 more than 200 000 accessions (Brežnev 1969), including a tremendous amount of European landraces.

The German Institute for Cultivated Plant Research was founded in Vienna (Austria) in 1943. It was transferred to the village of Gatersleben close to the Harz Mountains in central Germany after World War II. All collections, including among others, landrace material collected earlier from the Balkans and Crete, was transferred to this new location (Stubbe 1982). The Gatersleben collection was established and researched using the scientific approach established by N.I. Vavilov and his school. In other Eastern European countries, similar activities for the collection of landraces were initiated early. In Bulgaria, the Institute of Genetics and Plant Breeding has carried

out research in the Vavilovian style since its foundation in 1947. In Czechoslovakia, the exploration of genetic resources began in 1951 when various scattered collections were concentrated under the supervision of the Division of Genetics and Plant Breeding Methods at the Research Institute of Crop Production in Prague-Ruzyne. In Hungary, the Institute of Agrobotany was established in 1959 at Tápiószele and initiated the collection and use of the still-existing old landraces, old cultivars and other locally adapted plant populations. The Institute of Plant Breeding and Acclimatization at Radzików near Warszawa established the main collection (mostly of cereals and some pulses) in Poland; a special collection of rye was established at the Botanic Garden in Warsaw. In Rumania, work on plant genetic resources has been done at the Agrobotanic Garden of the Agronomy Institute at Cluj-Napoca (Szabó 1981) and at the Suceava genebank (Monitoring Institute 2002). These early activities (Lehmann 1981) were guided by the scientific ideas of N.I. Vavilov and gained support from the politically dominating role of the Soviet Union. Though N.I. Vavilov was imprisoned in 1940 during a collecting mission in western parts of the Ukraine, close to the city of Chernivtsi, and died in the prison of Saratov in 1943, some of his co-workers continued his work. The collections in Leningrad were saved and further developed after World War II (Dragavtsev et al. 1994; Loskutov 1999). A Technical and Scientific Council of the Eastern countries was established in 1964 and headed by the N.I. Vavilov Institute of Plant Industry (VIR). The VIR was named after Vavilov following his rehabilitation in 1955 (Loskutov 1999). This second period of landrace collecting and research (1953-1974, after Zeven 1998) was strongly dominated by the Eastern European countries.

In 1974, the International Board for Plant Genetic Resources (IBPGR - now Bioversity International) of the Consultative Group on International Agricultural Research (CGIAR) was established to promote a world-wide network for genetic resources (for the history of the term plant genetic resources see Hammer 2004). With this, the third period of collecting and documenting landraces (and plant genetic resources) started (1975 - present, after Zeven 1998). This also marks the beginning of the so-called 'plant genetic resources movement' (Pistorius 1997). The European Association for Research in Plant Breeding (EUCARPIA) promoted a regional network for genebanks in Europe, connecting the already functioning genebanks in the Eastern countries with some newly established ones in Western and southern Europe (Hawkes and Lamberts 1977). In the early 1970s, the foundation of genebanks at Bari (Italy) and Braunschweig (Western Germany), and later on at

Lund (Sweden) for the Nordic countries, was organized and many other activities started. In Geneva, at a Government Consultation in December 1979 the 'European Co-operative Programme for Crop Genetic Resources' was established and started its activities (Hanelt and Lehmann, 1981; Lehmann 1981). With this, a Europe-wide framework became available, which proved to be useful in times of larger political changes. The EUCARPIA Gene Bank Committee helped to guide the process for Europe-wide cooperation on plant genetic resources after the breakdown of the Soviet Union. The work of the genebanks in the Eastern countries was evaluated and found to be useful and efficient with respect to landrace conservation (Frison and Hammer 1992). New programmes associated with genebanks arose in the now independent states of the former Soviet Union (e.g. the Baltic States, Ukraine), the Balkans (e.g. Albania and Slovenia) and other changes and rearrangements occurred (e.g. in Germany, Czech Republic and Slovakia). The main task, to continue the urgently required collection and preservation of landraces in their niches, has been tackled within the 'European Programme'. A closer cooperation among the European genebanks has been promoted, e.g. by meetings of the EUCARPIA section on genetic resources, which also took into account the special experiences of the Eastern countries (Poznan, Poland, 2002; Piešťany, Slovakia, 2007). Joint European Documentation systems for genebank collections (EURISCO) have been created that allow centralized access to national genebank collections (Bioversity International 2008).

2.3 Landrace collecting and major collections

The problem with the exact definition of landraces as part of a dynamic system limits the possibilities of conclusions regarding their *in situ* status or *ex situ* preservation, presence and collection. From the very beginning (Proskowetz 1890; Schindler 1890), collecting activities tried to capture as much as possible of the landraces' diversity, and significant contributions were made by the Vavilovian School. Geographical names associated with crop germplasm can be good indicators for landraces, but they are often similar to those of cultivars, such as the winter wheat landrace 'Limburger Kleine Rode' or the white clover landrace 'Fries-Groninger' which may also have been registered and listed in official variety lists (Zeven 1991). Therefore, landraces can be mistaken for cultivars. Landrace names usually indicate the geographic origin, e.g. the oat 'Probsteier' from a region in northern Germany, but often they have no names at all.

Landrace collecting has been undertaken in all European countries. Systematically it started in the Soviet Union, but expanded to the Mediterranean area (representing one of the classical diversity centres of Vavilov) and some other countries, e.g. Austria (Mayr 1934).

As state and cooperative farms prevailed in the Eastern countries, early collecting of landraces (prior to the formation of collective farms) turned out to be critical for rescuing this diversity. Considerable differences existed among Eastern European countries with respect to farm size and degree of state control. The private structure of Polish agriculture allowed landraces to be found as recently as in the 1980s (Hammer and Hanelt 1979; Hammer et al. 1981). In the neighbouring Czechoslovakia with cooperative and state farms, landraces had mostly been maintained only in relatively remote areas (Kühn et al. 1976) or in some very traditional farming environments, such as under slash-and-burn cultivation (Kühn and Hammer 1979). In Germany, there have been differences between east and west according to the economic structure, with the western part being slightly better suited for landrace preservation (Dambroth and Hondelmann 1981), although such niches also existed in eastern Germany (Hammer et al. 1977). There is a general decrease of landraces caused by globalization. Sometimes, specific causes, such as the shift from agriculture to tourism-based economies in the alpine region, resulted in the loss of landraces (Hammer et al. 1999). Altogether, a great amount of landrace material has been collected in Europe and is mainly stored in genebanks. Some material is maintained actively on-farm (Zeven 1996). There are continuing collecting activities in the different European countries because niches for landraces still exist. Intensive recent collecting of landraces has been documented for Italy by Hammer et al. (1999) and numerous studies on Italian landraces of legumes and vegetables have recently been made. Jones et al. (2008) provide a listing of genebanks that preserve landrace material of emmer wheat and barley and point out that the genetic diversity preserved may represent only a fragment of what existed in the past. Therefore, these authors included, in addition to living genebank material, dead plant material from herbarium collections and other sources in a genetic diversity study of landraces to obtain a more complete picture.

2.4 Landrace use

Next to breeding stocks and crop wild relatives, landraces are the most important source for genetic improvement of cultivars. Sometimes the importance of landraces as genetic resources for breeding improvement in yield and resistance has been denied:

Roemer (1942) saw no value in European landraces for disease resistance breeding. However, the impact of landraces has been documented in breeding the mildew-resistant barley cultivar 'Pflugs Intensiv' and the stripe rust-resistant cultivars 'Ackermanns Bavaria', 'Heils Franken' and 'Fuchs Pfälzer'. The Dalmatian barley landrace 'Ragusa' determined for many years the mildew resistance for several European barley cultivars (Lehmann 1981). The importance of landraces was rediscovered, after a certain period of neglect between 1953 and 1974, because of their useful genetic variation.

A brief summary of landraces in Europe reads like this: initially they were exploited by selecting homogenous, well defined pure lines, which responded better to the higher-input agricultural techniques that followed the industrialization of Europe. This resulted in a drastic loss of on-farm diversity. Standardization of products and processing technologies also required less of the raw product diversity often associated with landraces. This happened largely until World War I. In the time following, breeders exchanged their lines with each other, hybridization replaced line selection, and the decline in diversity continued, though at a lower rate until the 1970s. Later, possibly driven by increased search for disease resistance or other traits, landraces once again had greater impact in plant breeding as genetic resources and the genetic diversity in cultivars increased slightly until the end of the 20th century. For bread wheat, Hysing et al. (2008) demonstrated such a temporal pattern using a molecular approach.

In Finnish oat landraces, Ahokas and Manninen (2000) pointed to the loss of landraces and their potential when looking for certain nutritional properties. An emotionally loaded debate regarding the impact of modern plant breeding on crop plant diversity has been going on for a while. Some molecular studies even went so far as to question entirely the concept of genetic erosion (Landjeva et al. 2007). However, molecular approaches do not come to unambiguous answers regarding genetic erosion, which may be partly due to the fact that they are based on non-functional diversity and partly due to the fact that older landraces are often poorly represented in such studies (Fu 2006).

Landraces are sometimes still important for agricultural production, particularly in marginal environments, because of their competitive advantage. They fulfil a continuing commercial role in specialist production for niche markets (Camacho Villa et al. 2005), are useful in traditional and subsistence farming (Wood and Lenné 1997), continue to play a key role in food security (Brush 1995) and are increasingly associated with alternative farming

systems such as organic agriculture (Negri et al. 2000; Horneburg and Becker 2008).

2.5 Landrace diversity

In general, there is consensus that landraces are genetically heterogeneous (Harlan 1975; Camacho Villa et al. 2005). Zade (1918) provided an impressive illustration for this by showing that simple line selection without any hybridization allowed 17 oat cultivars to be directly or indirectly selected from the landrace 'Probsteier' (Figure 2.3). This provided evidence of a tremendous amount of variation in the 'Probsteier' oat landrace. It can be assumed that other landraces of oats or cereals in general had comparable levels of diversity. The genetic loss is tremendous with every landrace that has disappeared. The loss of entire species from cultivation has even more drastic effects, and there are several examples for this in Europe.

While genetic heterogeneity is the basis of diversity in landraces, it makes their *ex situ* preservation and utilization in plant breeding difficult (Lehmann and Mansfeld 1957; Agorastos and Goulas 2005; Diederichsen and Raney 2008; Jones et al. 2008). However, there are also cases where landraces are genetically homogenous (Camacho Villa et al. 2005). Vavilov (1935) already emphasized that the genetic constitution of landraces can range from extremely heterogeneous to very homogeneous.

2.6 Landrace inventories

Collections of landraces are available from the last 100 years. Some genebanks indicate landraces in their indices by listing their names (e.g. *Index seminum Gaterslebensis*, Knüpffer 1999a). Landraces without names can be found by searching for geographic denominations (Knüpffer 1999b). Internet-accessible germplasm databases provided by Bioversity International (2008), the Food and Agriculture Organization (FAO 2008), the Nordic Genebank (2008) or the national genebanks of the United States (GRIN) and Canada (GRIN-CA) allow for searches by improvement status of the accessions, directing the seeker to landraces or other categories. However, the differentiation among wild material, primitive varieties, landraces and obsolete cultivars is often not handled consistently when documenting the passport data, resulting in database query results that need to be taken with a grain of salt. A more qualified and consistent documentation by genebanks would be necessary to obtain a better overview of European landrace preservation *ex situ*.

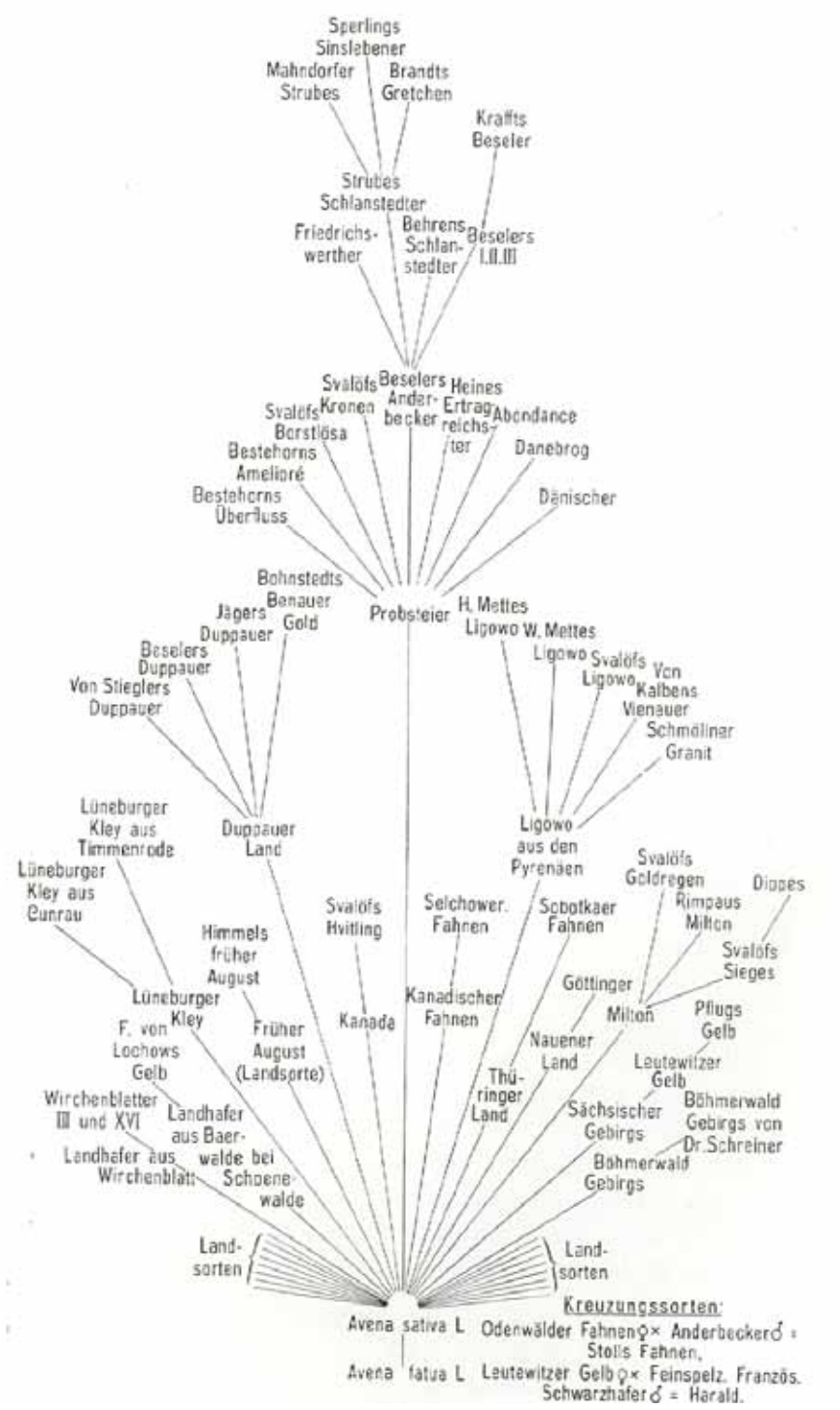

Figure 2.3. Oat cultivars resulting from line selection from landraces reported by Zade (1918).

Another source of information is the collections of non-governmental organizations (NGOs), which emerged in several countries since the 1970s. Catalogues and seed lists of e.g. Arche Noah (Austria) contain many landraces. The catalogues and other publications of Seed Savers (USA) contain many examples of heirloom varieties (mostly of European origin) which have to be considered for possible landrace inventories. Extant landraces conserved on-farm are monitored in many European countries (Germany, Italy etc.). Slow Food has developed a special programme 'The Ark of Taste' for registering stocks of local breeds and crops (mostly landraces) in order to secure their use in the production and preparation of high-quality food (Slow Food 2008).

In some countries, e.g. the UK, recent activities have led to partial inventories and assessments of genetic resources for food and agriculture. A national inventory for crop wild relatives has also been incorporated in this activity (Negri et al. 2000). Networks and communication among the NGOs are becoming more professional, for example the high-quality publications by the German Verein zur Erhaltung der Nutzpflanzenvielfalt (VEN 2008).

2.7 Threats and why diversity has been lost

Landrace extinction and genetic erosion of crop genetic resources are in the focus of the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) 2010 Biodiversity Target. There are a number of other strategies and treaties, such as the Global Strategy of Plant Conservation, the International Treaty on Plant Genetic Resources for Food and Agriculture and the European Plant Conservation Strategy which are concerned about genetic erosion, emphasizing the need for agro-biodiversity conservation. There is still a need for further clarifying the concept of genetic erosion (including its definition), which presents similar problems to the vague concept regarding landraces themselves. In some countries, other than Europe, genetic erosion of selected crops has not been observed (Barry et al. 2008). Approaches for qualitatively and quantitatively assessing genetic diversity need to be refined (Ford-Lloyd et al. 2006). In crop plants, this is a controversial issue. Starting with the early reports by Baur (1914), researchers became more and more aware of a continuing loss of landraces. The American 'plant explorers' Harlan and Martini (1936) are often credited with first recognizing the problem of genetic erosion (Harlan 1975; Brush 1999). But only in 1970 (Frankel and Bennett 1970), was genetic erosion accepted as a verified observation. Frankel (1970) gave a loose definition of genetic erosion and referred to the following five principles (see also Brush 1999):

1. Diversity in crops exists because of adaptations by localized populations (landraces).
2. Pre-modern agriculture in centres of diversity (using landraces) is stable.
3. Introduction of modern agricultural technology, including modern varieties, is a recent phenomenon and leads to instability.
4. Competition between local (landraces) and introduced varieties (cultivars) results in displacement of local varieties (landraces).
5. Displacement of local varieties (landraces) reduces the genetic variability of the local crop populations (landraces).

As emphasized by our additions (in brackets), these considerations are explicitly based on landraces. Frankel (1970), one of the founders of the 'plant genetic resources movement', wanted to stress the predominant importance of landraces. Hammer and Teklu (2006) referred to genetic erosion in a narrower sense (*sensu stricto*) when pointing to the disappearance of landraces. Methods of using chronological diversity comparisons have been applied (Guarino 1999). Examples of quantitative assessments of genetic erosion have been provided for Albania and south Italy (Hammer et al. 1996) where the erosion of landraces when comparing the years 1940 with 1991/93 and 1950 with 1983/86, respectively, was about 75% for an average of landraces of all crops. Examples are also known from Italy, reporting genetic erosion per year for the period between 1950 and 1983/86 of 3.6% for cereals and 2.8% for pulses (Hammer and Laghetti 2005). In the earlier years (from the 1920s to the 1950s), a relatively high genetic erosion of 13.2% per year was observed. This was partly due to the very successful breeding work in wheat by Strampelli (Giorgi and Porfiri 1998).

There are still many questions open regarding genetic erosion (Hammer 1996; Hammer et al. 1999): How much of the diversity of landraces has really been lost (considering the dynamic evolutionary interactions, new activities of NGOs, etc.)? How much genetic information has been transferred into modern cultivars (in different countries)? How much of the diversity was collected by previous explorers and is actually preserved in genebanks (on-farm, NGO collections)? Have the landraces already conserved a broad enough genetic base for sustaining the agriculture of today and tomorrow? What needs to be said about genetic erosion within genebanks and other germplasm collections? There is still no systematic effort to address these questions regarding the loss of landraces, nor regarding the genetic erosion in a wider sense (*sensu lato*) according to Hammer and Teklu (2006).

Modern technologies claim exactness in addressing genetic erosion and the term gene-ecology has been introduced. Mainly molecular methods are being applied with convincing repeatability but, mostly, genetic erosion in a narrower sense (loss of landraces) is not investigated. As a typical example, Donini et al. (2000) studied temporal trends in diversity of wheat cultivars from the UK. There are many similar investigations with different results for different crops depending on the selection of material (Fu 2006). Often an increase of diversity in the modern cultivars is shown (Landjeva et al. 2007), via germplasm enhancement by the breeders (wild relatives, foreign cultivars, landraces). There are only a few studies that actually include landraces (Grau Nersting et al. 2006; Hysing et al. 2008; Jones et al. 2008) showing among other things the difficulties of molecular studies in describing genetically variable landraces. The methods have still to be adapted for studying genetic erosion in a narrower sense, i.e. the loss of landraces.

2.8 Why have landraces survived in intensive agriculture?

There are two main reasons for the survival of landraces:

1. They may belong to crops which are not in the official seed lists and accordingly have not been considered by breeders. Famous examples are *Avena strigosa* (Camacho Villa et al. 2005), an oat from the northern parts of Europe, and the primitive wheats *Triticum monococcum* and *T. dicoccon* from parts of western and southern Europe (Perrino and Hammer 1984).
2. Landraces can also survive under agricultural conditions due to geographical (islands, see Hammer and Laghetti 2006) and other forms of isolation (ethnographical, geographical, ecological, etc., see Bullitta 2007).

Within landraces, the general tendency is that landrace garden plants (vegetables, fruits and some aromatic and medicinal plants) have a better chance of survival, whereas the field crops (cereals and pulses, forage plants, industrial plants) show very strong genetic erosion (see also paragraph 2.9). Landraces of strictly agricultural crops such as cereals are at present rarely cultivated on-farm. Exceptions are leisure or small-scale agriculture, to use them as feed for chickens or horses (Diederichsen et al. 2007). Landraces of annual vegetables are also much more likely to be preserved in industrialized countries as the numerous examples from Italy prove. Among the vegetables, landraces of annual species or perennials are more likely to be preserved than biennial species, due to the technical and biological challenges in seed production. NGOs play an important role in preserving such landrace material (Hammer

2004). Dishes that are traditional for a certain region or associated with a special holiday or season often make use of a particular landrace, and such traditions have contributed to the on-farm or *in horto* preservation of vegetable landraces.

2.9 Landrace hotspots

As a classical centre of diversity proposed by Vavilov, the Mediterranean area represents a hotspot for landraces (genecentres and hotspots are briefly compared by Hammer 2004). Because crops have been grown there for a long time in proximity to many wild relatives, this created a unique situation which favoured crop plant evolution (Hammer et al. 1999). Landraces of diverse crops from cereals to fruit trees are still present. A recent review (Laghetti and Hammer 2004) describes the situation in the Mediterranean area. Parts of southern Italy can still be seen as a hotspot for vegetables and some minor crops. Cereals suffered from genetic erosion except for some landraces of maize, rye and hulled wheats (Lucchin et al. 2003). A similar situation prevails in Spain, Portugal, southern France and the Balkans. Countries with extremely high levels of genetic erosion are Albania (Hammer et al. 1995) and Greece, where replacement by modern cultivars (Bennett 1971) resulted in the extinction of many landraces. In the former Yugoslavia, the situation is slightly better. Micro-hotspots for landrace diversity can be found here. Several of the countries in Europe which are in transition from centrally planned to market economies have until recently still cultivated landraces, and these regions need to be explored more systematically. The Carpathian Mountains represent such a region in Europe, in which vegetable maize and occasionally cereal landraces can still be found (Hammer et al. 1981; Szabó 1981; Monitoring Institute 2002; Diederichsen et al. 2007).

Most of Europe belongs to the European-Siberian, and parts to the Mediterranean, centres of origin of crop plants, according to Zeven and Zhukovsky (1975). Some Mediterranean islands still preserve landraces. The small Italian islands can serve as an example (Hammer and Laghetti 2006). A similar situation was observed in the UK (Scholten et al. 2008). The larger Mediterranean islands are less promising, especially Corsica (Bullitta 2007; Bullitta et al. 2008) or Malta (Laghetti et al. 2004). The situation is slightly better on the islands of Sardinia (Pignone et al. 1997), Sicily, Crete (Laghetti et al. 2008), Cyprus (Della 1999) and the Balearic Isles. A special situation has been described for the Canary Islands (Gil 2005), Madeira and the Azores (Vieira 2002).

2.10 Opportunities for the future

Based on the hypothesis that the genetic diversity in landraces is important and threatened by extinction, priority measures should be taken. (1) Landraces still in cultivation need to be identified by species and region. Such an inventory needs to be compiled in close cooperation with NGOs engaged in preserving and developing crop diversity. (2) Collecting of landraces, in particular in regions that are undergoing drastic economic changes, e.g. in east and southeast Europe, needs to be conducted so that *ex situ* conservation can complement the *in situ* conservation. (3) Legislation on breeding variety protection that conflicts with on-farm diversification needs to be questioned seriously at the national and European levels. Variety protection laws and European production standards have had negative impacts on agro-biodiversity. Therefore it would be wise to monitor the changes in agriculture in the countries which recently joined the European Union. (4) Localization of production and consumption of food should be promoted whenever economically possible, as this is the socio-economic sphere in which landraces can thrive. (5) New approaches in plant breeding including participatory plant breeding need to be actively explored, developed and systematically studied with regard to their economic feasibility and ecological impact (Ghaouti et al. 2008; Horneburg and Becker 2008). One area with a great potential for agro-biodiversity is the increasing demand for organic production, including the production of cultivars as an integral part of this approach (Finckh 2008; Wolfe et al. 2008). For the specific situation in Germany, Becker et al. (2002) made some suggestions for policy makers and researchers.

When taking an overview of the drastic changes which crop diversity underwent during the last 200 years, it is obvious that the route taken cannot be continued. The economic pressures under which genebanks operate make it very questionable whether the *ex situ* approach will be sustainable over time in preserving landrace diversity. In addition, even among the pioneers of the plant genetic resources movement, questions regarding the *ex situ* approach have been asked because it 'freezes evolution' (Hawkes 1991). Hence, the seed storage vault on Svalbard under the control of the Global Crop Diversity Trust may not be the sole insurance we should rely on for preserving cultivated plant diversity. Working on on-farm projects and evolutionary breeding strategies (Suneson 1956) that actively explore new approaches is probably the best strategy to ensure that crop diversity becomes more dynamic and that the evolution of landraces will continue.

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Section 2 - Landrace Inventories

3. Landrace Inventories: Needs and Methodologies

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3.1 Introduction

Countries that have ratified the Convention on Biological Diversity and the International Treaty for Plant Genetic Resources for Food and Agriculture obviously wish to meet the CBD 2010 target of achievement "by 2010 of a significant reduction of the current rate of biodiversity loss" in the components of biodiversity, which includes agro-biodiversity defined as "the genetic diversity of crops, livestock, and harvested species of trees, fish and wildlife and other valuable species" (CBD 2004). As a consequence of ratifying the Convention and Treaty, they engaged themselves to make inventories of their biodiversity, design national conservation plans and monitor diversity to assess the efficiency of conservation actions. The principles of producing national inventories of the wild components of biodiversity are well established, and botanists have been creating checklists and floras since the time of Theophrastus in the third century BC (Davis and Heywood 1973). But while each country has a national Flora or checklist, there are far fewer examples of inventories of the cultivated components of biodiversity (see Maxted et al. 2007). Specifically, as far as is known there are no fully comprehensive national inventories of crop landrace diversity, but national accounts do exist (see: www.catalogovarietalocali.pris2.parco3a.org/).

It is important that stress is laid on 'comprehensive' in the previous sentence as there have been many landrace inventories in recent years, as will be shown in subsequent chapters, but each can be considered 'partial' in the sense of covering a specific crop gene pool or target area or, while attempting a national inventory, failing to be fully comprehensive. Yet we suggest it is national inventories of crop landrace diversity that are required if the CBD 2010 target

for agro-biodiversity is to be met. National inventories are required because agro-biodiversity policy is applied at a national political level and, without knowing what exists, how can governments plan and implement the systematic conservation and use strategies for landraces that are necessary to underpin national food security – if we do not know what exists how can we conserve and use it effectively? As such it seems self-evident that an inventory of resources is the starting point for agro-biodiversity conservation.

The subsequent chapters in this section of the text outline the practical experiences of specialists in preparing landrace inventories and provide examples that may assist others attempting to produce landrace inventories. This introductory chapter aims to review the limited literature and build on the practical experiences outlined, and so to address the more generic questions associated with the methodologies for how to prepare landrace inventories.

3.2 What constitutes landrace diversity?

The answer to this question is relatively straightforward but may be difficult to apply in practice. Once a definition of a landrace is agreed, the inventory aims to catalogue the distinct landrace entities that constitute the breadth of that diversity. So a comprehensive landrace inventory would be made up of the diversity both among the different extant landraces and the full range of genetic diversity found within each landrace. It should be noted that landraces are, almost by definition, constantly evolving within the *in situ* context as a result of farmer selection and environmental changes, so the diversity found within landraces changes with time and with the turnover of maintainers. As a consequence, instead of 'conservation' (*sensu stricto)*, we should talk of 'preserving' or 'maintaining' landrace diversity in the field (i.e. through landrace cultivation on farms), possibly besides providing backup security through *ex situ* conservation. However, an inventory necessarily takes the form of a 'snapshot' and this then leads to a second question: how are distinction and difference to be recognized in the field? The conclusive answer would be to sample and investigate genetic diversity between and within landrace material using some form of diversity index, but when creating a national inventory it would be impractical to consider investigating the patterns of genetic diversity both between and within all national landrace material either using molecular or even morphological evaluation techniques.

It is therefore necessary to use a proxy for estimating genetic diversity among and within landraces. Pragmatically the two proxy

measures that are often employed are nomenclature and expert knowledge. It may be assumed that if two landraces have different names they are in fact different, they are internally consistent and distinct from each other. Also while preparing an inventory, if an expert (e.g. crop specialist, local extension officer or farmer), says two landraces are distinct then it is assumed that the expert's knowledge is correct and the landraces are distinct. While both of these assumptions will on occasion be false, in the absence of actual knowledge of patterns of genetic diversity or knowledge to the contrary, then we can apply Ockham's razor and assume the assumption is correct. Therefore, the diversity of landraces to be included in the inventory will be pragmatically based on landrace nomenclature and expert knowledge.

3.3 Actual scope of a landrace inventory

Although the general aim of a national inventory should be to catalogue all national landraces, the actual scope of the landrace inventory may be limited and defined by the commissioning agency which will make the resources available for the data collation, and may thus explicitly (stating which species should be covered) or implicitly (sufficient resources are available to cover only a limited range of species) establish the breadth of the inventory. The plant scope may therefore be universal, covering a complete inventory of all socio-economically valuable species with landrace diversity, or restricted to a subset, e.g. major field crops, forages, fruits, medicinal species or wild harvested species.

As well as restricting the scope of the inventory to crop groups, the inventory might conceivably also be restricted in terms of landrace localization or threat. In terms of localization, it might be desirable to restrict the inventory to what might be considered 'native' landraces, autochthonous as defined by Zeven (1998a) rather than allochthonous or Creole landraces of recent introduction. It is likely that autochthonous landraces will have evolved over time unique local adaptations and may therefore be of greater interest to plant breeders; certainly the characteristics of the landrace would be more easily predicted using ecogeographic and GIS techniques.

Another aspect of scope will be the relative level of cultivation of the landrace to warrant inclusion in the national inventory. For example, would only commercially available landraces be included, or would a landrace held by a single farmer be considered for inclusion in the inventory? To illustrate this point, when preparing the UK national landrace inventory (see Scholten et al. Chapter 15 this volume) a landrace of the forage legume sainfoin (*Onobrychis*

vicifolia Scop.), 'Hampshire Common', was included even though it was only grown by one maintainer, the Cholderton Estate in Hampshire, on about 450 hectares annually. If including single-maintainer landraces, and depending on the remit of the inventory, it may be necessary to distinguish between individual maintainers growing a crop landrace for commercial sale and individual home or allotment gardeners, growing for home consumption. Given the overall goal of an inventory it would be wise to maximize the inclusiveness of the inventory and include single-maintainer landraces wherever possible; one would not wish to exclude the 'last survivors' from the inventory.

An extension of the question over the relative level of cultivation of the landrace is whether the landrace has to be grown by a farmer or whether home garden cultivation of landraces would also be included. For vegetables and fruits, for example, it is well known that home gardens have a particular wealth of diversity, much of which has been cultivated and seed saved for generations. As such this material falls within the definition of a landrace outlined above and so should be included in the national inventory. In addition vegetable and fruit landraces are not always cultivated as open field crops (i.e. cultivated on a large scale). The inclusion of home garden landraces is however likely to expand the resources required to undertake the inventory, as the number of landrace growing units (farmers or householders) would be likely to be expanded by a degree of magnitude. Also if including home garden cultivation of landraces, the formal agricultural or plant genetic resource networks may have less direct access to maintainers and there may be a need for collaboration with more informal sectors, such as NGOs or farmers' associations working to promote organic gardening or traditional rural pursuits.

3.4 How to collate information on landrace diversity

The first point to stress is that there is no widely tested model for collating information on landrace diversity, so that the methodology applied by individual inventories is likely to depend on the reasons for undertaking the inventory, the geographic and crop scope of the inventory, access to appropriate data sources and maintainers, available expert knowledge and resources available. The methodology therefore needs to suit the application, but we can learn from previous inventories the kinds of approaches that have been taken to prepare inventories.

Information relating to landraces, their cultivation and use is often anecdotal. Historically such information was obtained during

germplasm collecting missions. A more comprehensive 'checklist' approach was developed by Hammer and associates (Hammer et al. 1999; Hammer 1990, 2001) and also by Negri (2003), where farmers and gardeners were approached directly and their gardens or fields screened for all crop diversity. Smaller-scale surveys targeting specific amateur vegetable varieties used publicity campaigns directed at the target community. Hammer et al. (1977) and Weibull et al. (Chapter 14 this volume), for example, collected home garden landraces following advertisements in amateur gardening magazines, and Zeven (1979 and 1998b) used local newspapers as well as a radio announcement to collect Dutch bean and Dutch kale landraces. In the UK a similar approach was used to assess heirloom vegetables by Stickland (1998). So to summarize, the possible means employed to track extant landraces might include:

- *Expert advice* - from genebanks, national testing centres, research institutes, agricultural extension divisions, farmers' organizations, agricultural statisticians, other professionals and NGOs
- *Commercial companies* - companies involved in seed production, brewing, milling, distilling etc.
- *Scientific literature* - including reviews of historical literature, research reports, papers and articles
- *'Grey literature' archival materials* - associated with genebanks, research institutes, seed companies, NGO newsletters, local farmers' society publications, farm records
- *Internet searches*
- *Official documents* - such as agricultural statistics, e.g. EU Common Catalogues for vegetable and agricultural varieties (EU 2008a and b) or National Varietal Lists
- *Farmer interviews* - farmers themselves may be approached indirectly through advertisements, articles in farmers' magazines and local newspapers or other non-print media, and directly via personal contacts.

All contacted persons should be clearly informed of the goal of the inventory in promoting landrace conservation and use. When dealing directly with the landrace maintainer the desired information may be obtained by questionnaires completed either remotely or in the presence of the researcher via telephone or interview. However, for areas considered to be particularly rich in terms of landrace diversity, ideally the researcher would visit the area and interview the maintainers, as was the case for the Outer Hebridean islands of Western Scotland during the preparation of the UK national landrace inventory (see Scholten et al. Chapter 15 this volume).

3.5 Data collated for a national landrace inventory

The actual data collated for each landrace inventory will probably be dependent on the resources available for collation, the scope of the landrace inventory, diversity of landraces encountered, level of knowledge of the inherent diversity within the landraces, cultural practices involved and how the landrace information is obtained. Obviously much more information will be recordable if the landrace has been extensively studied at first hand as opposed to a landrace known simply from a remotely completed questionnaire. However, the broad categories of information that might be included in a national landrace inventory will be:

- Scientific name
- Name of landrace
- Maintainer details (e.g. name, contact details, age, gender, family structure, education, main source of income, owned or rented land, size farm, organic status, arable or mixed farming system)
- Geographic location (e.g. province, nearest settlement, latitude, longitude, altitude)
- Landrace characteristics (e.g. characterization and evaluation details, maintainer-perceived value, length of seed saving, relationship to other landraces)
- Cultivation details (e.g. area currently sown, history of area sown, time sown, time harvested, cultural practices, cultivation inputs, method of selection of seed saved, method of seed storage, maintainer exchange frequency, other and non-landrace material grown, maintainer's comparison with modern varieties, local or national maintainer incentives)
- Relative uniqueness of landrace (e.g. grown on single farm or more widespread, genetic distinction)
- Usage (e.g. description of main usage, secondary usage, home consumption or marketed, marketing, current and past values, member of grower or marketing cooperative)
- Threats (e.g. perverse incentives, lack of sustainability of farming system, lack of market).

Specifically, and based on wide practical experience, a landrace diversity information collecting form that aids the documentation of landrace on-farm conservation activities has been developed by Suceava genebank (Romania) and Dipartimento di Biologia Applicata (Italy). It was then revised with the help of all the members of the On-farm Working Group within ECPGR and is now available to potential users at www.ecpgr.cgiar.org/Networks/Insitu_onfarm/Docs/OnfarmDescr_DRAFT271107.pdf. Although this descriptor form is extensive and it is unlikely that all the above information will be recorded for each landrace

in the national inventory, it represents a detailed, practical example of the information to be recorded while inventorying landraces.

The creation of the national landrace inventory should not be an end in itself, the information contained in the inventory must be made available. Once the data are collated into the inventory database it should be made public, ideally via a web-enabled database (e.g. see the Italian and UK landrace inventories at www.catalogovarietalocali.pris2.parco3a.org/ and http://grfa.org.uk/search/plants/index.html respectively).

3.6 Post-inventory follow-up

As already noted, the creation of the national landrace inventory is not an end in itself, the inventory must justify its creation in terms of the promotion of landrace conservation and use. Detailed knowledge from the inventory of the location of landrace diversity means that the ease with which that diversity can be studied and safely duplicated *ex situ*, primarily in genebanks, can be systematically expanded. The generation of the inventory will also enable the *in situ* landrace diversity to be matched against the conserved diversity, as either accessions of the landrace held in *ex situ* collections or landrace diversity effectively conserved on-farm through time, and the 'gaps' targeted for conservation action. The inventory should also act as a stimulus not only to the formal use of landraces in breeding programmes, but also to the promotion of specialized or novel marketing niches based on landraces and the underpinning of local cultural heritage. Use of conserved landraces is essential and is likely to underwrite the long-term sustainability of any landrace. Finally, the inventory should be periodically updated to monitor changes in on-farm maintained landrace diversity. In this way the inventory will become a tool to assess the efficiency of conservation actions and fully serve the purposes of a proper conservation strategy.

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4. Bulgarian Landrace Inventory – Significance and Use

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4.1 Introduction

The rapid development of plant selection began with the development of the scientific and technical revolution. 'The green revolution' played a significant role for provision of food and clothes for the people, but it also had negative aspects. The main accusation was that it led to the large-scale elimination of local landraces of which the genetic variation had been established for millennia. The plant germplasm, both that existing in nature and that created by purposeful human activity represents an invaluable treasure for mankind. It should be studied, maintained and stored in living condition in order to be used now and in the future (Guteva et al. 1998).

The reasons why there is so much genetic variation in Bulgaria are:

- The location of the country between Europe and Asia and the three phyto-climatic areas: European broad-leaved forest, Steppe and Mediterranean
- The diverse climate, determined by the influence of four air masses: from the north-west – cold and humid; from the south-west – warm and humid; from the north-east – cold, continental, arctic; from the south-east – humid and warm. The climate is also influenced by the Black Sea, directly in the coastal zones, and less directly by the Mediterranean Sea
- Orthographic conditions are complex and there is a rich variety of soil formations with nine predominant types
- Geomorphological structure with four distinct altitude zones: low /0-200m/ 31.5%; hilly /200-600m/ 15%; semi-mountainous /600-1000 m / 15%; and mountainous /over 1000m / 12.5%
- Historic uses of land which developed according to the needs of the population, the available biological diversity and the natural and climatic activities for each region (Koeva 1998).

Work with plant resources in Bulgaria was informally established in 1906 by means of the activities of K. Malkov and his followers in introducing plant resources for selection purposes and direct use. The beginning of scientific research activity in the sphere of plant resources in Bulgaria was established by Acad. Doncho Kostov in

1940. In 1952 at the Institute of Genetics, Sofia, a Department in Plant Introduction was established, and in 1977 the Institute of Introduction and Plant Resources K. Malkov was established in Sadovo. Later its name was changed to the Institute of Plant Genetic Resources (IPGR).

4.2 Bulgarian National Institute of Plant Genetic Resources

IPGR-Sadovo, Bulgaria was recognized as a national centre, responsible for scientific research work regarding organization, collection, study and use of landraces for the needs of selection and their direct use in production, as well as for storage in the genebank at the Institute for future generations. The activities related to:

1. Collection of large-scale information and specimens from various regions of the country.
2. Formation and continuous enlargement of the landrace collections and preservation of their genetic variety.
3. Inventory and complex study of the landraces' germplasm suitable for use in plant selection.
4. Creation of a database of evaluation information for acceleration of the selection process and for responding to practical needs.
5. Identification of the gathered collection of the local landraces.
6. Creation of characteristic collections and core collections, supporting the use of the most valuable specimens in the selection process and for direct introduction into production.
7. Enrichment of the national variety list by new varieties with valuable qualities.

IPGR Sadovo developed a programme in which the priority was to collect landraces of vegetable, cereal, grain legume and medicinal crops (Figure 4.1). The collection of landraces which were still preserved and maintained in Bulgaria was carried out by means of organized expeditions in various regions of the country.

One of the most important factors in expedition organization was the choice of a route for collection; the main factor considered being crop distribution by regions:

- *cereal crops* – regions with extensive agriculture, including mountainous and semi-mountainous regions of the country – south-east and south-west Bulgaria, closed border regions, monastery lands, etc., i.e. places where the replacement of varieties was happening slowly

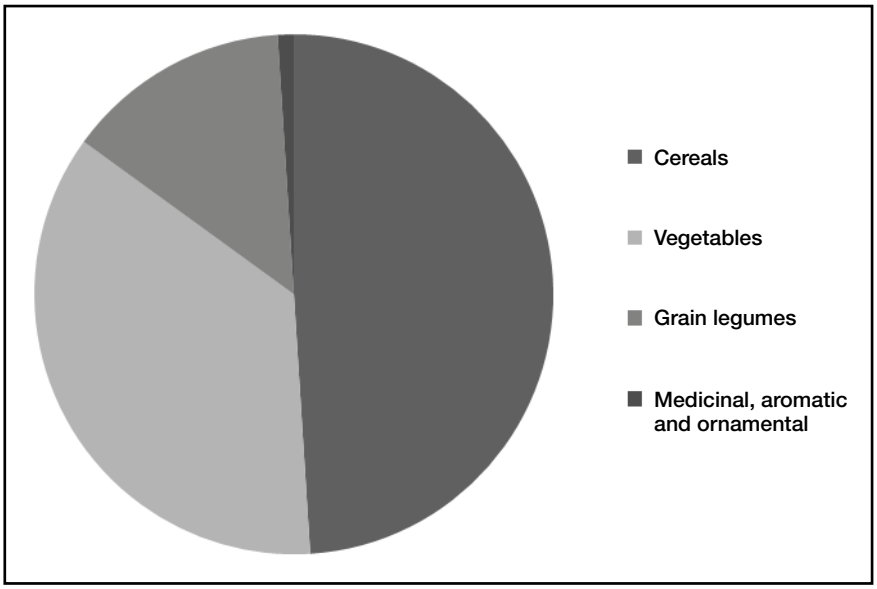

Figure 4.1. Percentage of major crop landrace accessions preserved in IPGR.

- *grain legumes* – the regions of Blagoevgrad, Kyustendil, Strandzha-Sakar, Rodopi, Ludogorie, etc.
- *basic vegetable crops* – the old garden regions of the country near Gorna Oryahovitsa, Veliko Tarnovo, Svishtov, Vidin, Popovo, Petrich, Sandanski, etc.
- *water melons, melons, pumpkins* – Pleven, Vidin, Razgrad, Shumen, Yambol, Lyubimets, Svilengrad
- *flower, decorative, spices* – home gardens, monasteries and church estates throughout the country.

During expeditions small seed specimens were taken from the local farmers. According to the instructions of IBPGR for the collection of genetic resources, adapted for Bulgarian conditions (Krasteva 1989), the passport data of the specimen were registered in a special log, including the country of expedition, the type of specimen, the local name, the residential district, the region, the altitude, the source. Later this passport information along with a temporary number for each specimen was printed in the register issued by the Institute (1982-1987). Twenty expeditions were organized in the period 1977-1996, through which a great number of specimens from all varieties of crop plants still grown in some regions of the country was collected (Table 4.1). In the group of the wheat landraces, the largest percentage was of durum wheat, 45%, followed by maize, 28%, soft wheat and barley, 24% (Figure 4.2).

Table 4.1. Collecting accessions of green beans in Bulgaria, during 1977-1996.

Collection Year	Collecting mission / Region	No. Accessions
1977	1 . Pazarzhic, Plovdiv, Stara Zagora, Kurdzhali regions	116
1978	1. Sliven, Turgovishte, Razgrad, Shumen regions	230
	2. Vidin, Vratsa, Montana regions	69
	3. Stara Zagora, Sliven, Ruse, Dobrich, Gabrovo, Varna regions	8
1980	1. Veliko Turnovo region	18
	2. Lovech region	26
	3. Gabrovo region	17
1981	1. Blagoevgrad region	37
	2. Montana region	1
	3. Botevgrad region	3
1983	1. Pleven, Sliven, Shumen, Burgas regions	91
	2. Blagoevgrad, Kyustendil, Sofia regions	78
1985	1. Kyustendil region	36
1986	1. Burgas region	32
1989	1. Sofia region	83
	2. Lovech, Yambol, Lom, Razgrad regions	267
1990	1. Smolyan region	136
1991	1. Veliko Turnovo region	134
1992	1. Veliko Turnovo, Turgovishte regions	4
1993	1. Plovdiv, Pazarghik, Burgas regions	5
1994	1. Smolyan region	4
1995	1. Sofia region	3
1996	1. Stara Zagora, Plovdiv regions	72
	Total for all period, 1977-1996	1 452

4.3 Cereal crops

The number of durum wheat landraces was significantly the largest category at over 1118 accessions, collected from various regions of the country. Their largest number was from southern Bulgaria – the regions of Svilengrad, Elhovo, Ivaylovgrad, Yambol and Topolovgrad (Popova and Koeva 2001; Ganeva et al. 2005). These landraces were evaluated according to the international classification system and stored in the genebank. Also 700 accessions of Bulgarian soft wheat (*Triticum aestivum*) were collected and stored over the last 20 years. They were evaluated according to a classification system and a database was created (Kolev 2001; Odgakova et al., in press).

During later expeditions in 2007 and 2008, single accessions of wheat, maize and rye were collected (Figure 4.2) as a result of the

introduction of high-yielding varieties, which had quickly replaced the old low-yielding varieties and populations. The contemporary wheat and maize varieties are high-yielding, well-adapted to the conditions of growing and are highly resistant to the economically important diseases, which supports the solving of the global problems related to hunger and poor nutrition. The selected varieties have close genetic heredity in contrast to the traditionally grown old local varieties and landraces, which were characterized by strong polymorphism due to the variety of source specimens, the diverse ecological conditions of the country and the non-purposeful selection.

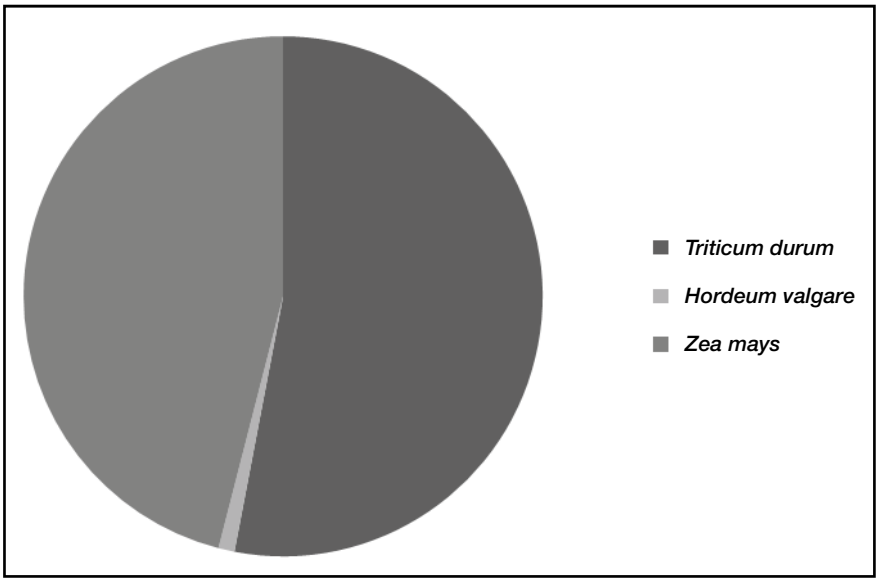

Figure 4.2. Percentage of cereal landrace accessions preserved in IPGR.

The maize collection contains 960 landraces, many of which are included in the long-term evaluation programme and improvement work, aiming at full description of the collection of local landraces. Selection of landrace accessions with valuable agricultural qualities, as well as pre-selective improvement work with the selected groups aiming at the accumulation of favourable gene combinations, provided the opportunity for obtaining valuable self-pollinated lines in the subsequent stages of the selection. A small number of landraces have been analysed by means of DNA analysis. The results showed unique genetic diversity in some accessions (Kostova et al. 2006, 2007).

In total 63 landraces and old varieties of oats and rye were tested and evaluated. Parameters identified that were important for selection were: shortened stem with rye, short vegetation period and grain rich in protein and lysine in oats and rye (Antonova 2009).

4.4 Vegetable crops

A large part of the conserved landraces are vegetable crops including French beans, pepper, water melons, melons, pumpkins, tomatoes, onion and spice crops (Table 4.2). The pepper (*Capsicum annuum* L.) which was imported into Bulgaria around the 16th century, very soon became one of the most popular vegetable crops. As a result of the geographical remoteness of our country from the centres of origin, the natural cross-fertilization among plants and the continuous selection activity, a specific Bulgarian group of peppers can be recognized and Bulgaria is considered a secondary specimen-formative centre. Pepper is a traditional and economically significant vegetable crop in Bulgaria. Various types of pepper were grown in Bulgaria for centuries. The fact that 98% of the peppers grown in the country result from Bulgarian selections and that crop production is largely based on landrace production indicated the necessity for collection, evaluation and storage. Following these activities 263 pepper landraces were collected during six expeditions organized by IPGR in the period of 1983-1990. They were reproduced and evaluated according to the classification system of VIR, Leningrad, 1979 (Todorova and Jodorov 1998; Todorova 1999). The evaluation included vegetative, reproductive and agronomic properties, chemical indices and resistance to some widespread diseases affecting pepper. The database is at the disposal of interested persons at the IPGR computer centre. The large morphological differences between particular specimens and the various guidelines for use suggested that Popov's classification (1940) could be used, and eight different size groups were recognized. The largest group of tapered varieties var. *conicum* consisted of 96 specimens or 36.4% of the collection, followed by var. *kapia* of 65 specimens or 24.6%, and the small-fruited peppers subsp. *microcarpum* provided a smaller number, defined as cone peppers var. *conoides* with 31 or 11.7%. The populations of var. *rotundum* 83E1211, 87EM63, 87EM26; var. *dogma* - 83E1103, 83E1216 and 83E125; var. *condatum* - 87EM21 had resistance to *Verticillium dahliae* with attack index of 0.1 to 10%.

Table 4.2. Vegetable landraces held in IPGR Genebank, Sadovo, Plovdiv, Bulgaria.

Crops	1977-2006	2007-2008	Characterized	Total
Lycopersicon esculentum	164	115	235	279
Solanum melongena	5	12	7	17
Capsicum annuum	283	506	564	789
Phaseolus vulgaris	657	226	811	883
Pisum sativum	-	1	1	1
Cucumis sativus	18	27	33	45
Cucumis melo	135	32	151	167
Citrullus edulis	70	13	81	83
Cucurbita sp.	149	78	189	227
Allium	62	158	162	220
Brassica	12	4	16	16
Lactuca	31	19	44	50
Spinacia	5	2	5	7
Daucus carota, *Anethum*, *Apium* and other *Umbelliferae*	31	11	31	42
Total	1 622	1 204	2 330	2 826

The pumpkin collection consisted of 243 specimens, 94 of which were introduced varieties and 149 were landraces. It included the varieties *C. maxima*, *C. pepo* and *C. moschata*. Each particular variety had a wide diversity of plant and fruit morphology. Accessions E6368 and E6349 of the *C. maxima* variety and E6373, E6355 of the *C. pepo* variety were classed as highly reproductive; they surpassed the standards: White Grande and Raketa 47-4, by 15-20% for the first group and by 20-27% for the second group. The expedition activity at IPGR Sadovo was resumed in 2007 (Figure 4.3) and 2008 (Figure 4.4), and as a result approximately 800 specimens with local origins were collected from regions in southern and a part of north-eastern Bulgaria. Approximately 200 villages were visited as the expedition's purpose was to collect material at greater distances in order to include the largest possible genetic diversity in populations. During the expeditions carried out in the last two years, most of the specimens were collected from pepper (*Capsicum annuum*), 107 specimens in 2007 and 215 specimens in 2008 with various directions for use: for roasting, for filling, chilli pepper, for ground red pepper and for drying. The collected specimens belong to various varieties: a group of wide peppers (var. *rotundum*), corneous (var. *corniforme*) – long narrow peppers, a group of long peppers (*var. longum)*, all varieties of long fleshy peppers – Kurtovska, Pazardzhishka, etc. belong to these varieties. Small-fruited peppers also represent a large group, which also includes: chilli peppers – cone pepper and cherry tomatoes (var. *shipka* and var. *cerasiforme*).

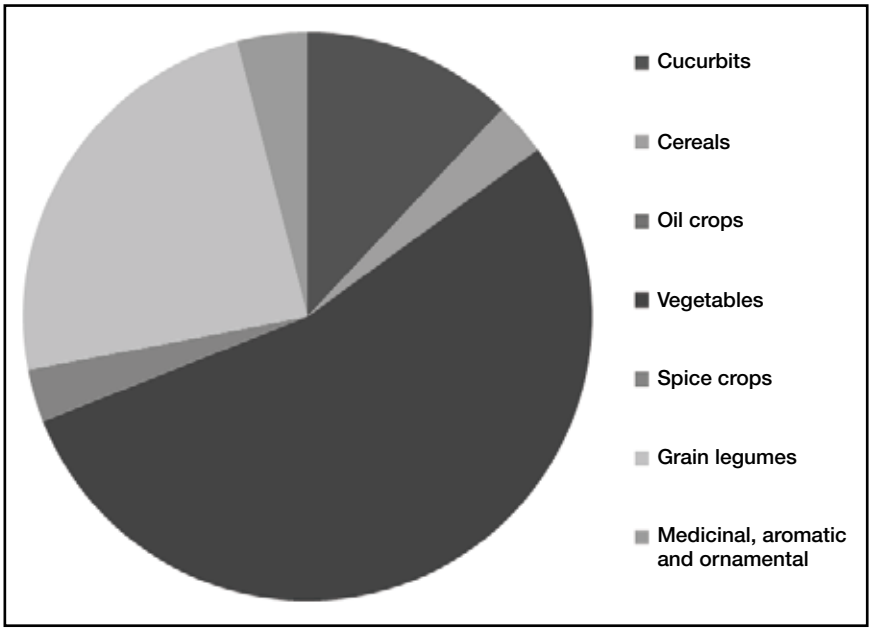

Figure 4.3. Landrace accessions collected in 2007.

As a result of the organized expeditions a rich collection of 1452 specimens of garden beans (*Phaseolus vulgaris* L.) was gathered, which was characterized in two ways, the first related to national standards for the varieties (*volubilis* and *nanus*) and the second was based on unified international descriptors. A total of 1376 garden bean landraces were evaluated for bean weevil resistance during a 16-year test and 305 accessions were found to have varying degrees of resistance: 158 landraces from northern Bulgaria (Pleven, Svishtov, Targovishte and Lom) had the highest resistance, 105 from southern Bulgaria (Plovdiv, Yambol and Kyustendil) also showed some level of resistance, and from the mountainous and semi-mountainous regions of Smolyan, Blagoevgrad and Sliven 44 accessions also showed resistance. A characteristic collection of the species *P. vulgaris* was established with various degrees of resistance to bean weevil, which may be used for selection programmes. In further tests, 333 landrace accessions were studied for their resistance to mechanical traumas during a 16-year test and 45 accessions were nominated as gene sources for resistance to mechanical seed trauma, and the resistant accessions were predominantly white seeded and round types *sphaericus* and *oblongu*s. A further 367 landrace accessions were screened for cold resistance and 45 specimens were nominated which had different tolerance to low temperatures in various development phases (Table 4.3). A characteristic collection has been created with a high degree

of cold resistance, containing specimens of the two varieties of the species *P. vulgaris* L. In a separate trial, 213 landrace accessions were characterized for nitrate accumulation in beans and 14 were found to have very low nitrate content, which may be used for direct production of ecologically clean produce. A characteristic collection of 67 landraces with low nitrate content was created (Krasteva 2000).

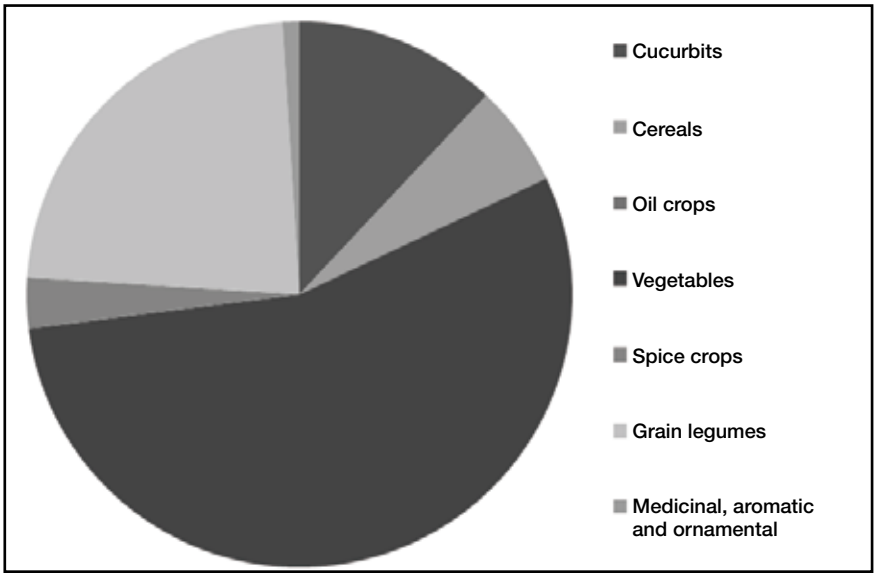

Figure 4.4. Landrace accessions collected in 2008.

Table 4.3. Green bean landraces accessions testing under controlled conditions.

Characters	Number of accessions showing higher value of one or more traits compared with control variety						
	1	2	3	4	5	6	7
Field conditions							
Plant morphology	38	15			7	1	
Pod morphology	42	21	5		7	1	2
Seed morphology	90		14	36			
Biology of plant	66					1	2
Plant productivity	106		10	36		1	2
Pods biochemistry	134	20	1				
Total	476	56	30	36	7	1	2
Control conditions							
Resistant to bean weevil	305						
Resistant to mechanical seed damage	45						
Resistant to low temperatures	45						
Resistant to nitrate accumulation	67						
Total	462						

4.5 Grain legume crops

The next largest group of landraces is represented by grain legume crops (Figure 4.5). Twenty percent of the pea collection had a Bulgarian origin. The landraces were represented by 45 specimens collected from everywhere in Bulgaria in the period of 1955-1965. These were predominantly old landraces used for herbage and suitable for fresh forage. The majority of them had high tolerance to winter conditions and were used as donors of this characteristic (Angelova and Guteva 2001; Angelova 2002).

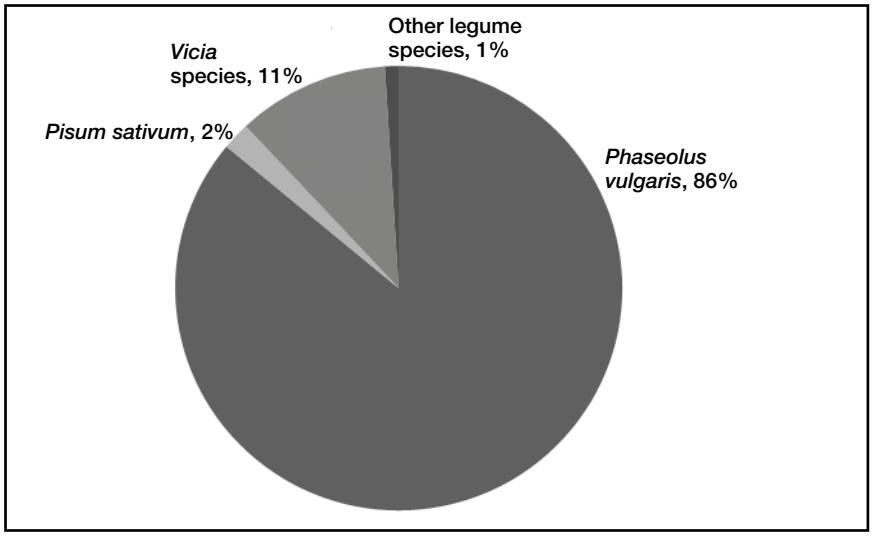

Figure 4.5. Percentage of grain legume landrace accessions preserved in IPGR.

The common vetch collection had representatives of approximately 200 historic Bulgarian landraces. Some had good herbage productivity, others had high resistance to stress factors and others had resistance to diseases important for the country (Kitcheva et al. 2003; Angelova and Guteva 2007).

The landraces of beans in Bulgaria are distinguished by their great diversity, and therefore required a continuation of collection and research. The bulk of bean landraces were collected during previous expeditions and 1450 were studied at IPGR (Krasteva 2000; Stoilova et al. 2004, Stoilova and Sabeva 2006). The group of common beans (*Phaseolus vulgaris)* was largest with 226 specimens collected in 2007-2008. Some specimens named after a village, such as 'Maglizhki beans' or 'Raykin beans' were particularly valuable. In mountainous regions large salad beans – *P. coccineus*, better

known under the name of the village as 'Smilyanski beans' were widely used; 20 landraces of them were collected. These salad beans were characterized by growing and fruiting in the particular micro area (village of Smilyan and its vicinity), a region which is more characterized by higher humidity and lack of high day temperatures (> 30˚C), than those of the plain regions of the country. After its transfer to Sadovo to our experimental field under very different climatic conditions, it did not form reproductive organs or if it formed such organs, they could not reach the maturing stage (Stoilova and Sabeva 2008).

In the group of grain and leguminous crops two lentil landraces are of particular interest: they were collected at the village of Zetyovo, region of Aytos, the only village where lentils were grown in order to meet the villagers' own needs and landraces were cultivated. In the south-eastern part of the country (near Svilengrad, Lyubimets, Kap. Andreevo) another variety of grain and leguminous crop was grown, known under the local name of 'roglyo' or 'papuda': this is a variety of *V. unguiculata* L. It is remarkable for its drought resistance and productivity (Stoilova 1998; Stoilova et al. 2004).

4.6 Vegetable crops

The pumpkin collection consists of 149 landraces. During the last two expeditions a significant number of specimens were collected, 36 accessions in 2007 and 63 in 2008 respectively. The group included pumpkins – white pumpkin (*Cucurbita maxima*), field pumpkin (*Cucurbita pepo*) and Muscat pumpkin (*Cucurbita moschata*), as well as zucchini (*Cucurbita pepo* L. var. *giromontia*). Each particular variety was notable for the large diversity of its plant and fruit morphology. It is noteworthy that these varieties were grown in almost all regions, in contrast to cucumbers, where the farmers mainly sowed purchased seeds, so the specimens collected from this crop were fewer, only four accessions in 2007 and eight in 2008 (Neykov et al. 2005). One of the preferred vegetables in Bulgaria is tomato *(Lycopersicon esculentum*) and 66 accessions were collected in 2007/8. Pink and red large home-grown tomatoes cultivated for two or three farmer generations predominated. They are characterized by thin skin and a sweet and acid taste. They are grown by almost every household.

Among the other vegetables were the onion crops with 220 accessions, including garlic and onion (*Allium sativum* and *A. cepa*), and some landraces of 'bunching garlic' type *A. sativum* var. *sagitatum*, and some shallot type onions.

The variety of spice crops in Bulgaria is great, which makes their collection, research and storage challenging (Neykov and Todorova

1998). One spice crop which is most widely spread across all regions is the traditional Bulgarian spice – savory (*Satureja montana*), but many other spice crops are grown along with it. Seeds of them were collected: basil (*Ocimmum basilicum*), parsley (*Petroselinum hortense*), celery (*Apium graveolens*), dill (*Anethum graveolens*) and fenugreek (*Trigonella foenum-graecum*). In all 26 landraces were gathered in 2007/8. Farmers still sow and grow spice crops, which are traditional for our table.

4.7 Medicinal, aromatic and decorative plants

Landraces of medicinal, aromatic and decorative plants are grown in many home gardens. Some farmers have created bio-gardens in order to extend the usability of medicinal plants for medicinal and herbal teas. In recent years 76 accessions representing over ten species were collected by IPGR. *Calendula officinalis, Helichrysum bracteatum* and *Ocimmum basilicum* were the species most widely represented. A morphological and production evaluation trial was carried out and, for example, 21 specimens from *Calendula officinalis* showed high plant productivity i.e. number of racemes per plant (Figure 4.6) for selection of plants for decoration and for the usability of racemes for medicinal purposes.

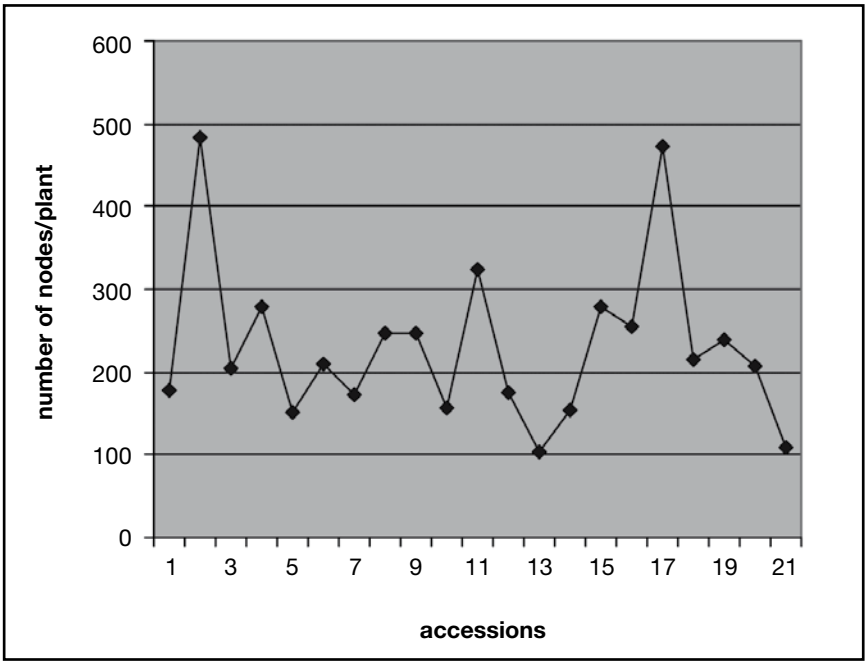

Figure 4.6. Productivity of *Calendula officinalis* landraces.

During the last two expeditions in 2007/8 many landraces of medical and decorative species were collected. Some naturalized landraces, transferred from the wild flora and grown for years in gardens and on larger areas in regions suitable for that purpose, such as Mursala tea (*Sideritis scardiaca*) and *Salvia sclarea* were collected. Seeds from other landrace varieties, such as basil (*Ocimmum basilicum*) and tagetes *(Tagetes patula)* were collected and stored in the genebank, and single pieces of roots were collected from *Hypericum perforatum*, *Thymus* sp., *Centaurea diffusa*, *Fragaria moschata* and *Teucrium chamaedrys*. They are valuable for the marking of locations and for cultivation in the institute's botanical garden for demonstration purposes (Varbanova et al. 2002; Varbanova 2004; Varbanova et al. 2008).

4.8 Conclusions

The inhabitants of Bulgarian villages are industrious and willing to produce crops which are suitable for the agro-climatic conditions of the region, in order to meet family needs and to offer the surplus produce at the local market. This has maintained great diversity in the landraces of many crops. The fact that these varieties, with excellent taste qualities, created many decades ago in the respective micro-areas with characteristic agro-climatic peculiarities, are grown by an aged population makes our activity in collection and preservation of this wealth priceless, as the desire to cultivate landrace diversity is not being handed on to the younger generations. Many expeditions were carried out over the last 20 years by IPGR, during which a large quantity of material from landraces, mostly from vegetable crops and bean landraces were collected, studied and stored in the IPGR genebank (Krasteva 2000; Krasteva et al. 2002; Neykov and Angelov 2002). The following collections were created: 2161 landraces from cereal crops, 1943 landraces from grain legume crops and 2826 vegetable crop landraces, all collected from various regions of the country which were each evaluated by a large number of indices according to the respective characterization and evaluation systems.

An inventory and registration of Bulgarian landraces were performed, which highlighted the richness and diversity of Bulgarian landrace diversity. The collected information on the geographic origin and the characteristics of landraces provide the basis for priority organization and storage, through conservation both on-farm and in home gardens. The grouping of the landrace collections and the establishment of parameters for their more important characteristics may be used as a basis for

the development or updating of standardized documents. The information from the landrace characterization and evaluation was stored in databases, which provide easy access for breeders and contribute to the improvement of exchanges between genebanks. The data bases are published on the web page: www.eurisco.ecpgr.org

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5. Landrace Inventory of Denmark

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Denmark takes part in the Nordic collaboration on plant genetic resources in NordGen (formerly, Nordic Gene Bank). On the international level Denmark has acceded to the Convention on Biological Diversity and the International Treaty of FAO. However, Denmark differs from the collaborating countries in making fewer efforts on plant genetic resources work.

The existing inventory was carried out by NordGen through other previous activities. The Danish landrace material comprises 86 accessions: 49 vegetatively propagated accessions preserved in clone archives. The seed-propagated material includes 27 cereal accessions, three forages, four vegetables and three of flax. The cereals were collected during the 1980s and a collection of shallots was established at the end of the 1990s. Fruit trees were collected in the 1940s when the Agricultural University (Faculty of Life Sciences of Copenhagen University) established its collection. There may still be some landrace material to be discovered out there, particularly of vegetatively propagated crops.

All seed accessions are conserved *ex situ* in NordGen. It is not the optimal way to preserve populations with a broad diversity, and part of the variation in the landraces is expected to erode over time. There are no on-farm conservation activities taking place in relation to landraces *sensu stricto*, but some cases of on-farm preservation of older varieties of fodder beet exist. Small-scale home garden maintenance is carried out by the Seed Collectors' Organization. Cultural museums have started to use the potential of on-farm conservation and cultivation in their communication and education activities

On the documentation side, retrospective inventories which would cover landraces, have not yet been compiled. However, it is anticipated that the increased awareness of the cultural history environment may raise the possibility of improving knowledge on agricultural material that was cultivated prior to professional plant breeding. The Ministry of Food and Agriculture has launched a regulation to support cultivation and use of older varieties of cereals and vegetables in the genebank. As it takes time to multiply the seeds for field-scale cultivation and the funding is temporary no results have yet been obtained.

6. Cereal Landrace Inventories in Finland

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6.1 Introduction

Planned collecting missions and inventories are essential for the conservation of plant genetic resources for food and agriculture. In Finland the starting-signal was given in the late 1970s when the Nordic countries started their joint genebank activities. Before the Nordic Gene Bank activities, the first professional plant breeders collected and studied an extensive amount of landrace samples for breeding material during the early 1900s.

The Nordic Gene Bank (NGB; today NordGen) conducted its inaugural landrace collecting missions during the late 1970s and early 1980s in Finland (Table 6.1). The focus was on the cereals and forages. During 1979-1983 for example, samples of barley were collected. The Finnish State Seed Testing Station tested 62 barley samples of which 22 were landraces (Ulvinen 1986). Tested samples of the collecting missions were sent for *ex situ* maintenance to the NGB. Since the first collecting missions only few NGB collection projects have been launched in Finland and the target species have been other than cereals (Table 6.1).

Table 6.1. The NGB organized collecting missions in Finland and *ex situ* accessions conserved at NordGen (Veteläinen et al. 2008).

Year	Collection	Species
1979	Collection in North Finland	mainly forages; some cereals
1980	Collections in Finland	mainly rye; also barley, forages, turnip and broad beans
1981	Collection in Ostrobothnia, Finland	mainly rye; also barley, forages, swedes, turnip and broad beans
1982	Collection in Finland	mainly forages and rye; also barley
1983	Collection in Finland	mainly forages and rye; also barley
1994	Conservation of potato onions, Finland (collected before NordGen)	potato onions
2000	Collection in Finland	natural populations of reed canary grass
2007	Collection in northern Finland	grasses, clovers

In addition to the NGB collection missions there are a number of *ex situ* accessions that have been collected through national activities and they have been donated to NordGen (Veteläinen et al. 2008).

Today, there are a total of 330 cereal accessions from Finland in long-term storage at NordGen. The share of cereal landraces is 46% (in numbers 153). Compared to the total number of stored landraces (537), the share of cereal landraces is 28% (Table 6.2).

In this article we demonstrate implementation and main results of the cereal landrace inventories carried out in Finland after the first collection missions of the NGB. There have been two project-based inventories, the first carried out during 1996-1998 and the second a decade later.

Table 6.2. The Finnish long-term *ex situ* seed material at NordGen (Veteläinen et al. 2008).

Species (Taxon)	Cultivar	Breeding material	Landrace	Wild	Other	Total
Cereals in total	127	49	153		1	330
Oat (*Avena sativa*)	26	5	13			44
Barley (*Hordeum vulgare* subsp. *vulgare*)	39	38	51		1	129
Rye (*Secale cereale*)	29		82			111
Wheat (*Triticum aestivum* subsp. *aestivum*)	33	6	7			46
Other species	79	43	384	357	18	881
Species in total	206	92	537	357	19	1 211

6.2 Implementation of the inventories

6.2.1 Inventory in the mid-1990s

Following the obligations of CBD (1993) and FAO Global Plan of Action (1996) a 'Landrace project' (Onnela 1996, 1999a, 1999b) financed by the Ministry of Agriculture and Forestry in Finland and realized by the Seed Testing Department at the Plant Production Inspection Center at the former KTTK (from May 2006, EVIRA) was initiated during 1996-1998. The aim was to draw up a proposal on how varietal research, registration and on-farm maintenance of cereal, forage grasses and legume landraces and old commercial cultivars could be organized in Finland.

The first step for the on-farm maintenance system was to carry out varietal trials on landraces. This presumed that there would be some landraces for trials. Landraces still in cultivation were called for through newspapers in 1996. Seed material of some landraces and old cultivars for comparisons were received from the NGB and breeders. In an inquiry, farmers cultivating landraces were asked to give a short description of the cultivation methods and history of a landrace, as well as some background information about the farmer.

Data handling

The call resulted in a total of 39 samples from farmers. These along with some other landraces and old commercial cultivars (Table 6.3) were field-tested in varietal trials based on the UPOV guidelines for conducting tests for distinctness, uniformity and stability. The DUS testing method was adapted in order to distinguish them from commercial cultivars.

Table 6.3. The number of samples in the varietal testing in the 'Landrace project' (Compiled from Onnela 1999a)

Source of the samples	Oat		Barley		Spring rye		Winter rye		Wheat		Timothy	
	CV	LR	CV	LR	CV	LR	CV	LR	CV	LR	CV	LR
Farmers	2			1		5		24				8
NGB						9		2				6
Breeder seed					1		2					
Foreign seed					2							
Comparison material	4		4						4			

CV = old commercial cultivar; LR = landrace; Comparison material = breeder's seed was compared with the sample of the KTTK and/or the NGB of the same cultivar.

6.2.2 Inventory in the mid-2000s

The National Programme for Plant Genetic Resources for Agriculture in Finland was established in 2003 and the first landrace inventory was undertaken early in 2006. In the inventory, the cereal landraces and old commercial cultivars were especially highlighted because their seed materials were regarded as the most threatened.

The inventory has gone forward with a twofold and simultaneously proceeding process: a call for landraces and a research project. They have shared the same target: to contact growers of landraces and to obtain landrace seeds for further evaluation and in relevant cases to preserve them *ex situ* at NordGen. The research project also has tasks related to the socio-cultural context of the on-farm maintenance of PGR, e.g. cultivation motivation; indigenous knowledge related to the landrace and its use; and mapping farmers' values and meanings and how they anchor them with a landrace.

The Call

The National Programme for Plant Genetic Resources for Agriculture in Finland announced the 'National Call for Landrace and Old Commercial Cultivars of Cereals and Forages´ in early 2006. In addition to cereals, forages and some other species (flax, pea and hemp) were also requested. The main interest was in landraces but also in those old commercial cultivars that are not yet stored

at NordGen. In order to reach the growers, a poster (Figure 6.1) and leaflet designed for the Call were distributed nation-wide through different organizations. One distribution channel was the municipal libraries. As a 200-year-old public library institution with long traditions of enlightenment of the common people and a dense network of libraries, these present a forum for information services with easy access in Finland. Another channel for information distribution was rural advisers at the Rural Advisory Centres and municipal offices. The call was also announced in various thematic e-mail lists (e.g. the Organic Agriculture Association), in some NGOs' magazines (e.g. the Landrace Association in Finland) and in the website of MTT Agrifood Research Finland.

Farmers were asked to contact the national PGR programme with a written document to be sent by e-mail or mail, in which they were asked, using unstructured questions, to describe the cultivation history of their landrace or old cultivar (where and how long it has been cultivated; where it originated; who has been cultivating it), its phenotype and properties. On the basis of the farmers' responses, they were contacted for further information and eventually asked to send a seed sample (0.5 - several kilograms) for testing.

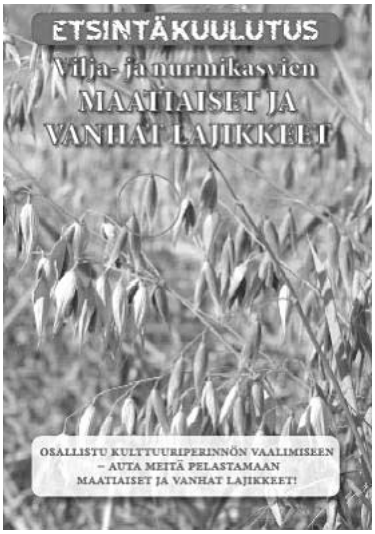

Figure 6.1. The poster of the National Call for Landrace and Old Commercial Cultivars of Cereals and Forages in Finland

The research project

The research project 'Social and cultural value, diversity and utilization of Finnish cereal landraces (OnFarmFinland)' closely connected to the Call was co-financed by the Ministry of Agriculture and Forestry for the years 2006-2008 (Heinonen and Veteläinen 2007). The Call and the research project have shared the farmer

contacts. However, the research project extended the scope of the pure seed Call and *ex situ* conservation to study the praxis of the on-farm management of landraces on single farms. We also included old commercial cereal varieties bred before the rise of intensive agriculture (i.e. before the 1960s) which are still in cultivation.

The data were collected in stages. In the first stage, an inquiry was sent to contact cereal landrace growers in order to gain initial knowledge on who, why, where, how and what cereal landraces are grown today in Finland. The questionnaire was mailed to those cereal farmers who had registered themselves in the subsidy system of on-farm cultivation and those who participated in the earlier inventory of 1996-1998. In addition, we utilized the contact network of Finnish plant breeders, researchers and NGOs dealing with crop landraces in order to reach cereal landrace farmers. We announced the inquiry in various thematic e-mail lists (e.g. the Organic Agriculture Association), NGOs' magazines (e.g. the Landrace Association in Finland), and local newspapers. We also distributed inquiry forms at seminars and farmer events. An e-questionnaire was also prepared at the website of the MTT Agrifood Research Finland. So far (Autumn 2008) we have received responses from 31 farms that still grow cereal landraces or old cultivars. In addition to farm visits and face-to-face interviews, we have also conducted a few farmer interviews by phone.

The second stage of the project aimed to gain understanding of both social and cultural aspects that motivate farmers to grow landraces at present and in the future. Values associated with landraces have also been highlighted. Hitherto we have conducted thematic interviews (e.g. Gubrium and Holstein 2001) in five farms where we interviewed 14 persons in total. In every farm we interviewed in addition to a farmer, his or her spouse and parents if possible. This was done since older and younger generations and sexes may have different indigenous knowledge on landraces, their use and value. Furthermore by applying the (focus) group interviewing method (e.g. Morgan 1988) on two generations in a single farm, it was possible to approach sensitive but crucial issues related to the transfer of landrace cultivation to a descendant in subtle ways. The farm visits have also resulted in very valuable observational data, e.g. on households, fields, farm buildings and surroundings. Seed samples were also collected when available.

Seed handling

Through the Call and the research project we have received in total 46 notifications of cereal landraces or old commercial varieties from farmers (Table 6.4). Most of the landraces are still in cultivation; only in four cases were they old stored seed.

Table 6.4. The received notifications of landraces and old commercial varieties of cereals (by autumn 2008) (Heinonen and Veteläinen 2007; unpublished research data).

	Oat	2-row barley	4/6-row barley	Spring rye	Winter rye	Spring wheat	Winter wheat
Landrace	4*	3**	-	1	23***	1	1
Old cultivar	4	2	2	-	3	1	1

* In two cases landrace oats had not been cultivated for a long time.
** The very same old two-row barley is in cultivation in three separate farms.
*** In two cases a rye had not been cultivated for a long time. In three cases the very same landrace winter rye is in cultivation in two separate farms.

The seed material received from farmers has been evaluated for phenotypic traits by specialists in cereal genetic resources. In addition germination tests were carried out on the old stored seed that had not been cultivated for a while. Some landraces were sent to NordGen to be conserved *ex situ*. We have also returned one *ex situ* stored landrace rye back to on-farm cultivation to the family farm where it was collected in 1981. The qualitative socio-cultural data on farmer perspectives have been analysed by sociological tools. We have been focusing on hermeneutic understanding of the complex set of values, and the process of how those values are implemented in cultivating a typically non-profitable landrace.

6.3 Main results and outcomes of the inventories

The two landrace inventories have achieved, on the one hand, unique knowledge on landrace cultivation, and on the other hand, concrete support systems for on-farm management in Finland.

6.3.1 Knowledge on landraces and their farmers

The landrace inventory in the mid-1990s was focused on landrace identification. The main seed data were received from farmers. The field testing showed that most of the farmers' seeds were landraces or mixed seed including other landraces and/or old cultivars (Onnela 1999a). Rye is clearly the most cultivated among cereal landraces in Finland. In the mid-1990s, the landrace project received 29 samples of seed which were identified as rye landraces; and in the mid-2000s the number was 21 (only including landraces in cultivation). Other cereal landraces are very rare in cultivation (Tables 6.3 and 6.4).

The 'OnFarmFinland' project has revealed knowledge about the praxis of on-farm management among farmers. Compared to modern cultivars, cultivation of low-yielding cereal landraces and old cultivars requires acquaintance with the material, more work and a special motivation. In most cases the motivation springs from the

cultural and symbolic value of a landrace. A typical landrace farmer in Finland cultivates an old winter rye strain which has been grown in the same family or in the home village for several generations. He cultivates it, if not every year, usually every second or third year on an area of 1-2 hectares, and uses the yield for his own consumption (for e.g. baking rye bread). However landrace farmers are not a homogenous group of nostalgic people but they have different economic and personal reasons for landrace cultivation. Moreover the family heritage is not always strong enough to keep a landrace in cultivation and many young farmers seriously reflect on the economic prerequisites for landrace cultivation.

6.3.2 Support systems for on-farm maintenance

As a result of the 'Landrace Project` in the mid-1990s, the first European support system for on-farm cultivation of landraces and old cultivars was developed in Finland. The support was paid as a special subsidy within an EU agri-environmental scheme. During the first agri-environmental scheme 2000-2006, the cultivation of landraces, old commercial cultivars and strains derived from old commercial cultivars of cereals and forages was subsidized. In the present scheme for years 2007-2012, the paid support has been extended also to pulses (pea and broad bean) (Anon. 2007).

The aim of the subsidy system is to enhance the continuity of cultivation of landraces and old cultivars by offering annual economic support based on the cultivated area to a farmer. Furthermore, the aim is also to enlarge landrace cultivation: the registration of a landrace not existing on the National List of Plant Varieties gives the right to the farmer to market seed in Finland. For more detailed knowledge of registration and the subsidy system for landrace cultivation in Finland see Paavilainen, Chapter 32 this volume.

The 'OnFarmFinland' project has resulted in a web-based information service containing knowledge of Finnish landraces and old commercial varieties of some agri- and horticultural plants. In the first phase, knowledge of cereals and potatoes is provided. For public awareness reasons the 'Landrace Information Service' was published on the International Day for Biological Diversity 22 May 2008. The information service is part of the web site of the national PGR programme in Finland at the portal of MTT Agrifood Research Finland (URL: www.mtt.fi/kasvigeenivarat). So far, the information is provided only in Finnish. The information service is intended to function as a documentation forum on landraces and old commercial varieties and their cultural history and properties in order to enhance their sustainable and manifold use and on-farm / in-garden maintenance today. The documentation stresses cultural

values and meanings anchored in landraces and in ways of using them. Information of the on-farm subsidy and registration system is also provided, as well as information on seed and seedlings sources. The information service is targeted at present-day landrace farmers, hobby-gardeners, agrarian museums and other organizations, and interested private persons. The information is expected to be useful in restoring historic gardens and fields, in building demonstration gardens, in educational uses, in the development of niche products, and in general in enhancement of the awareness of landraces among the general public.

6.4 Lessons learnt

The cereal inventories in the mid-1990s and 2000s in Finland have proven that it is still possible to find landraces that are not known and not yet stored *ex situ*, even in countries which have been using intensive farming methods for several decades. Cultivation and management of landraces on-farm in Finland lean greatly on the silent knowledge and actions of farmers. Only five farmers have registered their landrace cereals or old cereal cultivars on the subsidy system. In most cases, landraces are for subsistence cultivation and self-evidently part of their lifestyle. Many of the farmers have not thought that they are on-farm maintainers but just ordinary farmers who happen to cultivate landraces on a small scale.

The ageing of landrace-cultivating farmers and the declining number of farms in general are true challenges for landrace maintenance on-farm. There is need to study on-farm management also from a broader perspective and to find ways to commit new and different actors in on-farm management. For example agrarian museums with fields and gardens are potential actors, especially for bringing the message of the cultural heritage of landraces to the general public. Also the possibilities to develop niche products may stimulate new farmers to try landrace cultivation. To encourage this, documentation of landrace knowledge is needed. Different perspectives, not forgetting the cultural and historical knowledge of a single landrace, are valuable for developing and marketing landrace-based niche products, services and other uses.

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7. Landrace Inventory in Germany – Preparing the National Implementation of the EU Directive 2008/62/EC

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7.1 Introduction

Oats as a crop with a well-documented breeding history is used in this paper to describe the developments leading to variety names reported in the old literature which tend to be misinterpreted as 'landraces'. Breeders' selections in the landrace 'Sächsischer Gebirgshafer' had already started in 1876 and resulted in the 'Leutewitzer Gelbhafer' (Funke 2008). As the German Agricultural Association took notice of the 'Leutewitzer Gelbhafer' in the year 1907/1908 there must have been a significant seed trade in the breeder's product at that time. While the name 'Sächsischer Gebirgshafer' is not mentioned in any genetic resources information system, the variety 'Leutewitzer Gelb' still exists as a genebank accession. Many more selections were created and named by commercial cereal breeders during the past century.

J.N. von Schwerz (1836) conducting an analysis of regional agricultural systems in the Land Westfalen, cited farmers who preferred flax seed from places in Latvia as it produced better fibre quality under their conditions compared with self-produced flax seeds. This rare insight into the agricultural system which existed 172 years ago is interesting for three reasons. Firstly, not all farming communities adapted crops to the regional conditions by reproduction and selection. There must have been a portion of farmers relying on the seed trade, i.e. external inputs. Secondly, the value of the geographical origin of seeds was well understood and may have resulted in the named origins of merchandized seed such as the landrace 'Sächsischer Gebirgshafer' (oat, *Avena sativa* L.) indicating that the seed was produced in the hilly area of the Erzgebirge (Ore Mountains). Thirdly, the purchased seed of defined origin was tested and the type which performed better was used for agricultural production.

The names of these selections often refer to the breeder's family name and/or a region where they were bred. We generally

assume that the selections are adapted to that place or region. A geographical name as such, however, is no scientific evidence for the actual adaptation of a named historical variety which was bred under conditions set by the agricultural system of that period. It only describes a competitive product created during a specific historical period which left a footprint in breeding history.

The terms 'adaptation', 'genetic erosion', and 'landrace' are key elements of a new EU directive. The 'Commission Directive 2008/62/EG of 20 June 2008 providing for certain derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties' came into force. It will be interesting to learn how the key chapter I, Art. 1, 1. (a) and (b) of the directive will be interpreted in the European member countries. One interpretation could be that an applicant willing to reproduce and trade a Conservation Variety (chapter II, Art. 3) has to provide evidence that the landrace or variety is naturally adapted to local *and* regional conditions *and* is threatened by genetic erosion. The combination of all three criteria may be difficult to achieve. Moreover chapter II, Art. 4 requires that a Conservation Variety "shall present an interest for the conservation of plant genetic resources". If all four conditions need to be fulfilled by a candidate then most potential Conservation Varieties will fail to meet the defining criteria and so will not be placed on the national catalogues.

The German Information and Coordination Center for Biological Diversity (BLE-IBV) (www.genres.de/CF/pgrdeu/template_in_situ.cfm?page=landsorten) currently compiles in close cooperation with counterparts of the 16 federal Laender the national catalogue of named genebank accessions which will fulfil the conditions set by the EU directive for Conservation Varieties. The list could be completed by germplasm that is not part of the governmental genebank system and is actively managed by farmers and gardeners organized in seed savers' associations or any other private person engaged in the development of informal seed supply systems. Such an informal seed supply system was described by Ribeiro-Carvalho et al. (2004) for northeast Portugal, where a farmer-managed group of wheat populations has existed for more than a century. The populations, collectively named 'Barbela', are grown in different geographic sub-regions, and do not only contain high amounts of genetic diversity. 'Barbela' is also known for its natural introgression of small rye chromosome segments (Ribeiro-Carvalho et al. 2001), a finding which underpins the significant role of landraces in crop evolution.

Such groups of populations meet the definition for landraces proposed by Negri (2006),

> *"The continuous maintenance by local people of a variable population(s) (e.g. a landrace), which is identifiable and usually has a local name, lacks 'formal' crop improvement, is characterized by a specific adaptation to the environmental conditions of the area of cultivation, is closely associated with the traditional uses, knowledge, habits, dialects, and celebrations of the people who developed and continue to grow it."*

who emphasizes the aspect of a long-standing, unbroken and active management of landraces within a specific cultural context. Under these conditions adaptation is proven by practical evidence, since a farmer or gardener would never grow germplasm which does not fulfil his/her needs, i.e. the term 'adaptation' in rural communities which value regional traditions counts for a lot more than just 'yield' or 'higher-income'.

It should be noted in this context that many unnamed accessions which exist in genebank collections were once landraces. They are only characterized by a documented collecting event (collecting date, collecting site). Often they have been named 'local' or labelled with group names such as for example 'acelga' for *Beta vulgaris* subsp. *vulgaris* Leaf Beet Group in Greece.

In the context of this paper we use the term 'Conservation Variety' for agricultural crops and 'Amateur Varieties' for fruit and vegetable crops. The EU directive for Amateur Varieties is being prepared and is likely to be published by the Commission within a short time. In the context of this paper we use the term 'landrace' in the sense of Negri (2006) and the term 'other varieties' used in the German translation of the directive 2008/62/EC for named material maintained in genebanks having a broken germplasm management history. We consider 'other varieties' and 'landraces' as subgroups of the categories 'Conservation Variety' and 'Amateur Variety'.

Breeding is a cyclic process. Independent of where (farm or field of a commercial breeder) and by whom selection is done, the selection pressure shapes germplasm handled in the process. A commercial variety or a Conservation Variety is just a state of the germplasm at a certain time. The state can be called latent, planned or active (Frese et al. 2007). Crop germplasm stored in a genebank can be seen as a latent genetic resource waiting for future use, crop germplasm used in formal breeding programmes (in contrast to 'informal crop improvement' mentioned by Negri 2006) can be seen as a planned resource. During this state new variability is created by recombination, introgression of genes from crop wild relatives and/or mutation. A new variety stands at the end of the process, which when grown for production (commercial, non-commercial) enters the active state. Once the production ceases

and a variety is no longer maintained by the breeder it can be donated to a genebank where the germplasm waits as a latent resource for a future application. P. Jantsch, a co-author of an on-farm management study in Germany (Becker et al. 2000) provided a systematic formulation of activities that in fact addressed these states, however without consideration of the cyclic character of breeding. According to his scheme it is definitely possible that a latent resource is reintroduced to its original region (Figure 7.1). If it is still adapted to today's production conditions and bred within informal seed supply systems it may change from subgroup 'other variety' into subgroup 'landrace'.

7.2 Methodology

When compiling an inventory of Conservation/Amateur Varieties we have to consider the two subgroups 'landrace' and 'other varieties' which coincide with the states 'active' and 'latent', respectively. An inventory is to be built upon the result of a retrospective search for 'other varieties' in genebank information systems and on an explorative search for landraces still being maintained by people in Germany. The first steps towards implementing directive 2008/62/EC in Germany consist of (i) identification of 'other varieties' and the place or regions mentioned in their names and (ii) a search for 'landraces'. This paper will not describe a comprehensive inventory; rather it highlights methodological aspects and experiences gained with:

- a crop-based approach
- a regional approach, and
- an explorative approach.

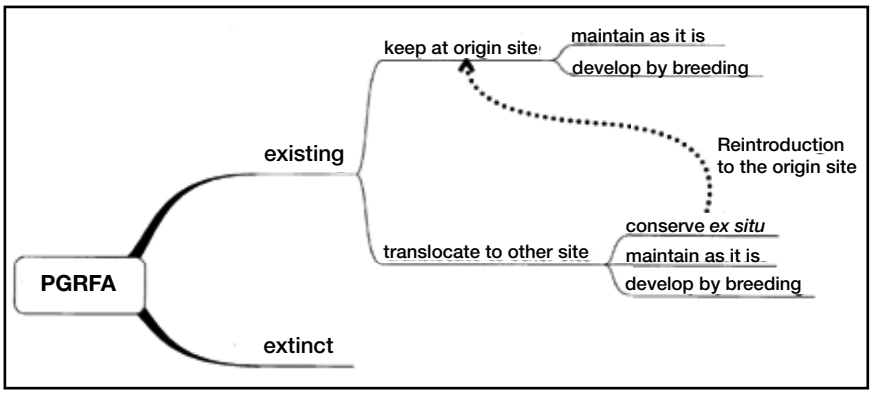

Figure 7.1. On-farm management schema.

7.2.1 Crop approach: Where is the origin of a named oat accession?

The compilation of a resilient national catalogue of Conservation Varieties covering all crops requires comprehensive knowledge of the genetic resources of many crops and their breeding history. We focused therefore on a crop and methods we felt competent for. Using oats as a model crop, we started the inventory of 'other varieties' on the website of the European Search Catalogue (EURISCO 2008) since unique oat accessions of German origin may not only exist in the German genebank managed by the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), but also in European partner genebanks. The European *Avena* Data Base (EADB) was then applied as a crop-specific information system for additional and more detailed searches. Finally, the results were compared with information published by Funke (2008) on oat breeding in Germany.

7.2.2 Regional approach: Which crops and named accessions originate from the Land Sachsen-Anhalt?

A list of accessions was compiled that probably originate from the federal Land Sachsen-Anhalt. For that purpose the IPK genebank provided an export in EURISCO format, which was joined with EUROSTAT (EC 2008a; EC 2008b) tables containing data on Local Administrative Units (NUTS level 1 to 3 and LAU2) as defined by the Nomenclature of Territorial Units for Statistics (NUTS) for the Member States of the European Union. Names of administrative units on four levels were searched within the accession names listed in the IPK export. Hits of more than four characters were listed as a first approach. Additional manual editing will be needed.

7.2.3 Explorative approach: Which landraces of fruit crops and vegetables are grown and maintained by civil society?

Landraces are often detected by persons organized in or cooperating with seed saver organizations such as the Pomologen-Verein e.V. (2008) and the Verein zur Erhaltung der Nutzpflanzenvielfalt (VEN 2008). The Pomologen-Verein e.V. founded in 1991 continues the work of the Deutsche Pomologenverein (1860-1919). This association is engaged in the retrieval of fruit landraces described in the historical literature. The Pomologen-Verein has organized since 1991 several hundreds of 'apple fairs' throughout the Federal Republic of Germany. During the fairs, apple landraces brought in by consumers are identified by the association's experts as a service to the visitors. Given this opportunity, visitors sometimes give hints on the

existence of landraces thought to have become extinct. The new finding is then compared with existing landraces and reports in literature, checked for synonyms and eventually classified as a newly detected landrace. In this way landraces are traced and documented. Experts of the Pomologen-Verein also map the geographical distribution of apple, pear, cherry and plum landraces. Gradually, the distribution pattern of landraces and their region of adaptation will be visualized and both narrow (e.g. 'Westfälische Tiefblüte') or widely distributed apple landraces (e.g. 'Oberlausitzer Muskatrenette') identified.

The scope of the VEN is much broader than the maintenance of the genetic diversity of traditional German vegetables. The VEN Samenliste (a seed catalogue) therefore contains many accessions from European countries or even overseas. An item of the VEN Samenliste was categorized as a landrace if:

- the item has a unique name
- the description of the listed item contains information on the geographic origin of the material
- this place or region is located in the Federal Republic of Germany
- the description of the item gives good reasons to assume that a long-standing use within a cultural context exists.

7.3 Implementation

7.3.1 Other varieties: Crop approach

Genebank information systems such as EURSICO hold data on the biological status of accessions. A search for Biological Status = Traditional cultivar/Landrace and Country Source = Germany yielded 3053 accessions of which 1459 accessions are named. The 3053 accessions are split over 157 genera. As there is no generally agreed definition of a 'traditional cultivar/landrace' the sample status cannot be used as the sole descriptor to identify 'other varieties'. The dataset needs further qualification as is exemplified by the model crop oats.

The variety names of the oat pedigree (Figure 7.2) published by Zade (1918, cited in Funke 2008) were compared with accession names extracted from EURISCO. For oats, 13 areas have been identified as potential 'regions of origin' according to Art. 8 of the EU directive for Conservation Varieties. Ten regions are located within Germany, two in Poland (Jasnien, Wierzchno) and one in the Pyrenees.

Additional geographic origins of oat germplasm could be identified by comparison of the pedigree with named accessions

documented by the European Avena Database (EADB 2008) namely Holstein, Thüringen, Nauen in Brandenburg, and Sachsen. Bohemia with the place Doupov (Duppau) in northern Bohemia is located in the Czech Republic. The variety name Milton points to a place located in the UK, Canada or the USA as do the variety names Kanada and Kanadische Fahnen.

Varieties' names in Figure 7.2 shaded by a dark grey colour are neither documented in EURISCO nor in the EADB. The respective germplasm is probably extinct. Names shaded with light grey colour are similar to names that are documented in the EADB but do not match the names exactly such as Duppauer Land = Duppauer (Lohmanns Weender?). All other varieties are documented in genebank information systems and are probably available for reintroduction as 'other varieties' according to the schema shown in Figure 7.1.

7.3.2 Other varieties: Regional approach

The comparison of EURISCO data with EUROSTAT data (matches of accession names with Local Administrative Units' designations) located 199 accessions of potential origin in Sachsen-Anhalt. The accessions are divided over 26 categories (25 crop groups plus the group 'others'). The list was reviewed and accession names such as 'Tetraroggen Bernburg K 211', which is probably a breeding line, were excluded from the final choice. In total 95 accessions including several accessions of ornamentals can be nominated by the Land Sachsen-Anhalt as candidates for the national catalogue.

7.4 Landraces: Explorative approach

Promotion of landraces should be considered as the prominent objective of directive 2008/62/EC. The list of landraces of fruits exemplified by apples and of vegetables was also extracted from information systems for fruits and the VEN Samenliste (2006 and 2007). Many more than 1000 apple landraces once existed in Germany, only approximately 230 landraces bred before 1900 are conserved as *ex situ* accessions (as of the year 2003). Since the Pomologen-Verein started the inventory of landraces in the year 1991, 400 to 500 apple landraces have been retrieved and identified. Information on all landraces detected so far will be made accessible to a broader public on the Internet after the establishment of a database on fruit landraces of the Pomologen-Verein, which will probably be operational in 2009. The Pomologen-Verein promotes the use of landraces by providing advice to any person or institution interested in growing regionally adapted landraces

in orchards for private consumption. In this context the term 'regionally adapted' is applied correctly. The advice is based on the practical experience with the germplasm gained by this group of experts during the past two decades.

The VEN focuses on the maintenance of vegetables. Similarly to the Pomologen-Verein for fruits, the VEN keeps a library of historical books and other literature on vegetables and uses this pool of information for searching for forms of vegetables that were once used in agriculture and home gardening. In addition, the VEN offers a cataloguing service to its members and other interested persons, the VEN Seed List, wherein any private person can publish a description of self-produced seeds of vegetables, which are available for germplasm exchange on a small scale. This seed list contains approximately 2000 private offers of seed and clone material available for exchange and non-commercial purposes. Several of the seed producers offer vegetables that are neither available in the commercial sector nor maintained by genebanks. Eighteen samples match with the landrace definition of Negri (2006): they were detected in a specific geographic region and are closely associated with the traditional uses and knowledge of the people who developed and continue to grow it. They concern leaf beet (*Beta vulgaris* L. subsp. *vulgaris* Leaf Beet Group, one sample), spinach (*Spinacia oleracea* L., two samples), pea (*Pisum sativum* L. s.l. subsp. *sativum*, two samples), bean (*Phaseolus vulgaris* L. subsp. *vulgaris* var. *nanus* (Jusl.) Ascherson, five samples) and *Phaseolus vulgaris* L. subsp. *vulgaris* var. *vulgaris,* five samples), cabbage (*Brassica oleracea* L. convar. *acephala* (DC) Alef. var. *sabellica,* one sample), turnip (*Brassica rapa* L. Vegetable Turnip Group, one sample) and leek (*Allium lusitanicum*, one sample).

7.5 Lessons learnt

Altogether, the EU directive for Conservation Varieties works with criteria which tend to escape a hard scientific proof. Without a clear idea of actions that can be undertaken within the limits set by directive 2008/62/EC it may be a cumbersome task to operate the directive in practice. The term 'landrace' is a term which is difficult to work with. Most attempts to define the term have failed as the dynamic and cyclic nature of plant breeding is seldom taken into consideration. We suggest using within the framework of directive 2008/62/EC the criteria listed in Table 7.1 to distinguish a 'landrace' from a 'variety' and 'accession' and find it to be a workable definition.

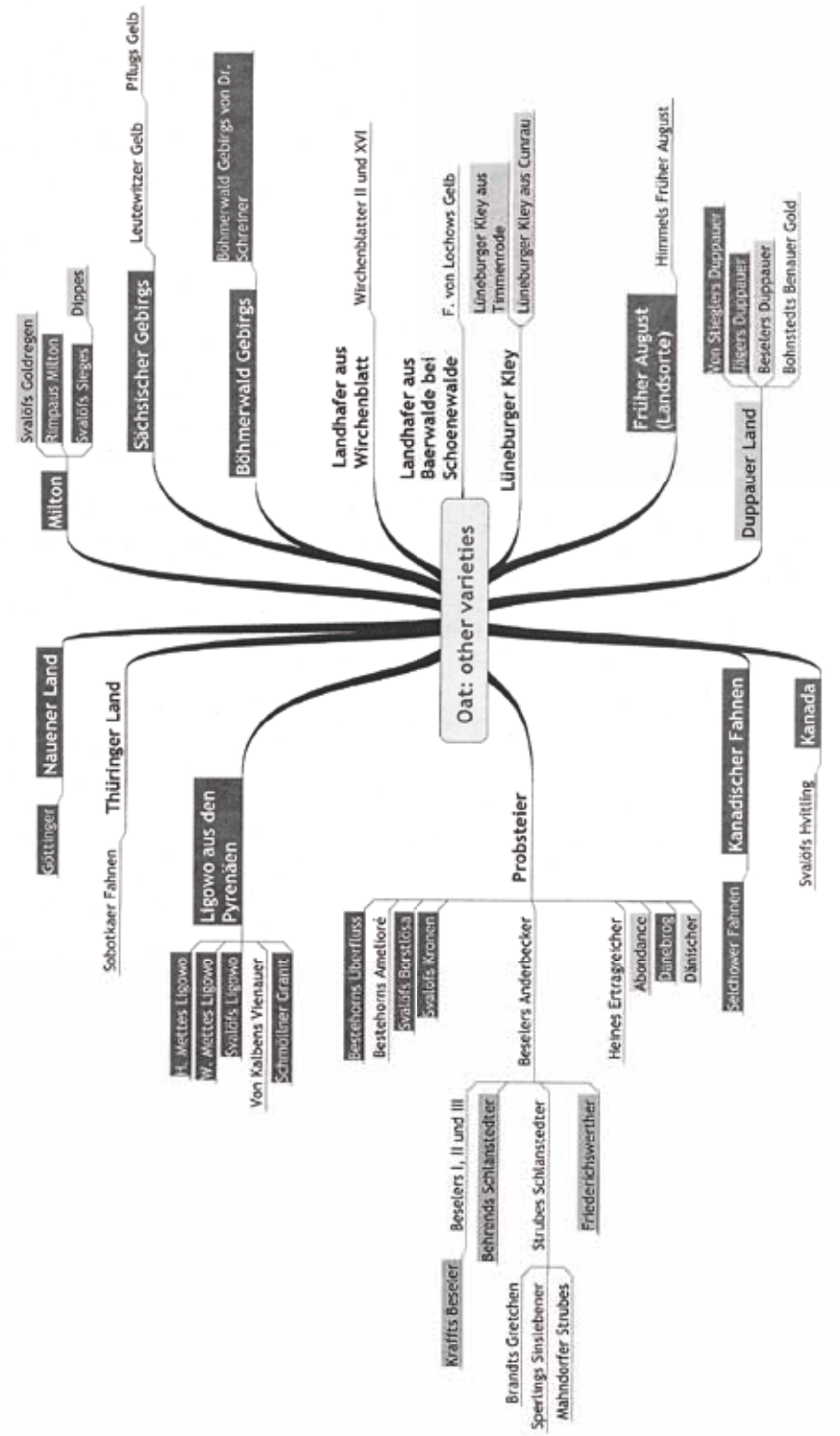

Figure 7.2. Pedigree of oat varieties selected before 1918.

The term 'landrace' or 'traditional cultivar' is often taken to be synonymous for germplasm that is said to be better adapted to the regional conditions than modern varieties. Chapter I, Art. 2 (a) of the directive 2008/62/EC refers to the natural, farmed environment where the cultivated plant species have developed their distinctive properties. Where for example is the natural, farmed environment of the still existing oat varieties described by Zade (1918, cited by Funke 2008)?

Table 7.1. Three categories of germplasm and their features.

	Landrace	**Variety**	**Accession ('other varieties' are named accessions)**
Biological state:	active, evolving	active, evolving within the narrow limits set by seed legislation	latent, genetic snapshot
Legal state:	not protected	protected and/or registered	not protected
Adaptation:	evidenced by practical proof	evidenced according to the rules set by the seed legislation	needs to be re-evidenced
Seed supply system:	informal	formal	part of the formal system

Table 7.2 shows that it is difficult to delineate the farmed environment, as it can be a place like Anderbeck or a region like Bavaria. A place or a region does not represent a homogeneous environment. Especially at the larger geographic scale a high environmental diversity exists. How can we know in which farmed environment germplasm such as the 'Bayerischer Gebirgshafer' has developed its distinct characters, exactly? Geographic indications like 'Fläming' are even misleading, since the varieties with the character string 'Fläming' were not bred in the Fläming region (Land Brandenburg) but at Hasselhorst/Bergen in the Land Niedersachsen (Lower Saxony). Altogether the geographical denomination as a sole criterion appears unsuitable to justify the inclusion of a named accession in the national catalogue. We cannot use a geographical name to identify the historical farming environment of germplasm of the subgroup 'other varieties' or to postulate the adaptation of germplasm to the environmental conditions of its region of origin. Furthermore, since the farming environment has changed during the past 100 years and is continuously changing, we need to re-evidence the adaptation of the named accessions.

Inherent to the word 'adapted' is a comparison of at least varieties A and B whereby A may perform better at site A and B at site B.

Accessions often perform less well than varieties, as was exemplified by Ruckenbauer and Steiner (1995). They compared oat accessions from the year 1877 with a set of standard varieties called modern in the 1990s and besides producing 52% less grain yield, the accessions were more susceptible to lodging and crown rust. Similar observations were made by the team of the GENRES CT99-106 project 'Evaluation and enhancement of *Avena* collections: for extensification of the genetic basis of *Avena* for quality and resistance breeding' (Katsiotis et al. 2004). If we test adaptation by measuring traits of economic value we will probably find not the obsolete variety performing better, but more often the new material selected from the historical sources. Hence, adaptation as a selection criterion for Conservation Varieties is to be viewed critically since it can be expected that most of the 'other varieties' will not be well adapted to today's environmental conditions, hence they may not qualify as candidates for the national catalogue.

Table 7.2. Indication of the farmed environment in the sense of directive 2008/62/EC. Exemplified by selected oat accessions of known geographic origin.

Accession name	Farmed environment
Anderbecker	Anderbeck, Sachsen-Anhalt
Bayerisher Verbesserter Gebirgs	Bayern
Bestehorns Verbesserter	Bebitz/Könnern, Sachsen-Anhalt
Fichtelgebirgs Zuchtsaat	Fichtelgebirge, in northeast Bayern
Lüneburger Kleykönig	Lüneburg, Niedersachsen
Nürnberger Linie 3 (Nürnberg 4)	Nürnberg, Mittelfranken, Bayern
Oderbrucher	Oderbruch, Brandenburg
Westfaelischer Schwarz	Westfalen, Nordrhein-Westfalen

Equally difficult to operate is the criterion 'threatened by genetic erosion'. Prudently, Vögel et al. (2006) avoided application of 'varieties threatened by genetic erosion' and focused their attention on threatened crop species in their paper 'Red list for endangered crops in Germany: Possible actions and selected case studies from the region Brandenburg'. If we assume that the EU directive 2008/62/EC was approved not only to satisfy political needs but also to better control genetic erosion in crops, then we should develop ideas on how the directive can best serve this significant aim. According to Chapter I, Art. 2 (a) the directive will be applied if the variety is threatened by genetic erosion and (b) defines 'genetic erosion' as the loss of genetic diversity between and within populations and varieties of the same species over time.

The probability of genetic erosion *within a population or variety* depends on the breeding system of the crop concerned. The breeding system determines the breeding category (Table 7.3). As obsolete hybrid varieties are certainly not in the focus of the directive 2008/62/EC this category is excluded from further consideration.

Table 7.3. Breeding categories according to Schnell (1982).

	Clone breeding	Line breeding	Population breeding	Hybrid breeding
Mode of propagation	Asexual	Sexual	Sexual	Sexual
Heterozygosity of the plants	Heterozygous	Homozygote	Heterozygous	Heterozygous
Variation within the varieties	Homogeneous	Homogeneous	Heterogeneous	Homogeneous
Manufacturing possible?	Yes	Yes	Yes	No

Crops like potato, Jerusalem artichoke, fruit crops and grape vines are bred, marketed and maintained as *clonal accessions*, i.e. unique heterozygote genotypes, and by definition there is no variation within the clonal variety, hence genetic erosion within the variety cannot occur. However, oats, barley, peas and many more crops are bred as *line varieties* and by definition pure line varieties cannot suffer from genetic erosion as there is no within-variety diversity. In practice, line varieties may contain a certain amount of residual heterozygosity causing some heterogeneity and off types. Back-mutation such as is known for the trait 'stringiness' in *Phaseolus* beans can also result in off types, i.e. forms deviating from the defined features of a variety. Plant breeders select against off types to maintain the variety (Kuckuck 1979) while, owing to the sheer size in terms of accession numbers and due to the high species diversity, genebanks cannot. The deviation of a genebank accession from the original variety characteristics should not be misunderstood as genetic erosion; it is rather the effect caused by a lack of maintenance breeding. However, *population varieties* are heterozygous and heterogeneous. They are the breeding category that can suffer from genetic erosion due to drift, in particular if a small effective population size is used for their reproduction. Animal breeders consider a herd with an effective population size of 200 or less as highly endangered due to genetic erosion (Anonymous 2008). It should be noted that the international guidelines for plant genetic resources management recommend an effective population

size of 50-100 plants as good population management practice. The risk arising from the current genebank management practice consists in a gradual loss of the reproductive ability of an accession due to increasing inbreeding depression.

It can be concluded that with population varieties, there is potential for within-population genetic erosion while there is no such danger in clonal varieties or pure line varieties. This is a trivial finding which nevertheless is mentioned here just for the purpose of putting the coming discussion on the national catalogue on a rational basis.

The criteria of genetic erosion *between populations or varieties* can be discussed in a similar way. *Clonal accessions* are maintained in genebanks as field stands, as *in vitro* collections and as cryopreserved duplicates. Safety duplicates are kept by partner genebanks. If the conservation of a crop germplasm collection is organized according to the standards set by Bioversity International, then the whole management system needs to fail at once before a clone gets lost for ever. If a clone is completely lost then a single unique heterozygote genotype is lost. Why should we worry about a single genotype knowing that a cross between two heterozygote clones produces thousands of new, unique genotypes?

It is the risk that matters in this context. Risk is defined as the chance of an event multiplied by the damage that is caused if that event ever happens. We could define 'damage' as the loss of past investment in the development of a variety, which, in perennial, asexually propagated crops such as fruit trees or grape vine is high. We could further argue that the risk of the loss of a clone accession is high due to the potential high damage caused. The risk can differ with different clone accessions. For instance, since the parents of the apple cultivar 'Jonagold' (cvs. 'Jonathan', 'Golden Delicious') are known for a genotype like 'Jonagold', the variety could basically be developed again by crossing the parents again. The parents of the 'Ananasrenette' are unknown, and the breeding of a genotype with characters very close to the 'Ananasrenette' would be even more difficult. This consideration leads to the conclusion that there is a specific interest (Chapter II, Art. 4, 1.) in the conservation of clone accessions. Amongst this group landraces not conserved by the formal genebank system deserve highest priority and should be put on the national catalogue.

Major crops such as wheat and barley are bred as *line varieties* by many companies in the world and are a subject of many research and development programmes within the public breeding sector, not to speak of the huge numbers of genebank accessions of barley and wheat kept world-wide in genebanks. Again, loss of a line

variety equals the loss of a single genotype or a couple of closely related genotypes. If the parents are known genotypes, progeny with a very similar set of characters can be bred again much more easily than a specific form of a perennial crop. The risk of genetic erosion can therefore be considered less. Moreover, it will be hard to furnish proof that there is a significant risk of genetic erosion within these crops that can seriously affect breeding progress in Germany. Investigations into the long-term temporal trend of diversity of European barley (Ordon et al. 2005; Malysheva-Otto et al. 2007) and wheat (Donini et al. 2000) show significant loss of genetic variation in the breeding pool of barley over time. The loss is compensated by gains in genetic variation, for example from the introgression of genes of crop wild relatives into the crop gene pool. As a result there is a balance between loss and gain over decades of plant breeding activities. The adaptability of the crop gene pool obviously was always high enough to service the breeders' needs either in the 1930s or today.

There are good reasons to assume that the loss of genetic diversity between populations increases with decreasing breeding activities in a crop. In the early 1900s 53 farmers were breeding oats in Germany (Funke 2008); today two breeding companies and one breeders' association are left. During the decline of oat breeding activities in Germany three groups of material reported by Zade (1918, cited by Funke 2008) were completely lost (Kanadische Fahnen, Nauener Land, Böhmerwald Gebirgs), of others at least the descendants still exist in genebank holdings. In total 26 of the 56 varieties of Zade's oat pedigree have been lost (Figure 7.2). Due to a lack of investigations into the dynamics of genetic diversity in oat breeding over the past decades we have no idea whether the crop gene pool of oat is balanced, as in wheat and barley, or threatened by genetic erosion.

If the candidates for the national catalogue of conservation varieties need to be prioritized within the group of self-pollinating agricultural species, crops of the line breeding category with declining breeding activities in Germany should receive higher priority. Incentives should be set to stimulate breeding activities in the informal sector to compensate for possible genetic losses within the formal sector. Oat as a model crop stands for many other crop species with declining breeding activities in Germany such as *Phaseolus* beans and *Lactuca* salad, just to mention two important vegetable crops.

Varieties or populations of *outbreeding crops* share most of the genetic diversity contained in the whole crop gene pool in common (e.g. Jain 1975; Loos 1994). It is the different frequencies of genes

and alleles within individual populations which cause the trait differences between them. A loss of genetic diversity by extinction of a population or variety can only happen if genes or alleles occur within that particular germplasm which are not available elsewhere. Hence, the loss of a single or several accessions of an outbreeding crop does not necessarily cause genetic erosion.

In the long run, as a result of past (genetic bottlenecks) and current genebank management practices (small effective population sizes), inbreeding depression of accessions of outbreeding crops will increase and the reproductive ability may decrease until the accession gets lost. Advisory bodies responsible for the compilation of the national catalogue should therefore consider conserving varieties representing heterotic groups such as the rye varieties 'Carsten' and 'Petkus' (Hepting 1978). As for line varieties, priority should be given to crop species with decreasing breeding activities within Germany, i.e. in general outbreeding vegetable crops.

7.6 Perspective

The regulation 2008/62/EC has actually come into force to promote a broader deployment of genetic diversity in agricultural systems and to improve management of plant genetic resources for food and agriculture. The organization of an integrated germplasm management system allowing the best possible conservation of genetic diversity of a crop should be the common interest of the system's stakeholders. Interrelated fields of interest for conservation that can be used to fulfil the fourth criterion set by directive 2008/62/EC, namely the specific conservation interest, are:

- compensation of inherent shortcomings of the *ex situ* conservation method
- maintenance of heterotic groups
- maintenance breeding, in particular in vegetables
- conservation by use
- conservation of the cultural heritage.

The implementation of the directive in Germany should not be governed by an incorrect historical understanding of the last 150 years of our agricultural system, including the breeding history of varieties. The Ministry for Food, Agriculture and Consumer Protection (BMELV) with its political mandate for sustainable agro-biodiversity management should rather steer the management of the genetic diversity of our crops through actions only where they are really needed owing to a failure of market mechanisms.

Rational decisions require a monitoring of the gene pool of crops including a risk analysis for crops as conducted by Vögel et al. (2006),

suggesting a threat assessment system for crops very similar to the wild plant species threat categories. The red list system should be applied as a tool for monitoring the active state of germplasm only. This can be achieved by calculating trends (increasing, stable, declining production) by using existing agricultural production data.

To improve the management of germplasm, different mechanisms are required for the different germplasm states. Marketing mechanisms are required to stabilize the production of crops still in use but with a clear decline in acreages. Mechanisms such as the directive 2008/62/EC can be applied in the active state to prevent crops and their landraces from devolving from a lower threat category into a higher. Support of the activities of seed saver associations will be an effective measure in this context.

A wider use of genetic diversity in the agricultural system usually requires enhancement programmes to improve the competitiveness of a crop. Programmes specifically designed to promote breeding research will be more effective in the 'planned' state of a germplasm example. Finally, if it is not possible to keep germplasm in the planned or active state, actions need to be undertaken guaranteeing the best possible *ex situ* management of the genetic resources of that crop.

If all stakeholders interested in well-managed crop gene pools understood the management of PGRFA as a cyclic system, then the discussion on the best management of plant genetic resources for food and agriculture would be less prone to controversies between the formal sector, stressing the great advances of modern breeding, and the informal sector, stressing the high value of landraces. Commercial, private and public partners have important and complementary roles to play in this system where landraces do play a role but only their specific one.

The role of BMELV would be to monitor the system and take actions when needed to guarantee effective and efficient conservation of PGRFA. We hope that this paper may help to implement the directive 2008/62/EC which actually aims at a better management of plant genetic resources in agricultural systems.

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8. Inventory of Greek Landraces

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8.1 Introduction

Greece is located in the south-eastern part of Europe and, more precisely, at the southern end of the Balkans. Four-fifths of Greece consists of mountains or hills, with the Pindus mountain range dominating. The range starts from the north-west borders of Greece, continues through the western Peloponnese, crosses the islands of Kythira and Antikythira and ends at the island of Crete. The Pindus mountain range strongly affects the climate of the country by making the western side of it more wet on average compared with the areas lying to the east of it; thus, the average yearly rainfall in the island of Corfu is 1165 mm, while in the island of Syros it is less than 400 mm. Greece also has a long coastline (more than 14 000 kilometres) with more than 2000 islands (of which at least 75 are inhabited) present in the Aegean (mostly) and the Ionian Seas. Depending on the location, the climate can be alpine (in the mountainous areas of the north-west), temperate (north-central and north-east) and Mediterranean in the rest of the country.

Parts of modern Greece have been inhabited since 6800 BC, including settlements that have domesticated plants, such as olives, wheat, figs etc. (Foxhall 2007). Thus, geographic and climatic diversity, combined with the long presence of certain cultivated crops in the area, have an impact on plant diversity. Furthermore, in excess of 1275 plant species, including wild species, are endemic to Greece, some of them having narrow distributions due to their geographic isolation (present in islands or high mountainous ranges).

8.2 National Greek PGR System

At present the public sector is mainly responsible for collecting, storing, conserving and distributing annual and perennial crops grown in Greece. The public sector includes the Ministry of Rural

Development and Food (Research Directorate of Land Planning and Environmental Protection as the competent authority), the Greek Genebank, the National Agricultural Research Foundation (NAGREF) institutes throughout Greece, the universities (Agricultural University of Athens, Aristotelian University of Thessaloniki, University of Thessaly and the Democritus University of Thrace) and the technological education institutes. Collection, characterization, documentation, regeneration and conservation activities are carried out mainly by the Greek Genebank. The National Genebank at Thermi, Thessaloniki, was recently reorganized and is about ready to be relocated in new buildings with modern facilities. The total number of accessions stored at the National Genebank is 10 650, belonging to 66 genera and 169 cultivated species, from which 3523 accessions are wild species (Stavropoulos et al. 2006). In 2003 the National Genebank was the recipient of a state-funded project for collecting, regenerating and storing germplasm from all around Greece. During the project, which is still under way, more than 5500 accessions were collected and are currently being characterized. Currently more than 4000 landrace accessions are held by the Greek Genebank and the NAGREF research institutes (Table 8.1). The universities and other institutes maintain small working collections for their continuing research and are involved in characterization of landraces using morphological, cytological, biochemical and molecular markers. All of the above organizations evaluate landraces for agronomic or horticultural traits and exploit their value for breeding programmes. Thus far, cabbage (Koutita et al. 2005), cherries (Hagidimitriou, unpublished data), dry beans (Arvanitoyannis et al. 2007; Tertivanidis et al. 2008), faba beans (Terzopoulos et al. 2003; Lithourgidis et al. 2004), melon (Staub et al. 2004), oats (Katsiotis et al. 2006), olives (Hagidimitriou et al. 2005, 2008), oregano (Katsiotis, unpublished data), tomato (Terzopoulos and Bebeli 2008; Terzopoulos et al. 2009) and wheat (Agorastos and Goulas 2005; Mantzavinou et al. 2005; Abdellatif 2007) are among the crops that have been characterized. For some of these crops characterization was accomplished through projects funded either nationally (from the Ministry of Development) or internationally (mostly by the EU under Council Regulation No. 1467/1994 for Genetic Resources).

Table 8.1. Number of landrace accessions maintained by the Greek National Genebank for different genera.

	Genus	Species	Number of accessions	Collection years
1.	*Abelmoschus*	*esculentus*	20	1983-1999
2.	*Allium*	*cepa*	53	1982-1999
3.	*Allium*	*porrum*	64	1982-2005
4.	*Allium*	*sativum*	30	1982-2005
5.	*Anethum*	*graveolens*	7	1983-1999
6.	*Apium*	*graveolens*	16	1982-1999
7.	*Arachis*	*hypogaea*	2	1999
8.	*Avena*	*sativa*	47	1979-2005
9.	*Beta*	*vulgaris*	448	1979-2005
10.	*Brassica*	*oleracea*	150	1982-2005
11.	*Capsicum*	*annuum*	41	1982-1999
12.	*Cicer*	*arietinum*	184	1981-1999
13.	*Citrullus*	*lanatus*	10	1993-1999
14.	*Cucumis*	*melo*	18	1993-1999
15.	*Cucumis*	*sativus*	38	1983-1999
16.	*Cucurbita*	*maxima*	52	1983-2005
17.	*Cucurbita*	*moschata*	7	1992-1999
18.	*Cucurbita*	*pepo*	20	1982-1999
19.	*Cynara*	*scholymus*	4	1992-1999
20.	*Daucus*	*carota*	38	1982-1999
21.	*Dolichos*	*lablab*	3	1999
22.	*Ervum*	*ervilia*	16	1982-2005
23.	*Gossypium*	*barbadense*	1	1984
24.	*Gossypium*	*herbaceum*	1	1931
25.	*Gossypium*	*hirsutum*	305	1931-1985
26.	*Helianthus*	*annuus*	3	1999
27.	*Hordeum*	*vulgare*	111	1982-2005
28.	*Lactuca*	*sativa*	53	1982-2005
29.	*Lathyrus*	spp.	55	1982-1999
30.	*Lens*	*culinaris*	102	1982-2005
31.	*Lupinus*	spp.	87	1983-1999
32.	*Lycopersicon*	*esculentum*	75	1982-2005
33.	*Medicago*	*sativa*	18	1995-2005
34.	*Nicotiana*	*tabacum*	488	1982-1984
35.	*Petroselinum*	*sativum*	15	1982-1999
36.	*Phaseolus*	*coccineus*	30	1982-2005
37.	*Phaseolus*	*vulgaris*	436	1982-1999
38.	*Pisum*	*sativum*	46	1982-2005
39.	*Prunus*	spp.	142	1995-2005
40.	*Raphanus*	*sativus*	17	1982-1999
41.	*Solanum*	*melongena*	22	1995-2005
42.	*Spinacia*	*oleracea*	11	1982-1999
43.	*Triticum*	*aestivum*	126	1982-2005
44.	*Triticum*	*baeoticum*	50	1995-2005
45.	*Triticum*	*durum*	154	1982-2005
46.	*Vicia*	*faba*	171	1981-1999
47.	*Vicia*	*sativa*	50	1982-1999
48.	*Vigna*	*unguiculata*	37	1982-2005
49.	*Vitis*	*vinifera*	567	1995-2005
50.	*Zea*	*mays*	353	1965-2005

Non-governmental organizations and farmers have also shown interest in landraces and they contribute to their on-farm conservation. Some of these organizations cooperate with the Greek Genebank. In addition, an unknown number of accessions (cultivated and wild species) were collected in Greece during the last century by foreign collecting expeditions. Thus, plant material, including Greek landraces, can be found in a large number of genebanks world-wide but are not present in the Greek National Genebank.

8.3 Landrace perspective

During the last decades, due to the introduction of pure lines and hybrids, a severe decline in large-scale cultivation of landraces has been recorded. However, due to the geographical morphology of Greece (almost 70% is hilly and/or mountainous) and the presence of small-size farms (the average size of a farm is 10 acres), landraces can still be found under cultivation, especially by people in villages in remote regions and isolated islands, who keep their own seeds and use them mainly for their own consumption and, to a lesser extent, market them as speciality crops. Also, depending on the economic value of the crop, landraces are still grown in certain areas (tomatoes in the island of Santorini, beans in the region of Prespes lakes), or spread throughout Greece (olives).

Tomato, a plant introduced into Europe from the New World, started to be cultivated in several Mediterranean countries by the end of the 16th century. In Greece tomato landraces present a wealth of fruit shape, size and colour, and gained an important place among the local agricultural products of various regions. However, due to the introduction of improved tomato cultivars, nowadays landraces are mostly cultivated in gardens or small fields by a few elderly farmers for personal consumption or local markets. Recently, there is an increased interest in tomato landraces for cultivation in sustainable farming systems and production of locally named added-value products. The most famous Greek tomato landrace is 'Tomataki Santorinis' a small-fruited tomato that is grown in the volcanic soil of the island of Santorini under rain-fed conditions. It produces a very tasty small tomato that is connected with the local culinary habits and is characteristic of the local cuisine. However the evaluation of tomato landraces collected from various regions of Greece has shown that Greek tomato landraces present very good horticultural traits and a wealth of phenotypic and molecular diversity. Most of them have a potential to be cultivated *per se* and also constitute promising breeding material. The Greek Genebank maintains a large number

of tomato landrace accessions but the promotion of their on-farm conservation is imperative for the conservation of this valuable genetic resource (Terzopoulos and Bebeli 2008; Terzopoulos et al. 2008).

Legumes are an important source of proteins, contributing to human diet all over the world. The adequate nutritive composition and variable uses of beans (*Phaseolus vulgaris, P. coccineus, P. lanatus*), lentils (*Lens esculentum*), chickpeas (*Cicer arietinum*) and vetchling (*L. clymenum*) in different culinary forms (canned or frozen grain and pod, dry seeds) makes them interesting crops for consumers and processors. In Greece these legumes are an important component of the Mediterranean diet and are cultivated in a number of areas located in northern (Macedonia, Thrace) and central (Thessaly, Hepirus) regions as well as the Aegean islands (Crete, Santorini). In some such cropping areas, farmers have maintained some common landraces, whereas in the majority of others they have progressively been replaced by elite cultivars. However, because the quality, nutritional composition and morphological characteristics of some landraces of beans (in the Prespes region of lakes), lentils (in the island of Kefallonia) and chickpeas (in the region of Maronia) are preferred by consumers, they are also willing to pay higher prices. In a number of cases legume products are characterized as 'regionally protected', giving them the opportunity of cultivation under *in situ* conditions close to their places of origin.

Greece is considered to be a secondary centre of diversity (Damania 1995). Fossils of olive leaves found in the islands of Santorini and Nisyros date back to more than 30 000 years ago. According to Tavanti, in ancient Greece, at least 15 cultivars were described based on morphological characters whereas, at the same period, only two were described in Egypt and three in the Middle East (Prevost and Mostardini 1999). Nowadays Greece is among the leading olive producing countries with an average annual production of more than 85 000 tonnes of table olives and more than 350 000 tonnes of olive oil. More than 90% of the total acreage is cultivated with about 20 cultivars that have adapted in a wide range of environmental conditions, such as 'Koroneiki' (grown in areas with less than 400 mm of rainfall), 'Lianolia Kerkyras' (grown in areas with more than 1100 mm of rainfall), 'Karydolia' (cultivated in the province of Chalkidiki, Macedonia, tolerant to frost), and 'Kalamon' (grown in areas with high rainfall and air humidity), to name a few. A total of 130 Greek olive landraces have been differentiated using molecular markers, indicating the genetic diversity present in the region (Hagidimitriou et al. 2005, 2008).

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9. Inventorying and on-farm Maintenance of Hungarian Landraces

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9.1 Introduction

The National Institute for Agrobotany, as the predecessor of the Central Agricultural Office, Research Centre for Agrobotany (CAO, RCA) was founded by the Ministry of Agriculture in 1958 with the following responsibilities:

> *"...collection, maintenance and taxonomic, botanical, physiological, biochemical as well as plant pathological examination of domesticated plant species, and a world collection of cultivated crops".*

After several reorganizations, RCA has been functioning as a department of the CAO since 1st January 2007. In spite of the reorganizations, RCA has kept its responsibilities concerning the development and maintenance of collections of field and vegetable crop genetic resources and has performed overall genebank activities for 50 years, including the following tasks:

- Exploration and collection of genetic resources of field and vegetable crops with special emphasis on local Hungarian material
- Medium- and long-term conservation of seed samples in cold storage rooms and by using meristem cultures in the case of vegetatively propagated crops
- Multiplication and regeneration of accessions in order to obtain sufficient quantities of high-quality seeds for medium- and long-term conservation, evaluation and distribution
- Isoclimatic regeneration of Hungarian landraces, ecotypes and populations in their places of origin (*in situ*, on-farm and home garden multiplication)
- Characterization and evaluation of plant genetic resource (PGR) collections according to internationally accepted descriptor lists
- Development and maintenance of the National Base Collection for seed-propagated crops
- Documentation of passport and evaluation data for the PGR collections maintained by RCA and other partners in Hungary (National Database)

- Distribution of seed samples to users, together with relevant information
- Nationwide responsibility for the technical coordination of Hungarian PGR activities
- Participation in the ECP/GR and other international and national programmes.

9.2 The collections of the Research Centre for Agrobotany

The collection of RCA consists of Active, Base, *In vitro* and Field Collections containing a total of 87 373 accessions representing 1914 taxa of 314 genera (Table 9.1). The collections of RCA show a wide range of diversity by country of origin, five continents with 108 countries are represented as sources of germplasm. The most important part of the collections, 30 780 accessions (35.5% of the entire collection) originated from Hungary and 80.1% of the Hungarian accessions maintained in the collections of RCA are landraces and ecotypes collected from 1364 collecting sites since 1959 (Figure 9.1).

Table 9.1. RCA collections in 2008.

Crops	Active	Base	*In vitro*	Field	Total
Cereals	33 037	3 167			36 204
Food legumes	14 139	2 446			16 585
Forage legumes	4 926	410			5 336
Grasses	3 201	283			3 484
Industrial crops	6 131	932			7 063
Medicinal plants	1 165	70			1 235
Roots & tubers	349	33	474	54	910
Vegetables	12 378	3 807		89	16 274
Other	272	10			282
Total:	75 598	11 158	474	143	87 373

During the collection of landraces all information related to the collected samples is documented. A new collecting protocol is being developed, which will support a new documentation system to be introduced in relation to the planned establishment of a 'Pannon Seed Bank' for collections of native cultivated and wild germplasm. In addition to the minimum collection data sets (collecting site, altitude, latitude, longitude, etc.), a module in the new system will facilitate the documentation of all kinds of cultural, traditional, nutritional etc. information related to the collected samples and

their habitats. Some examples of the additional information to be registered are listed below:

- Description of the collecting mission (e.g. date, duration, participants, itinerary, collector's name and institute, etc.)
- Description of the collection site (habitat, farmer's name and some relevant socio-economic information about the farmers, etc.)
- Description of the collected material (e.g. taxonomy, status of the material collected, quantity of the collected sample, number of plants sampled, isolation, usage, local name(s), tradition related to the production, related popular customs, unique morphological, phenological, quality features, etc.).

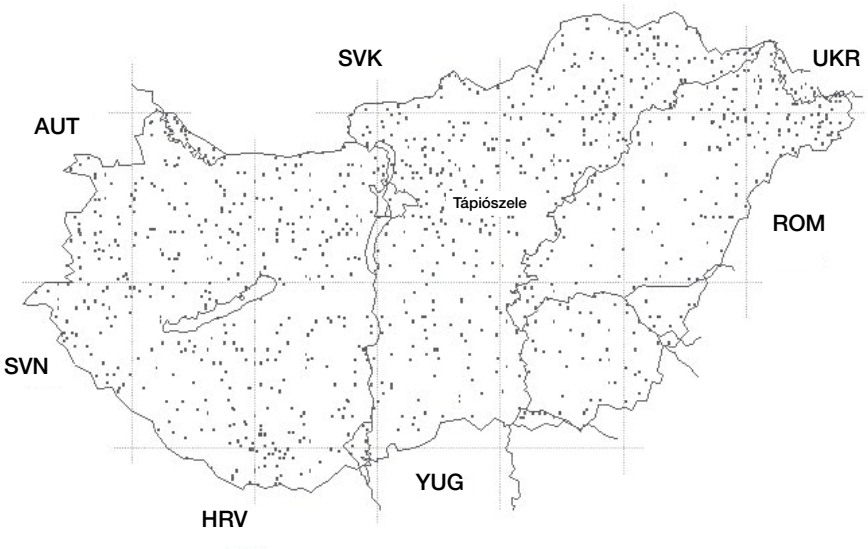

Figure 9.1. Landrace collection sites in Hungary.

9.3 Hungarian National Inventories for PGRFA

Holdings in all Hungarian institutions maintaining *ex situ* genetic resource collections (field crops, vegetables, fruits, grapes, medicinal and aromatic plants and microorganisms of relevance to agriculture) were assessed in 2003, in order to develop the National Inventory of PGRFA and to assist the supervision of collections funded within the state programme of Conservation and Improvement of the Biological Basis of Agriculture. In addition, a detailed survey was undertaken from 2000 to 2004 to assess the diversity of landraces in three target areas (ecologically sensitive areas) with special reference to *Phaseolus* bean and maize. This project also included a

socio-economic component and was conducted within the frame of IPGRI's global programme 'Strengthening the scientific base of *in situ* on-farm conservation of crop genetic resources'. The Plant Gene Bank Council decided to update the state of the *ex situ* collections in 2007. Negotiations have also started between the Ministry of Agriculture and Rural Development and the Ministry of Environment and Water in order to develop effective collaboration among stakeholders concerned in biodiversity issues, including the maintenance and utilization of agro-biodiversity. According to the latest application for support of the national genebank activities, the total number of accessions of the Hungarian National Inventories is 144 340 accessions including the collections of RCA (see Table 9.2).

Table 9.2. Institutions holding PGR collections and their contributions to the National Inventory.

Crop groups	2003/2007		
	No of inst.	Total number of accessions	RCA's share
Fruits	12	8 067	-
Grapes	11	4 758	-
Field crops	12	89 716	69 582
Medicinal plants	5	4 789	1 235
Microorganisms	9	2 890	-
Ornamentals	22	10 392	282
Vegetables	9	23 728	16 274
Total:	-	144 340	87 373

9.4 Protected area management

In situ conservation of crop wild relatives and landraces is closely associated with nature conservation in Hungary. Populations of several crop wild relatives live in protected natural habitats and such areas can also play an important role in *in situ* on-farm conservation of locally developed landraces. Protected natural areas can provide optimal conditions for long-term maintenance of protected species. The Hungarian law (especially Act on Nature Conservation No. LIII, 1996) classifies protected natural areas (on the basis of the extent of measures of conservation, their aims and national and international importance) into the following categories[1]:

[1] Source: State Secretariat for Nature and Environment Protection: www.termeszetvedelem.hu

1. Protected natural areas and assets of national interest
   a. Natural areas protected by a specific law
      - National parks
      - Landscape protection areas
      - Nature conservation areas
      - Natural monuments
   b. *Ex lege* protected natural areas
      - All qualified as nature conservation areas
        - Bogs
        - Alkaline lakes
      - All qualified as natural monuments
        - Tumulus
        - Earth fortifications
        - Springs
        - Sinkholes
   c. *Ex lege* protected natural assets

2. Protected natural areas of local interest
   a. Nature conservation areas
   b. Natural monuments.

National parks, landscape conservation areas and nature conservation areas (of national or local interest) are the most important protected habitats for crop wild relatives and can be seen to be increasing in number and area over time (see Table 9.3).

Ecologically sensitive areas can also play an important role in *in situ* conservation of landraces. Over 3 million hectares have been identified as ecologically sensitive areas in Hungary. It is anticipated that continued high-input and intensive agricultural practices would lead to further degradation of such areas. Strict restrictions in land management and use of fertilizers and pesticides should be introduced to prevent the degradation of natural, semi-natural and agro-ecosystems in these sensitive areas (Holly et al. 2002).

In Hungary the definition of Environmentally Sensitive Area (ESA) was first used in the Act on Nature Conservation No. LIII, of 1996. Accordingly, ESAs are such areas (Figure 9.2, Table 9.4) within which low-input cultivation should be applied and conservation of biodiversity, diverse habitats and cultural and natural values should receive high priority. The establishment of the ESA system is associated with the National Agri-environmental Programme (Government declaration NAKP – 2253/1999). The joint decree of the Ministry of

Environmental Protection and the Ministry of Agricultural and Rural Development (2/2002 (I.23.) KöM – FVM rendelet) has provided a regulatory mechanism for the designation of ESAs (Angyán et al. 2003). The different ESAs are classified on the basis of the level of protection required:

- Very important areas. These areas and their value are internationally recognized. Without low-input production their maintenance is doubtful in the medium time period.
- Important areas. These have national value. Low-input production is necessary to the conservation of their value or to improve their condition.
- Possible areas. The rate of extensive agricultural areas is large, whereas the importance of natural and land values is less. The natural value of these areas can be increased by supporting extensive cultivation.
- Pilot areas. In 2000 one ESA was established in each national park as a pilot area for further studies.

Table 9.3. Changes in Hungarian protected natural areas between 1997 and 2007.

	Number of National Parks	Total area of National Parks (ha)	Number of Landscape Protection Areas	Total area of Landscape Protection Areas (ha)	Number of Nature Conservation Areas	Total area of Nature Conservation Areas (ha)	Total area (ha)
1997	9	423 700	35	319 832	139	25 462	768 994
1998	9	429 415	37	341 696	146	26 440	797 551
1999	9	440 839	38	349 242	141	25 853	815 934
2000	9	440 839	38	349 242	142	25 927	816 008
2001	9	440 928	38	349 641	142	25 927	816 496
2002	10	484 883	36	309 817	142	25 927	820 627
2003	10	484 883	36	309 817	143	25 937	820 637
2004	10	484 126	36	316 677	144	27 687	828 490
2005	10	486 056	36	324 014	147	28 950	839 020
2006	10	485 806	36	324 035	152	29 191	839 032
2007	10	485 864	37	326 743	162	32 095	844 702

Twenty-one percent of Hungary's area is part of the Natura 2000 Network. The indicated areas comprise agricultural areas such as arable fields, grasslands, pastures and wetlands where traditional production has been going on for a long time.

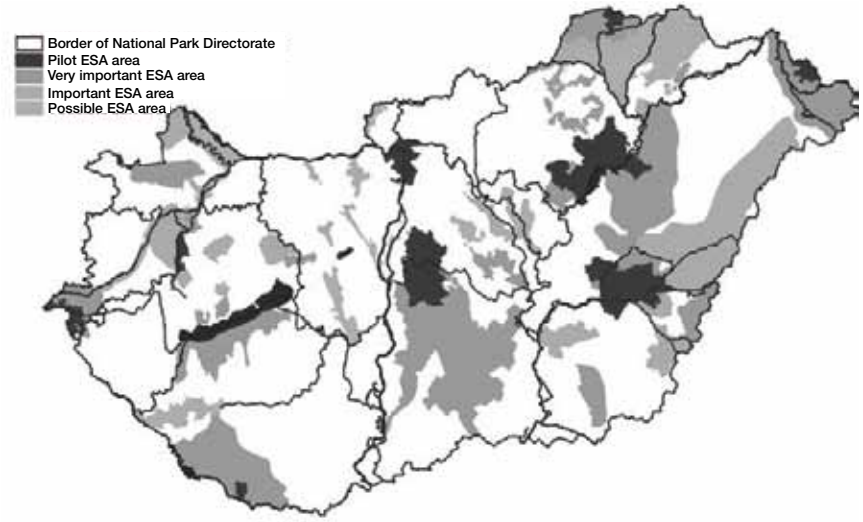

Figure 9.2. Environmentally Sensitive Areas in Hungary recognized in 2003.

Table 9.4. The areas and relative proportions of ESA categories.

ESA categories	Area (1 000 ha)	Ratio (%)
Pilot area	179.4	1.9
Very important area	1 883.2	20.2
Important area	936.4	10.1
Possible area	294.4	3.2
Total:	3 293.7	35.4
Country total:	9 300.8	100.0

9.5 On-farm management

In the frame of an IPGRI global project (Strengthening the scientific basis of *in situ* conservation of agricultural biodiversity) the Institute for Agrobotany (predecessor of the RCA) conducted detailed surveys in three ESAs (Szatmár-Bereg, Dévaványa, Őrség-Vendvidék ESA). Based on experience, and due to the difficulties in running the backyard multiplication system, RCA has developed collaborative linkages with different civil organizations in the field of *in situ* on-farm maintenance of native landraces. The following organizations and NGOs are involved in nature protection and maintenance of biological diversity including local landraces in Hungary:

- ***Ormánság Foundation*** (ormansag@axelero.hu): The aims of the foundation are:
  - The protection of lands against potential damage

  - Improvement of the land's condition by developing and spreading adequate landscape management techniques
  - Training and advising interested people
  - Propagation of local fruit varieties and distribution of grafted material.
- ***Gyűrűfű Foundation***, Gyűrűfű Society (www.gyurufu.hu): Gyűrűfű is a self-supporting village in the south-western part of Hungary. The people in the village intend to live in harmony with nature. The most important aims of the society and foundation:
  - Establishment of the harmonic coexistence model in terms of nature, technology and sociology
  - Representation of the interests of the members of the society
  - Training (Jurta University, permaculture course), advising
  - Ensuring democratic frame of local government
  - Dealing with social problems of local population.
- ***Association of Visnyeszéplak Village's Protection*** (www.visnyeszeplak.hu): Visnyeszéplak is a self-supporting village in the region of Zselic. The local population tries to live in harmony with nature. They realize it through ecological farming and bio-production. The most important aims of the association:
  - Protection of natural values including local varieties of Zselic subregion
  - Development of ecological wood felling and cutting methods
  - Cultural, social questions and problems of local population
  - Training and advising interested people.
- ***Gaia Ecological Foundation*** (*www.gaiaalapitvany.hu*):
  - Participation in local rural development
  - Participation in the functioning of Galgafarm (the first Hungarian Organic Agricultural Society)
  - Participation in the functioning of Galgahévíz Ecovillage
- ***Eco-resources Foundation***, Budakeszi:
  - Participation in the on-farm evaluation and maintenance of landraces
  - Safeguarding the scientific heritage of Prof. Andor Jánossy
  - Utilizing local landraces in ecological farming and on-farm selection.
- ***Hungarian Permaculture Association*** (www.permakultura.hu):
  - Training, advising
  - Spreading of permaculture methodology
  - Low-input production (use of landraces).
- ***Biohistorical site of Szarvasgede*** (gyulai.ferenc@kti.szie.hu):
  - Production of einkorn and fruit landraces (more than 200 landraces – cherry, sour cherry, apricot, plum, apple, pear – from the Carpathian Basin)

  - Archeobotanical research
  - Participation in higher education.
- ***Nimfea Nature Conservation Association*** (www.nimfea.hu): The 'Nimfea' works in the Great Hungarian Plain as a non-governmental organization, solving tasks related to the environment and nature protection. The association deals with practical realization of local sustainable agricultural production.
- ***Hungarian Bioculture Union*** (www.biokultura.org):
  - Low-input production, ecological production.
- ***Pangea Cultural and Environmental Heritage Protection Association*** (www.pangea.hu):
  - Environmental education (camps for children, 'on the spot' training)
  - Low-input production: biological farming using landraces
  - Biological sewage systems.

9.6 On-farm (dynamic) conservation of PGRFA in Hungary

At the beginning of the 21st century, when genetic erosion threatens most cultivated species, the need for using diverse conservation methodologies is important. The traditional genebank activity has therefore been complemented by two additional forms of conservation in the Hungarian National Programme, see Figure 9.3 and Már and Holly (1999) for discussion:

- **'Backyard' multiplication:** In 1959 Andor Jánossy initiated a programme for the multiplication of landraces under equivalent conditions. The principal purpose of this programme was to conserve the original genetic composition and integrity of landraces, old cultivars and local varieties by minimizing directional selection pressures. The programme is based on the multiplication of locally adapted populations in selected districts where the climatic and edaphic conditions are similar to those of the places of origin. In such districts farmers were contracted to grow about 400-500 accessions each year (Table 9.5).
- **On-farm conservation:** Within a given landscape and agricultural district, locally adapted populations are the most stable varieties. The specific genetic adaptation to local biotic and abiotic factors is the result of long-term selection and adaptation processes. Collecting seeds in the field and recording information concerning the motivation of farmers in growing them contribute to our knowledge on this neglected aspect of biodiversity. Recently, landraces of crops such as maize (*Zea mays*), vetch (*Vicia* spp.), cucurbits (*Cucurbita* spp.), bean (*Phaseolus* spp.), paprika (*Capsicum annuum*), rye (*Secale cereale*) and some under-utilized species (i.e.

safflower, *Carthamus tinctoria* L.) are used in on-farm conservation in various regions within Hungary. By extending the evaluation of local populations kept in genebanks or farmers' fields, they become known and readily available to the public.

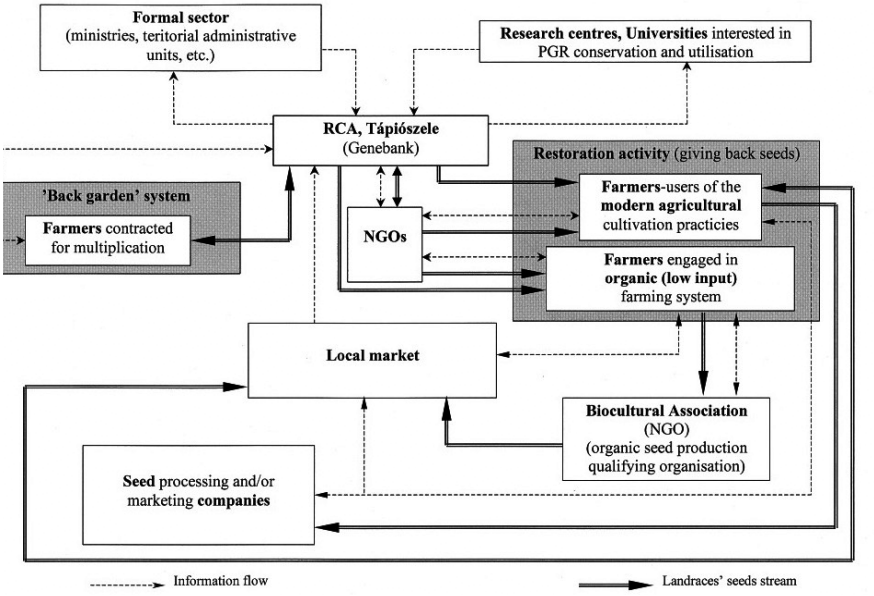

Figure 9.3. Information and material flow-chart of on-farm management of landraces in Hungary.

The dynamic conservation of landraces is based on the principles of on-farm activity and it is realized by a connected management of the informational and seed supplying system. It includes the 'back garden' system (adding benefits by drawing the attention of farmers involved in this system to landraces) and restoration activity (adding benefits by informing farmers interested in the application of principles of sustainable agriculture and quality food production on the real advantages of the cultivation of landraces).

The 'back garden' system has been running since 1959 and it has an essential role in the overall PGR conservation. The system includes several activities with additional benefits such as:

- The multiplication of the accessions stored in the *ex situ* collection in regions where the natural conditions are similar to the conditions of the original collecting sites. The main objective of this activity is the optimal maintenance of the original genetic composition of the accessions. It is realized by contracting farmers living in the relevant regions to grow landraces of different species originated

in their villages or nearby areas. The harvested seed is partly reintroduced to the *ex situ* collection as a regenerated sample of the original accession. The climatic conditions of the multiplication districts (Táplánszentkereszt, Lókút, Nagykálló, Dévaványa, Szatmár-Bereg, Őrség-Vendvidék) cover the conditions of the major agro-ecological sites of Hungary.

- The contractual multiplication of the stored accessions also plays an essential role in the reintroduction of partly forgotten cultivation knowledge among younger farmers, who, through the propagation of the landraces, can also satisfy their families' own consumption needs. Cultivation of landraces especially: bean (*Phaseolus* spp.), tomato (*Lycopersicon esculentum*), green and red pepper (*Capsicum* spp.), onions (*Allium* spp.) cucurbits (*Cucurbita* spp.), garden sorrel (*Rumex acetosa*), spinach (*Spinacia oleracea*), broad bean (*Vicia faba*), clover (*Trifolium* spp.) and maize (*Zea mays*) can complement the cultivation of modern cultivars, especially in regions where the average farm size is relatively small.

Table 9.5. Multiplication of landraces by crop groups and by five-year cycles.

Years of regeneration	Cereals	Food legumes	Forage legumes	Industrial crops	Vegetables	Other	Total
Before 1980	79	136	120	39	157	11	542
1981-1985	181	400	839	232	755	16	2 423
1986-1990	418	404	1 249	506	690	17	3 284
1991-1995	216	363	802	394	750	92	2 617
1996-2000	40	233	200	86	297	41	897
After 2000	15	183	38	45	247	3	531
Total:	949	1 719	3 248	1 302	2 896	180	10 294

High Nature Value Areas have been identified among the Environmentally Sensitive Areas on the basis of level of biological diversity and the occurrence of protected species, and special protection was assigned to such areas. We also used these districts to conduct surveys on the status of landraces and local agricultural practices. As an example, we can cite the results of a survey of the Dévaványa Environmentally Sensitive Area (ESA) which includes five settlements and is located in the centre of the Hungarian Great Plain. The landscape is flat and consists of mosaics of cultivated lands and grasslands. One of the aims of the survey was to identify the species composition and diversity index of kitchen gardens and small plots belonging to the households. As a first step, the average size of kitchen gardens in the region was calculated, the national average being 591 m^2. The following

table shows data concerning the size of kitchen gardens in the five settlements within Dévaványa ESA (Table 9.6). The size of kitchen gardens was found to vary between 30 and 5000 m^2, with an average size of 478 m^2. This value is lower than the national average, which may be due to the urbanized character of the region.

The second step was to estimate the diversity of home gardens using the Shannon-Weaver and Simpson indices. Between 1958 and 2002, the Research Centre for Agrobotany conducted 11 collecting trips to the five settlements and in total 143 samples belonging to 37 crops were collected (Table 9.7).

Table 9.6. Size of kitchen gardens in Dévaványa ESA.

Settlement	Average size of kitchen gardens (m^2)	Minimum size of kitchen gardens (m^2)	Maximum size of kitchen gardens (m^2)
Dévaványa	498.25	30	2 160
Gyomaendrőd	622.20	30	2 880
Körösladány	309.20	40	720
Szeghalom	425.71	100	1 440
Túrkeve	534.72*	70	5 000
Average	478.02	54	2 440

Table 9.7. Numbers of crops and landraces collected in the settlements of Dévaványa ESA.

Settlement	Number of crops	Number of landraces collected
Dévaványa	18	70
Gyomaendrőd	20	42
Körösladány	5	15
Szeghalom	5	5
Túrkeve	8	11
Total	37	143

The most common crops found were common bean (*Phaseolus* spp.) and maize (*Zea mays* L.) landraces. A total of two scarlet runner bean (*Phaseolus coccineus* L.), one Lima bean (*Phaseolus lanatus* L.) and 36 common bean (*Phaseolus vulgaris* L.) samples were collected in Dévaványa ESA. The majority of the 29 maize open pollinated varieties found are used predominantly but not exclusively for feeding animals. The majority of the collected species belong to the *Poaceae* and *Fabaceae* families. The most important agronomic groups of the collected material are vegetables, pulses and cereals.

Among the total 42 crop species collected, potato (*Solanum tuberosum* L.), maize (*Zea mays* L.) and alfalfa (*Medicago sativa* L.) are grown on the largest areas. Vine grape (*Vitis vinifera* L.) and plum

(*Prunus domestica* L.) are the most common among the 21 woody plant species registered during the survey. The shares of different species in the entire cultivated areas clearly show the importance of small farms and kitchen gardens in meeting the food and feed needs of the rural households in the target area.

In each Environmentally Sensitive Area (ESA), the agricultural diversity and biodiversity were assessed and documented. Results of the surveys supported the expectation that in such areas where high-input crop production technologies are harmful to the environment, excellent conditions might be provided for the survival and conservation of traditional farm management techniques and local landraces (Holly et al. 2002).

Another field of the work on landraces is the restoration of local varieties by on-farm maintenance in different regions. This activity is primarily based on the strong motivation of farmers and/or farmer communities (coordinated by NGOs) to maintain and use one or several elements of native PGR. The activity is promoted through a seed supply system: the seeds of landraces are taken from the national genebank (RCA) or directly from the local markets according to the needs of farmers involved. In many cases the farmers are interested in the cultivation of the earlier local varieties which had disappeared. Civil organizations (South Transdanubian Regional Centre, Drávafok; Ecological Institute for Sustainable Development, Gömörszölös), scientists and students from universities and research centres (Agricultural University of Debrecen - DATE, Agricultural University of Gödöllö - GATE), the Ministry of Agriculture and Rural Development and the Ministry of Environment and Water have supported and been involved in the survey and implementation. Another important experience is the recognition of the importance of local markets. These places should be considered as an integral and complex system providing a chance for the exchange of local plant materials among farmers and gardeners. Any changes in the legislation and in the functional structure of the local markets may strongly influence the survival of local plant genetic resources.

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10. Landrace Inventories in Italy and the Lazio Region Case Study

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10.1 Introduction

Landraces have been cultivated and continuously developed by local farmers for centuries in Italy. Although they run a severe risk of extinction, they are still part of the local productive systems especially (even though not exclusively) because of traditions linked to food (Silveri et al. 2002; Negri 2003; Porfiri 2004; Dalla Ragione and Porfiri 2005; Falcinelli et al. 2005; Dalla Ragione and Dalla Ragione 2006; Nanni et al. 2006; Negri et al. 2007 just to cite some of the numerous papers concerning them). In Italy the risk related to their genetic erosion, and to the loss of agricultural biodiversity in general, was fortunately perceived earlier than in other countries. A first national inventory of landraces still maintained on-farm was recently compiled within the frame of the national seed project PRIS2 (Azioni di Innovazione e Ricerca a Supporto del Piano Sementiero), which is available at www.catalogovarietalocali.pris2.parco3a.org/.

Italy was the first country in Europe (and probably in the world) to have created national and regional regulations (see Lorenzetti et al., Chapter 33 this volume; see also www.ense.it or www.semirurali.net) aimed at landrace inventorying and conservation. As early as the year 1997, long before any other European or Italian legislative initiatives, the Tuscany Region promulgated the first law which was then followed by other regional laws.

These laws are also concerned with the use of genetic resources in relation to the development of local agricultural systems. In particular, the relationship between genetic resources, territory, typical products and local traditions has generally been a focal point in establishing the measures aiming to preserve landraces. This *corpus iuriis* is probably unique in Europe as both an applicative and operative system. We are here taking the Lazio law (see www.arsial.regione.lazio.it/portalearsial/default.htm) and its implementation as an exemplar case study.

10.2 The Lazio Region law: main points

The law protects both animal and plant genetic resources; here we will refer only to the latter with specific reference to landraces. The law (Legge Regionale 1 marzo 2000, n 15. "Tutela delle risorse genetiche autoctone di interesse agrario") – similarly to other regional laws – initially defines genetic resources of concern and the concept of 'autochthony' (Article 1). All species (including wild relatives of cultivated species), varieties, populations, ecotypes and clones that have their origin in the regional area, or which were introduced into the regional territory at least 50 years ago and are integrated in the regional agro-ecosystem, are to be considered 'autochthonous'. They are going to be protected by the law only if they are subject to a process of 'genetic erosion'. The evaluation criteria of genetic erosion are one of the main features of this law which, needing an extensive treatment, will be reviewed in a purposely dedicated paragraph.

Article 2 provides for the setting of an official regional 'repertory' (i.e. inventory) in which to register the above-mentioned genetic resources at risk and the criteria for registering them in the repertory itself. The Agricultural Extension Service of Lazio Region (ARSIAL) is defined as the subject that takes care of the law's application and as the responsible holder of the repertory. The registration is submitted to the evaluation of a panel of experts (Art. 3). A network of conservation and security (Art. 4), which brings together different stakeholders, both public and private, is another tool created by the Lazio law with the purpose of promoting *in situ* and on-farm conservation of genetic resources and to organize the propagation of landraces. Article 5, recalling the Rio Convention on Biodiversity, declares that local genetic resources belong to local people and that benefits coming from their use should be equally subdivided among them. Article 6 defines the implementation plan and states that financial support should be given to people maintaining genetic resources at risk *in situ* (on-farm). The other Articles define constraints and finances.

10.3 The implementation of the law

The repertory or inventory is the pivotal tool to protect genetic resources under threat (www.arsial.it/portalearsial/RegistroVolontarioRegionale/Default.htm). It is a voluntary register since any subject (private persons, organizations, public institutes) can ask for free to include a certain genetic resource in the repertory. In particular, a written request must be send to ARSIAL jointly with a technical report where a detailed morphological description, inclusive of photographic documentation, and information about

the place of conservation and multiplication, its extension, the maintaining farmers, area of origin, history and main agronomic characteristics are to be described. Since the year 2000 the Lazio region has funded the implementation of the law which followed the steps reported below:

- the creation of a dedicated web page where all the information about the law and its implementation processes are given and continuously updated;
- the nomination of the technical-scientific committee whose main tasks, besides providing general information, have been to work out the forms for acknowledging the existence of a certain genetic resource, set the criteria to define it as 'under threat', evaluate all the requests for registration which arrive and give suggestions about the way to carry out characterization;
- the progressive collection of all possible information related to each signalled genetic resource (including historical documents and oral testimonies, etc.) in order to verify the autochthony of landraces, their diffusion, their relationship with rural communities, local traditions and their potential economic value;
- the elaboration and loading of information;
- the collection of seed/propagating materials and their multiplication;
- the characterization of genetic materials, by different tools (morpho-physiological traits, molecular patterns, comparative trials);
- the compilation of an on-line repertory of collected materials;
- the promotion of a stakeholders' network, which organizes the exchange of seed/propagating materials among its members, according to commercial seed regulations.

This work has been possible because since the publication of the law the ARSIAL officers have built up a consistent personal experience on issues related to on-farm conservation. After eight years the Lazio region has built up a repertory with more than 100 accessions of different species which are currently being characterized. At present Lazio has also prepared a list of the landraces which includes an estimate of the erosion risk they are running. This would be a prioritization tool to fund on-farm conservation activities.

10.4 The evaluation of genetic erosion threat: a model

As mentioned above, the evaluation of the threat level of a certain genetic resource conditions its inclusion in the Register. In addition, considering that finances are usually limited, the level of threat was assumed as the priority parameter to fund on-farm conservation activities.

Table 10.1 Indicators and indicator scores to evaluate genetic erosion and levels of risk adopted by Lazio Region.

Indicator	Description[2]	Risk level	Score
A Presence of the product on the market	Markets and/or producer's cooperatives Sector: main variety in a certain DOC, DOP, IGP, IGT certified production	Low	1
	Niche market: locally limited cultivated areas Market section: secondary varieties in a DOC, DOP, IGP or IGT certified production	Medium	2
	Only some fruits/few seeds available for consumption or research No product on the market	High	3
B Presence in the catalogues of the seed companies/ nurseries	Fruits: presence in variety list A, B and C Vegetables and plants: listed in the national register of varieties Grapevine: listed in the regional register	Low	1
	Grapevine: under registration to regional register Propagation materials available at a few nurseries	Medium	2
	Fruits: not registered in the variety list Vegetables and plants: not registered in the national register of varieties Grapevine: not registered in the regional register No propagating material available out of the maintaining farm	High	3
C Number of cultivating farmers	> 100	Low	1
	30 to100	Medium	2
	< 30	High	3
D Areas under cultivation (as percentage of the total regional area for the species)	> 5 %	Low	1
	1 to 5 %	Medium	2
	< 1% Isolated plants or home garden cultivations	High	3
E New dedicated area trend	New areas dedicated to landrace present	Low	1
	No new areas dedicated to landrace present	High	3

The setting of criteria to establish the level of genetic erosion has been a crucial step in the application of the law.

Despite the many authors who have studied the problem and given different definitions of genetic erosion, no studies are available that propose models to quantify it. In addition, the estimate of

[2] Data to be recorded by ARSIAL extension officers.

level of erosion may require different criteria in relation to the species, the environment and the interaction between the species and the environment (where environment is to be intended *sensu latu*, i.e. including the 'human environment'). It was a task of the expert committee to set criteria (i.e. indicators), based on personal experience and scientific expertise and the available literature and data which were useful to define the level of threat. The committee initially recognized that a changing socio-economic environment is the main cause of genetic erosion (or loss) of genetic resources (cf. Negri 2003): the increasing rate of farming drop-out, the farmers' ageing, the unwillingness of younger generations to reproduce seeds on the farm, the insufficiency of information exchange, the increasing use of modern varieties, all cause a progressive depleting of genetic resources. In addition some of the genetic resources that were signalled as autochthonous to the committee serve a niche or a wider market locally, since typical products are highly appreciated in Italy. In some cases they are also available on the seed market (i.e. some horticultural crops and fruit trees). The biological traits and cultivation conditions of different species (type of reproductive systems, propagation type, agronomic density of plants, etc.) were also taken into account in formulating criteria.

After discussion, the following indicators were chosen (Table 10.1):

a. existence of the product on the market;
b. presence of a landrace on the catalogues of a seed company or nurseries;
c. numbers of farmers still cultivating the landrace;
d. cultivated areas of the landrace in comparison with the total regional area for that crop;
e. trend of new cultivation areas dedicated to that specific landrace.

Each indicator was then associated to other conditions to attribute a risk score (1 = low; 2 = medium; 3 = high, Table 10.1). It was then decided that the sum of different values would have given a total level of erosion, with the following classification of the erosion risk:

- low risk as total value ≤ 9
- medium risk as total value 10 to 13
- high risk as total value ≥ 14.

It was also decided that the presence of only one indicator with a score equal to 3 was sufficient to consider the landrace as under threat and, as a consequence, enough to activate the law procedures (i.e. to register the landrace in the inventory). However, considering the financial aspect, the higher the level of threat the higher is the possibility of funding on-farm conservation activities through subsidies.

10.5 Lessons learnt

The experience of Lazio Region, as well as that of other Regions (i.e. Tuscany, Marche), demonstrates that a regional law is a good instrument to preserve agricultural biodiversity and to promote the use of landraces. The Regional Government, having good knowledge of the territory, is able to inventory its genetic resources better than other public bodies in Italy. In addition, the local regulations are generally discussed and applied with easier and more flexible procedures than national or EU laws. However, Italian experiences also show limits with regard to the followings aspects:

- Parameters used to identify local varieties are different from one Region to another, which makes for confusion at the national level.
- In defining landrace identity and autochthony it is difficult to take into account the rural traditions because they have mostly been passed from one generation to another orally.
- It is difficult for a farmer who cultivates a landrace on a limited scale and in a (usually) small farm to sell seed conforming to the official regulations on seed production and certification. This is especially true for rules such as those concerned with purity, traceability and packing. Specific skills and equipment are necessary for them, which are not generally present on small farms.
- A system that efficiently transfers the benefit of farmers' rights to the local agricultural communities (according to the enunciation of ITPGRFA) has not yet been found.

According to the experience gained by Lazio, two tools are particularly useful to preserve genetic resources on-farm:

a. the inventory: because (i) it publicly acknowledges the existence of single local varieties (which are well identified, differentiated from others of the same species, located in a specific area of origin, and described in terms of the genetic erosion threats) and (ii) it represents the basis for safeguarding landraces by a solid legal instrument,
b. the network of conservation and security: because it promotes seed multiplication and diffusion of the landrace registered in the regional repertory.

We would also like to note that the exchange of experiences between neighbouring Regions would be important not only for the best application of Regional laws but also for a better safeguard of genetic resources at a European level. Recently, a national law (Law n. 46, April 6, 2007, see Lorenzetti et al., Chapter 33 this volume) was approved which makes provision for the compilation of a national catalogue of landraces. The national catalogue will collate all the regional inventories in one. It further promotes the inventory of the cultivated biodiversity under threat and should harmonize

the regulations of different regions so as to avoid overlapping and inefficiencies.

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11. Landrace Inventory for Portugal

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11.1 Introduction

Portugal, at the confluence of Atlantic and Mediterranean climates, and with irregular landscapes and different types of soils is an interesting case study of the adaptability of plant genetic resources. Eurasian crops such, as wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.), arrived in the country between 3800 and 2500 BC (Diamond 1998), and the olive tree (*Olea europaea* L.) and grapevine (*Vitis vinifera* L.) were greatly spread during Roman times (Kiple 2007). Similar adaptation occurred with New World crops, such as beans (*Phaseolus vulgaris* L.) and maize (*Zea mays* L.) (Costa-Rodrigues 1971; Ferrão 1990). As a consequence, many landraces originated for each crop. Despite the great importance of these landraces, their maintenance has been seriously threatened, especially since the 1970s, when emigration was intensified and the land abandoned (Pêgo and Antunes 1997).

Empirical knowledge and Portuguese collective memory were also partially lost. At present, 68% of Portuguese farmers are older than 55, and only 3% are younger than 35 (Benoist and Marquer 2006). Furthermore, traditional agricultural systems are not economically viable, although environmentally sustainable (Alves et al. 2003). Thus, farmers need to be multifunctional (Pêgo 2007) i.e. genetic resources curators, environmental protectors, and service providers of green care in agriculture and keepers of cultural traditions.

In the beginning of the 1980s, landraces of several crops were collected (on the mainland and in the Azores and Madeira Islands) in order to complement the on-farm conservation. The samples were deposited in Portuguese genebanks (Mota et al. 1981; Bettencourt and Gusmão 1982), which necessarily functioned as a backup system (Maxted et al. 2002). A special situation was found with grapevine. More than 200 ancient cultivars still exist in Portugal and are maintained at the National Ampélographique Collection (Almandanim et al. 2007).

More recently (2000-2002), following the Global Plan of Action (FAO 1996) a strategy plan which aims to integrate the environmental components into the agricultural and forestry activities was established. One of the scheduled activities was the inventorying of traditional cultivars still grown by farmers (Anonymous 2000). A similar procedure was followed in the Azores and Madeira Islands with the Project 'Germobanco Agrícola da Macaronésia' and an inventorying of the traditional crops grown in the Islands was undertaken (I Workshop Germobanco Agrícola da Macaronésia, Açores, 2008).

The efforts developed by non-governmental organizations (NGOs) should also be acknowledged. For instance, 'Colher para Semear' is mostly active in inventorying and preserving traditional crops. It published a list of about 350 landraces of 22 species, yearly available to members. A catalogue was also prepared for landraces of 14 important crops of the Península de Setúbal, south of Lisbon (Ribeiro and Fonseca 2006; Moreira et al., in press-a).

This communication gives information about: 1) landraces still grown on-farm; 2) studies and research activities carried out (genetic relatedness, pre-breeding, participatory plant breeding).

11.2 Methodology

The inventorying of traditional cultivars has been conducted by governmental institutions (Research Institutes, Universities) and NGOs, always with the cooperation of the Agricultural Regional Services. Guidelines were followed referring to five main fields: farmer identification and localization, farm characterization, species grown, species phenology and traditional utilization. For herbaceous species, seeds were collected and conserved in the Portuguese genebanks: Banco Português de Germoplasma Vegetal (BPGV), Banco de Germoplasma – Genética, Banco da Estação Nacional de Melhoramento de Plantas, Banco de Germoplasma of Madeira University (ISOPLEXIS) and Banco do Centro de Biotecnologia dos Açores. For plants propagated vegetatively, such as garlic, sweet potato, yam and woody species, propagules were sent to the Germplasm Centres where the collections are located.

The collected germplasm was subsequently characterized according to the IPGRI descriptors, which for apple and pear were complemented with UPOV methodologies. Olive tree characterization followed the rules of the International Oleicole

Council. Molecular markers have also been used for the identification of synonyms and for monitoring the diversity of genetic relatedness.

11.3 Results

Cereals

Traditional maize is still cultivated in Portugal (mainland, Azores and Madeira Islands) and was recently (Vaz Patto et al. 2007) collected, from central and northern rural communities, as landraces used for bread production (broa). Traditional wheat (Barbela and Barbelinha) is still grown in the Mogadouro and Bragança regions (in the north of the country). In the Madeira Islands other traditional wheat cultivars are also still being grown (see Tables 11.6 and 11.7).

Legumes

Many common bean landraces are in use, in mainland north/central regions, Azores and Madeira Islands (see Tables 11.6 and 11.7). Important examples are 'Papo de Rola', 'Patareco', 'Canário', 'Sete Semanas', 'Manata', 'Bencanta', 'Vagem Rajada' and 'Tarrestre' (Carvalho and Proença 2000). Another important legume is broad bean (*Vicia faba* L.). The 'Do Algarve' traditional cultivar has great significance in the south (Carvalho 2008). A national inventory for grain legume collections was organized by Duarte et al. (in press) (Table 11.1).

Table 11.1. Portuguese landraces of grain legumes conserved in Portuguese genebanks.

Species	Total no. of accessions	Landraces %
Cicer arietinum L.	1 659	37%
Phaseolus vulgaris L.	3 262	100%
Pisum sativum L.	834	56%
Vicia faba L.	788	70%

Vegetables

Traditional vegetables that should be referred are: Onion (*Allium cepa* L.) - 'Branca da Lezíria', 'Setúbal Portuguesa', 'Vermelha de Povairão'; Tomato (*Lycopersicon esculentum* Miller) - 'Pendura'; Portuguese cabbages (*Brassica oleracea* L.) - 'Penca de Chaves', 'Penca de Mirandela', 'Penca da Póvoa Verde' which

are traditionally cultivated in the north of the country. Some traditional turnip (*Brassica rapa* L.) landraces are 'Greleiro Senhora da Conceição', 'Gandra', 'Greleiro Temporão', 'São Cosme', and for muskmelon (*Cucumis melo* L.) 'Lagarto', 'Carrasco', 'Casca de Carvalho Fino', 'Casca de Carvalho Robusto' and 'Casca de Carvalho Ponderado'.

Woody plants
Olive tree - Several olive autochthonous landraces are still grown (Table 11.2) (Leitão et al. 1986).

Table 11.2. Portuguese traditional olive landraces and most important regions for their cultivation.

Traditional name	Most important region(s) for the crop cultivation
Galega Vulgar (Galega)	Very common in the country
Carrasquenha	Alentejo
Redondil	Alentejo, Elvas
Azeitoneira (Azeiteira)	Alentejo, Campo Maior
Conserva de Elvas	Alentejo, Elvas
Galega Grada de Serpa	Alentejo, Serpa, Moura
Cordovil de Serpa	Alentejo, Serpa, Moura
Verdeal Alentejana (Verdeal de Serpa)	Alentejo, Serpa, Moura
Maçanilha Carrasquenha de Almendralejo	Alentejo
Cordovil de Castelo Branco	Beira Interior
Bical de Castelo Branco	Beira Interior
Maçanilha Algarvia	Algarve
Redondal	Trás-os-Montes
Verdeal Transmontana	Trás-os-Montes
Cobrançosa	Trás-os-Montes
Madural	Trás-os-Montes
Negrinha	Trás-os-Montes

Grapevine - The most important cultivation regions of autochthonous cultivars for wine making are referred to by Bohm (2007) in Table 11.3.

Table 11.3. Portuguese autochthonous grapevine landraces cultivated for wine making.

Traditional name	Most important region(s) for the crop cultivation
Antão Vaz	Alentejo
Arinto	In the whole country
Avesso	Minho
Azal	Amarante, Basto, Vale do Sousa
Baga	Bairrada
Bical	Beiras
Borraçal	Vinhos Verdes region
Castelão	Alentejo, Estremadura
Cerceal Branco	Beiras
Cercial	Bairrada
Diagalves	Alentejo
Encruzado	Dão
Espadeiro	Minho
Fernão Pires	Ribatejo
Folgasão	Trás-os-Montes
Malvasia Preta	Dão, Douro
Marufo	Beira Interior, Trás-os-Montes
Moreto	Alentejo
Rabo de Ovelha	All the country, particularly Alentejo, Ribatejo, Estremadura
Rabigato	Trás-os-Montes
Ramisco	Colares region (near Lisbon)
Sercial	Minho
Síria	Alentejo
Tinta Barroca	Douro
Tinta Caiada	Alentejo
Tinta Carvalha	Estremadura, Trás-os-Montes, Minho
Tinta Francisca	Douro
Tinto Cão	Douro
Touriga Franca	Douro
Touriga Nacional	Dão, Douro and in recent times the whole country
Trincadeira	Alentejo
Trincadeira das Pratas	Ribatejo
Vinhão	Minho
Viosinho	Douro
Vital	Estremadura

Fruit trees - More than 100 traditional fruit tree landraces were recently inventoried by Anonymous (2003), these included: pears (*Pyrus communis* L.), apples (*Malus domestica* Borkh.), fig trees (*Ficus carica* L.), cherries (*Prunus avium* L.), chestnuts (*Castanea sativa* Mill.), almonds (*Prunus dulcis* [Miller] D.A.Webb) and carob trees (*Ceratonia siliqua* L.). Tables 11.4 and 11.5 summarize the most important regions for apple and pear cultivation (Crespi et al. 2006; Godinho and Lampreia 2006). Apple is also very important for the Azores and Madeira Islands (see Tables 11.6 and 11.7)

Table 11.4. Traditional Portuguese mainland apple landraces.

Traditional name	Most important region(s) for the crop cultivation
Bravo	Beira Litoral, Viseu, Esmolfe
Gigante do Douro	Beira Litoral, Viseu, Vousela
Maçã das Velhas	Beira Litoral, Viseu, Carregal do Sal
Riscadinha Chão da Cunha	Beira Litoral, Viseu, Mangualde
Verdeal de Bodiosa	Beira Litoral, Viseu, Bodiosa
Malápio da Ponte	Beira Litoral, Viseu, Mortágua
Pipo de Basto	Beira Litoral, Viseu, Lamego
Camoesa de Alcongosta	Beira Interior, Castelo Branco, Alcongosta
Maçã do Limoeiro	Entre Douro e Minho, Viana do Castelo, Melgaço
Pero de Coura (Pero Mulato)	Entre Douro e Minho, Braga
Porta da Loja	Entre Douro e Minho, Braga, Tibães
Malápio de Gouveia	Trás-os-Montes

Table 11.5. Portuguese traditional pear landraces.

Traditional name	Most important region(s) for the crop cultivation
Bela de Junho	Trás-os-Montes, Bragança, Mirandela
Fim de Século	Trás-os-Montes, Bragança, Mirandela
Malheira	Trás-os-Montes, Bragança, Mirandela
Pêra Joaquina	Trás-os-Montes, Bragança, Mirandela
Pêra Marmelo	Trás-os-Montes, Bragança, Mirandela
Rabiça	Trás-os-Montes, Bragança, Mirandela
S. Bento	Trás-os-Montes, Bragança, Mirandela
Boticas Inverno	Trás-os-Montes, Vila Real, Boticas
Nacional	Trás-os-Montes, Vila Real
Coradinha	Trás-os-Montes, Vila Real
Marmela	Trás-os-Montes, Vila Real, Boticas
Pêra Cabaça	Trás-os-Montes, Vila Real, Boticas
Perola	Trás-os-Montes, Vila Real, Boticas

Table 11.6. Traditional cultivars of several crops in the Azores Islands.

Crop	Number of traditional cultivars
Apple (*Malus domestica*)	74
Pear (*Pyrus communis*)	19
Plum (*Prunus salicina*)	6
Chestnut tree (*Castanea sativa*)	15
Sweet potato (*Ipomoea batatas*)	30
Yam (*Colocasia esculenta*)	18
Milho (Maize) (*Zea mays*)	14
Common bean (*Phaseolus vulgaris*)	17
Broad bean (*Vicia faba*)	1
Onion (*Allium cepa*)	1

Table 11.7. Traditional cultivars of several crops in the Madeira Islands.

Crop	Number of traditional cultivars
Apple (*Malus domestica)*	20
Sweet potato (*Ipomoea batatas*)	37
Milho (Maize) (*Zea mays*)	21
Common bean (*Phaseolus vulgaris*)	95
Wheat (*Triticum aestivum*)	47
Onion (*Allium cepa*)	9

11.4 Discussion

The inventory is of extreme importance to identify the landraces that are still grown and the most susceptible to genetic erosion. Important studies were performed with several landraces and they could be grouped into the three following categories:

- Collecting and morphological, molecular and biochemical characterization;
- On-farm conservation;
- Traditional knowledge, pre-breeding and participatory plant breeding.

Cereals

The adoption of modern hybrids of maize and wheat has been responsible for intensive genetic erosion. However, the existing landraces still represent an important reservoir of biodiversity and source of novel gene alleles for breeding programmes. Vaz Patto et al. (2004) assessed the genetic diversity of Portuguese

maize germplasm using microsatellite markers and concluded that the Portuguese maize inbred lines represent a valuable source of interesting genes to introduce into modern cultivars. Maize germplasm from Madeira Islands was morphologically characterized (Pinheiro de Carvalho et al. 2008). Ribeiro-Carvalho et al. (2004) measured the diversity of the 'Barbela' wheat landrace and concluded that it had a high genetic diversity.

The most advanced work of on-farm conservation in Portugal refers to maize. The VASO project, a participatory breeding programme, was initiated in 1984 to improve maize landraces mainly used for bread production (Moreira 2006; Moreira et al. 2008). The VASO project also aims to decrease the gaps in commercial value between hybrids and landraces. Evidence from landrace cultivation in other regions of the world suggests that sustainability can only be ensured if there is a 'real' requirement for the locally adapted material (Scholten et al. 2008). Pre-breeding is an important tool to screen new potential germplasm, either for classical on-station breeding, or for on-farm conservation and participatory breeding projects, where adaptation to traditional sustainable organic farming and poly-cropping systems is recommended. At present selection for good-quality bread maize is under way (Moreira et al. 2007; Vaz Patto et al. 2007). So, pre-breeding evaluation of landraces continues (e.g., HUNTERS, Overlapping Index, heterotic groups, inbreeding depression and combining ability) (Moreira and Pêgo 2003; Moreira et al., in press-b).

Legumes

Common bean forms the biggest grain legume collection maintained in Portuguese genebanks with a total number of accessions of 3262 (Table 11.1). Some of these accessions have been studied under different perspectives, for instance, seed protein content (Palha et al. 1988) and seed content of eight minerals (K, P, Ca, Mg, Fe, Mn, Zn and Cu) (Pinheiro et al. 2007). A high degree of variability was observed in these studies. The genetic diversity of landraces still grown in the north of the country was studied through RAPDs (Martins et al. 2006). Rodiño et al. (2001), using the phaseolin marker, concluded that the Portuguese germplasm is important to widen the genetic base of currently cultivated bean varieties in Europe.

Woody plants

Olive - Olive is grown in 9% of the agricultural area (corresponding to 368 397 ha and 21 245 tonnes of olives, INE, 2008). The most representative traditional cultivars (Table 11.2) were morphologically characterized according to international descriptors (www.internationaloliveoil.org/resgen/eng/rg-var-por.htm). RAPD and

ISSR are relevant methodologies for management of olive genetic resources (Gemas et al. 2000; Martins-Lopes et al. 2007). The Portuguese cultivars Galega and Cordovil de Serpa are being replaced by Spanish cultivars, particularly in the Alentejo region, due to higher yields and less susceptibility to abiotic stress. However, some large farms in Alentejo and Ribatejo (e.g. Herdade do Freixo do Meio and Companhia das Lezírias) have programmes for the preservation of traditional Portuguese cultivars.

Grapevine - Grapevine is (1 029 127 tonnes of grapes, INE, 2008) important all over the country, where more than 200 ancient cultivars continue to be used. Besides the cultivars for wine making there are ten used for direct eating. Genetic erosion is being detected due to replacement of traditional cultivars by just a few commercial ones. For preservation of the cultivars, field collections have been set up, and in order to maintain the genetic variability existing within the cultivars (clonal variability) a further 73 collections were established in the farmers´ fields by the Portuguese Vitis Network. A molecular study for discrimination of the main Portuguese autochthonous cultivars used for wine making was published (Almadanim et al. 2007).

Fruit trees - Despite the genetic erosion which occurred during the last 50 years, there is still a great diversity of landraces for the various fruit trees. However, for characterization and molecular studies, work with apple and pear is more advanced. Apple cultivars most protected from erosion are those with high commercial value, particularly, 'Bravo de Esmolfe', 'Riscadinha de Palmela' and 'Porta da Loja', the first two are widespread and 'Porta da Loja' is mainly confined to the Minho region. 'Bravo de Esmolfe' is a Protected Designation of Origin. Goulão and Oliveira (2001) characterized the cultivars 'Bravo de Esmolfe', 'Casanova de Alcobaça', 'Riscadinha' and 'Espelho' concluding that they are distinct from foreign cultivars. Pear sales in Portugal are based (75%) on the 'Rocha' cultivar, which originated in Sintra during the last century (Silva 1996). Similarly to apples, pear cultivars most protected from erosion are those of high commercial value, particularly 'Rocha', 'Carapinheira' and 'Perola'. Rocha is protected by Designation of Origin. AFLP and RAPD markers were used to assess genetic relationships of pears (Monte-Corvo et al. 2000). This study concluded that the traditional Portuguese cultivars cluster together.

11.5 Conclusion

Considering farmers' mean age, the next five years will be crucial for landrace conservation, as well as for maintenance of traditional

farming systems (where landraces interact in poly-cropping). Traditional farming needs to be better understood and studied and to attract younger farmers. Knowledge obtained from these systems can be extended to organic farming and low-input agriculture for which there is a fast-growing interest. Rural development that is based on multi-task agriculture should integrate: 1) management of genetic resources (e.g. on-farm conservation, participatory plant breeding, legal issues on landraces); 2) Protected Designations of Origin (21 have already been attributed for vegetable products in Portugal); 3) tradition, social and health aspects (e.g. green care in agriculture); and 4) food sovereignty. As landraces are precious goods they need to be kept by the farmers with help from governmental and non-governmental organizations and with coordination by official services. Financial support is also fundamental for increasing the commercial value of landraces, implying the public awareness of their relevance.

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12. Landrace Inventory for Romania

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12.1 Introduction

Many centuries of Romanian agriculture have shaped important traditional agro-ecosystems that constitute significant *in situ* repositories of crop genetic diversity. Even today the maintenance of inter- and intra-specific diversity in peasants' fields is a base element for livelihood security, especially for resource-poor people practising agriculture under low-input conditions in certain remote and marginal areas in the mountainous depressions.

A core sub-set of agricultural ecosystems is represented by landraces providing the rural communities with food and some income. Recent field work showed that in Romania many farmers are involved *de facto* in on-farm conservation of different crop species through continued cultivation of local populations of cereals, grain legumes, vegetables, industrial and technical plants, spices and medicinal plants (Ibanescu et al. 2002). These landraces are cultivated in either their own fields or home gardens, in order to meet the particular needs and preferences of the grower. In most cases in the home gardens is to be found a broader range of plant species which the family uses for culinary, medicinal or cultural purposes, or for the market.

12.2 Material

Landraces in this paper are defined as locally adapted varieties of a species grown for at least ten years from farmers' saved seeds, and that lack formal breeding. The traditional, low-input farming system is used to grow these cultivars, where no herbicides, pesticides and chemical fertilizers are applied.

12.3 Methods and sources of information

While the national inventory of plant genetic resources kept *ex situ* was published in 2000, this is the first attempt to collate all data on landraces conserved on-farm over our country. The primary source of information was the BIOGEN Database designed and managed by the Genebank in Suceava that includes passport and on-farm descriptors gathered during 20 years of systematic survey and collecting missions. Selected villages were those of remote

and isolated areas, in most cases placed at the bottom of a hill or in mountainous depressions. Geographically, the focus was on three strategic areas, i.e. Suceava, Maramures and Apuseni Mountains, where a broad range of genetic diversity, in terms of local populations in the major crops such as wheat, maize, bean, potato and faba bean still exists. The method adopted was to contact agricultural extension services, local authorities, biology and agronomy teachers, as well as local priests to help us to identify the farmers recognized as 'conservationists' across the local community. Later, this category of growers was directly approached, and in-depth semi-structured interviews were used to record local knowledge. As regards crop selection, priority was given to *Phaseolus vulgaris* L., based on its importance in rural people's diet, the high number of landraces, and the wide distribution in Romania.

The baseline information was revalidated with farming communities during the recent collecting trips undertaken in 2007 and 2008 in Apuseni, Suceava and Maramures, the areas richest in landraces in general and in particular for common bean varieties. A second source of information for this study was the Internet and scientific literature.

12.4 Results

A general picture of the current distribution of landraces in Romania was got by building a map based on information in BIOGEN for the period from 2000 until today, and by using GIS technique (Figure 12.1). It could be considered that in Romania, a country where differences between rural and urban areas still persist, traditional

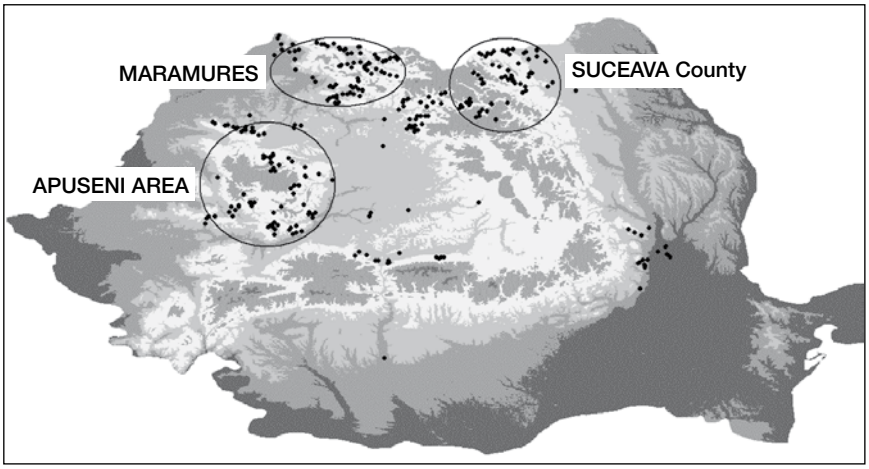

Figure 12.1. Landraces distribution in Romania.

farming, in terms of local populations, remains an important component of agriculture. Those three regions, Maramures, Suceava and Apuseni Mountains, already mentioned in the background, are clearly identified as places of interest for on-farm conservation activities. Details on the main crop groups and species of which landraces are maintained on-farm, with their extent expressed as number of counties and villages, is summarized in Table 12.1.

The data reveal that in almost all major species landraces are continuously cultivated, with wider distribution in the cases of bean, maize and potato. It was noted that many families grow vegetables, spices and medicinal plants on very small surfaces, particularly for home consumption. However, this valuable genetic pool of local populations is currently subject to serious genetic erosion and irreversible losses. The threat is the result of the interaction of certain factors including the replacement of autochthonous landraces by new, genetically uniform cultivars, changes in agriculture and land use, destruction of habitats and ecosystems, and recently inter-activity competition (Negri et al. 2000). Today, more and more peasants refuse to spend their poor resources in agricultural work: they are migrating abroad in search of more and immediately profitable income.

The speed of genetic erosion occurs at different rates depending on regions and crops. The worst situation is recorded in fibre crops, where extinction reached 100% in flax, and in the case of hemp, an old variety was found in cultivation in 2008, in Grosii Tiblesului, Maramures County. The same is going to happen with *Triticum monococcum* L. (einkorn), a relic crop found only in Apuseni Mountains, which is mostly used as fodder for animals, or in mixture with bread wheat (*Triticum aestivum* L.) for human consumption. Well adapted to grow under extreme environmental conditions, and carrying interesting characters including rust and powdery mildew resistances, before 1994, different winter, spring or intermediate varieties were common in many villages of Alba, Cluj and Hunedoara Counties. In the autumn of 2007, just one intermediate form was cultivated on a restricted area of less than 0.5 hectares belonging to one family living in Almasu Mare, Alba County.

At the opposite pole is *Phaseolus vulgaris* L. that is well represented (up to ten landraces/farm) in Maramures County, even if on smaller and smaller surfaces (under 0.05 hectares) in the home gardens. In the 1990s almost every household of Maramures area was growing up to 20 local bean types with seeds showing a rich variation in colours, patterns, size and shape (Strajeru et al. 2000). A narrow distribution in Suceava and Apuseni Mountains was noted in runner bean (*Phaseolus coccineus* L.), where the variety with white seeds is preferred and is intercropped with maize cultivars.

Table 12.1. Major crop species with their landrace distribution across Romanian counties and villages recorded between 2000 and 2008.

	Crop Group	Genus	Species	Counties Included	Villages Included
1	Cereals	*Avena*	*sativa* L.	10	58
2		*Fagopyrum*	*esculentum* Moench	1	1
3		*Hordeum*	*vulgare* L.	5	16
4		*Secale*	*cereale* L.	6	24
5		*Triticum*	*aestivum* L.	11	50
6		*Triticum*	*monococcum* L.	1	2
7		*Zea*	*mays* L.	13	175
8	Fodder crops	*Brassica*	*napus* L.	2	3
9		*Cucurbita*	*maxima* Duchesne	2	6
10		*Cucurbita*	*pepo* L.	11	74
11		*Vicia*	*faba* L.	3	31
12	Grain legumes	*Phaseolus*	*coccineus* L.	8	44
13		*Phaseolus*	*vulgaris* L.	12	174
14		*Pisum*	*sativum* L.	2	27
15	Industrial and technical crops	*Beta*	*vulgaris* L.	6	17
16		*Cannabis*	*sativa* L.	6	10
17		*Helianthus*	*annuus* L.	6	24
18		*Humulus*	*lupulus* L.	1	1
19		*Linum*	*usitatissimum* L.	1	4
20		*Solanum*	*tuberosum* L.	9	111
21	Medicinal and aromatic plants	*Calendula*	*officinalis* L.	1	1
22		*Carthamus*	*tinctorius* L.	1	1
23		*Carum*	*carvi* L.	4	8
24		*Ocimum*	*basilicum* L.	5	7
25		*Papaver*	*somniferum* L.	4	13
26		*Pimpinella*	*anisum* L.	3	5
27		*Satureja*	*hortensis* L.	7	19
28		*Sinapis*	*alba* L.	2	2
29	Vegetables	*Allium*	*cepa* L.	7	22
30		*Allium*	*sativum* L.	7	14
31		*Anethum*	*graveolens* L.	7	28
32		*Apium*	*graveolens* L.	3	4
33		*Atriplex*	*hortensis* L.	2	3
34		*Brassica*	*oleracea* L.	3	5
35		*Capsicum*	*annuum* L.	8	35
36		*Cucumis*	*melo* L.	2	2
37		*Cucumis*	*sativus* L.	9	41
38		*Daucus*	*carota* L.	3	10
39		*Lactuca*	*sativa* L.	6	21
40		*Levisticum*	*officinale* W.D.J. Koch	1	1
41		*Pastinaca*	*sativa* L.	5	8
42		*Petroselinum*	*crispum* (Mill.) Nyman ex A.W. Hill	6	16
43		*Petroselinum*	*hortense* Hoffm.	2	4
44		*Raphanus*	*sativus* L.	5	10
45		*Solanum*	*esculentum* Mill.	6	12
46		*Solanum*	*melongena* L.	2	2
47		*Spinacia*	*oleracea* L.	3	3

In general, cereals are among the crops most threatened by the progressive introduction of the new breeding varieties. Before the year 2000, the most valued maize landraces of five local races (Cincantin, Hanganesc, Portocaliu, Moldovenesc, and Optac Romanesc), and three sub-races (Cincantin / Moldovenesc, Cincantin / Hanganesc, Hanganesc / Moldovenesc) used to be grown in about 399 localities, up to 800 m altitude, and where cooperative agriculture had not penetrated (Cristea 2004). As a result of a strong pressure of the hybrids, in the year 2008 a limited number of original traditional varieties belonging to two races (Hanganesc, Moldovenesc) and one sub-race (Hanganesc/ Moldovenesc) were identified in six villages of Suceava County (Frumosu, Moldovita, Pojorata, Vama, Deia, Putna). In Maramures and Apuseni Mountains, a few variable local populations within the Optac Romanesc race are present exclusively at altitudes ranging between 600 and 900 m on plots smaller than 0.05 hectares. It was found that, especially in maize, the majority of today's peasants' varieties are derived from high-yielding modern cultivars (Strajeru et al. 2003).

In the case of potato, the situation is even worse as currently only five and three local genotypes respectively are passed down from generation to generation in the Bucovina and Apuseni Mountains areas. The genetic erosion has also been very fast for *Vicia faba* (faba bean) a crop at present only cultivated in Bucovina, especially in villages of the Dornelor Depression.

12.5 Conclusions

The present study has shown that Romania represents an important reservoir or genetic pool of landraces in the main crops, particularly in *Phaseolus vulgaris* L., and either farms or home gardens contribute to the country's agro-biodiversity conservation. Further concluding remarks are listed below:

1. Activities related to on-farm conservation of landraces in the major crops are not sustained by the formal agricultural sector, and peasants are the only actors maintaining and managing genetic diversity in their own fields.
2. Farmers in the richest crop diversity regions in Romania, i.e. Suceava County, Maramures County and Apuseni Mountains, preserve a large amount of variability in landraces through continued cultivation and use.
3. Rural people practising agriculture assess crop diversity in functional terms, the varieties chosen to be planted each year being closely linked to the family's needs or market demands.
4. The variety name cannot be used as a proxy indicator of diversity, at least as has been found in *Phaseolus vulgaris* L.

5. In order to keep alive this unique agricultural heritage, governmental and political measures are needed to establish as well as to promote *in situ* on-farm conservation national plans and programmes, in which farmers need to be involved.

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13. Cultivated Plant Inventory of Russia

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13.1 Introduction

Crop production in Russia, if compared with other European countries, the USA or Canada, tends to exist mostly under extreme environments of the forest, forest-steppe and steppe zones. Peculiarities of the country's geographical position do not allow plant biomass yield to exceed the level of 12.5–75 kg/m^2, while over the greater parts of Europe or the USA this parameter reaches 75–125 kg/m^2 (Fedorov and Gilmanov 1980). However, Russia's diversity of soils and climates brought about a rich assortment of local crop varieties. The process of their development went on under the significant influence of natural selection accentuated by generally rather low levels of agricultural practice. Local varieties from other countries also had an impact on this process (Zhukovsky 1957; Merezhko 2001). Nikolai Vavilov (1935) observed that in Russia even in the early 20th century "the assortment of cultivated plants and selection of crop varieties featured a spontaneous, disorganized process". The attempts to transfer foreign varieties directly to the Russian territory were inefficient because of the negative effect of its specific soil and climate conditions.

The idea of making a collection of the country's cultivated plants and wild species promising for utilization belonged to R. Regel, 'the father' of national applied botany and one of the first directors of the Bureau for Applied Botany (now the N.I. Vavilov Research Institute of Plant Industry). In 1900 he started the collection of barley and later in 1907 the collections of wheat, oat and other cereals and later of industrial crops, forages and potato. Germplasm accessions were shipped to the Bureau by local agronomists and breeders from all over Russia and the composition of crops and varietal characteristics were then studied.

N.I. Vavilov, who superseded Regel as the Bureau's director, and his colleagues continued active replenishment of the collection. A network of experiment stations was set up in different regions of the country in order to maintain the collection. Numerous plant collecting missions were launched, at first in the USSR and then to foreign countries. The collection was enriched with domestic materials during the All-Union Agricultural Fair (1922–1923), as Vavilov was one of its organizers (Sinskaya 1991). Seeds were sent to the Fair even from

the most faraway corners – from agricultural institutes, agronomists, individual farms, etc. Thanks to the Fair, the collection received new accessions of cereals, grain legumes and, to an even greater extent, vegetables. The most valuable materials were found in cabbage and other cruciferous plants, and among root crops.

The largest part of the collection was accumulated during the two decades of 1920–1940 – more than 100 000 accessions of cultivated plants and their wild relatives from 65 countries. While the collection was being formed, special attention was paid to local varieties, whose major advantage lay in their high level of adaptation to local environments (Brezhnev 1977). These included numerous landraces, which were understood as populations developed through artificial selection without targeted crosses and cultivated for a long period of time. A good example of how actively local varieties were added to the existing stock may be found in the collection of spring bread wheat: in the 1930s alone it was enriched with 2044 local accessions (Zuev 2008), nearly one half of which (958) were Russian, while 429 accessions were collected personally by Vavilov in 36 countries of the world.

13.2 The relay race of the centuries

13.2.1 Agricultural practice in European Russia

On the whole, agricultural practice in Russia developed uniquely and very slowly. While Western Europe inherited from ancient Greece and Rome a ready-made and quite advanced agricultural system, Russia was far away from the developed countries and did not experience much of their influence. In the south of the Russian Plain, the local agricultural system was preceded by the Tripolian and Scythian cultures, between which there was direct succession (Sinskaya 1969).

The Tripolian culture (3rd–2nd millennium BC) developed in the Dnieper-Dniester region, along the Danube and in the Balkans. Its farming system involved not vegetable gardening, but field husbandry, which is witnessed by large grain stores found by archaeologists in local settlements (Petrov 1947; Bibikov 1960). For example, they excavated ears of emmer wheat with oval seeds and uniform glumes, naked barley, millet, vetch and lentil. Even at the early stages of the Tripolian culture, two types of wheat were sown: durum and bread wheat. There was no oat crop in Tripoli, and their rye was weedy. The end of the Tripolian epoch is marked by a shift toward pre-Scythian ethnic formations. Scythians, who populated the Ante-Caucasus, southern steppes of European Russia along the Volga, Don and Dnieper, and the Crimean Peninsula, evidently

cultivated the same plants as the peoples who had resided in those regions before: wheat, millet, lentil, onion, garlic; very likely, barley; probably flax and hemp (Mavrodin 1948).

From the end of the 1st century BC through the early 1st century AD, when classes and political systems took shape, the Slavonic language and culture were moulded. Agriculture undoubtedly played the main role in the economy of ancient Slavs. Excavations in Slavonic settlements dating back to the Antean and pre-Antean periods discovered wheat, barley, millet and peas. Besides, archaeologists dug out hemp, flax, rye, turnip, onion, garlic, buckwheat and poppy attributed to the 9th–12th centuries AD. It is interesting that in the southern areas of Russia, as in Western Europe, dwarf wheat was quite familiar to the population (Yakubtsiner 1956), having won its popularity even earlier than the common one. Ahmad ibn Fadlan, a trade envoy to the Caliph of Baghdad (10th century AD), reported an important role with the Rus of such crops as wheat, barley, millet and onion, while hazelnuts and apples were gathered from the wild (Sinskaya 1969). Numerous archaeological data and written evidence attest to the assertion that one of the oldest crops cultivated by the ancient Slavs (if not the most ancient) was millet (Chukhina and Shitov 2007). Probably, this crop preceded naked wheat and barley. Millet, like the ancient emmer and einkorn wheats, was used to make gruel (gruel cooking is known to be older than bread making).

Cultivated in Kievan Rus were such field crops as wheat (bread and durum), barley (six-row, two-row and naked), millets, oats, rye, buckwheat and spring vetch (as food grain). Habitual domesticated vegetables were turnip, cabbage, onion, garlic, probably carrot and celery (it was grown by the Scythians). Spice crop diversity included mustard, bird rape, dill, mint, anise and pepper. Fruit trees were also domesticated – apple, cherry and plum (Voronin 1953). Head-forming types of cabbage were quite widespread all over Kievan Rus as garden vegetables. There is reliable documentary evidence of the 11th–12th centuries that cabbage was very popular in ancient Rus and widely used (Sinskaya 1969). Cabbage remains one of the favourite vegetables in present-day Russia, as cabbage soup (*shchi*) is still the basic traditional component of the national cuisine.

In the north of the Russian Plain, isles of crop husbandry emerged as early as the end of the Stone Age. Later the ancient agriculture of northern tribes got in touch with the Slavonic crop system, characterized by a higher cultural level. Slavonic influence spread from the south-west, and its outposts reached far into the north even in the 5th–7th centuries (Pskov, Novgorod and Old Ladoga).

Explorations undertaken in north-western Russia, especially archaeological excavations in Old Ladoga (Petrov 1945; Ravdonikas

1949; Kiryanova 1992; Aalto and Heinajoki 1997; Chukhina and Shitov 2007) and Novgorod (Artsikhovsky 1951; Yanin 1953), witnessed a considerable diversity of cultures in this region of the Russian Plain in the 8th–9th centuries AD. Major local crops of that period were emmer wheat, bread wheat and millet. Also domesticated were oats, rye and hemp, and in the vicinities of Pskov (Tarakanov 1953) at the turn of the 5th–6th centuries two-row barley and pea. Occasional findings of rye could not attest to its wide distribution in the north-west before the 13th century. Excavations in the 10th-century layers brought to the surface sporadic seeds of cucumber, possibly of Byzantine origin, and pumpkin. Widespread fruit trees were cherry and apple, plus blackcurrant and raspberry of the small fruit shrubs.

One of the most ancient kitchen-garden plants in the northern parts of Russia was turnip (*Brassica rapaeuropaea* Sinsk.), a typical crop of northern shifting cultivation. Shallow topsoil led to the development of local vegetable landraces with flat-shaped roots – for example, Petrovskaya turnip (subsp. *rossica* Sinsk.) and Karelian turnips. In the south turnips were not as important as in the north. By now, turnip has practically disappeared from cultivation in the country's southern regions; occasionally it can be found in areas adjacent to the Caucasian foothills. However, southern populations of this plant are much more likely linked not with the northern turnips, but with the ones grown in Asia Minor.

The non-black-soil belt of the Russian Plain, as early as in the 2nd–1st centuries BC, harboured a centre of flax cultivation for spinning, based mainly on var. *elongata*. However, flax cannot be called a primary crop for this territory, because wild flax forms never occurred there. Probably, flax had arrived from south-western Asia, and in the course of passing millennia the north-west of Russia became the homeland of famous unique types of fibre flax that differed from native and intermediate forms of other countries. Since ancient times (3rd–2nd centuries BC), northern areas of the Russian Plain had also been known for short hemp cultivation. Northern landraces of turnip and short hemp are endemic varieties, live fossils of the north.

13.2.2 Agriculture of the Asian part of Russia (Siberia and the Far East) and its relationship with the agricultural system of the European part

Siberia, with its severe climate, houses a rather limited assortment of cultivated plants that developed within its territory. In ancient epochs, crop husbandry had an expressly discrete pattern throughout Siberia and was regarded as a secondary economic activity. Its basic

feature was shifting cultivation and spring cropping. The Khakass sowed millet, filmy barley, wheat and naked Himalayan barley. Among fossil plants found in Altai there were such materials as *Panicum miliaceum, Echinochloa crus-galli* and *Setaria viridis* that date back to the period of the Early Bronze Age, and also *Triticum antiquorum* of a later age. In the 7th–8th centuries AD the development of Siberian cropping culture was greatly influenced by the Sayan-Altaic Kirghiz culture (Okladnikov 1949).

Among Altaic weedy oats there are forms similar to the Ural and North Russian ones (Mordvinkina 1960); some of the forms of fibre flax from Tuva look like the populations native to the Urals and the North. Violet turnips grown in Karelia are also found in the Urals and Altai. Probably, they entered the Russian Plain through the Ural Mountains and Altai in the same way that millet came to modern Russia from China.

Southern tribes of the Amur valley were the first to practise crop husbandry in the Far East; from this region agriculture could have penetrated the adjacent territories (Sinskaya 1969). In the 8th century AD, the kingdom of Bohai arose on the Far Eastern seacoast, with its advanced civilization and agriculture. It was considerably influenced by the neighbouring Chinese agricultural system. After the Bohai realm was destroyed by the Mongols, those territories for a long time remained deserted and wild.

A new agricultural epoch in Siberia started in the 17th century with the development of Russian cropping practice (Silantjeva 2008). There is no documentary evidence of any relation between this phase and the ancient farming culture in this region, but some old landraces were revived there – such as Mongolian-Buryat millet, Altaic spring rye and old wheat varieties. Out of the south, from neighbouring China, came millet and rice; later they were followed by the soybean landrace, *Perilla*, Oriental radish, green mustards, etc. Comparative analysis of germplasm samples collected in Siberia with archaeological and historical data suggests, for instance, the following route of wheat distribution: from Western Asia through China and Mongolia to Siberia (Sinskaya 1969). Coriander and turnip could have moved along the same route. From Siberia, cultivated plants might disperse across the Volga region to the southern lands of European Russia and over the Urals to the north-west. During the last centuries, migrants usually carried crop seed backwards – from the Russian Plain to Siberia and the Far East. Even now plant explorers find in isolated villages of the Far East samples of pumpkin, cabbage, tomato, maize and some other vegetables that were brought there about a hundred years ago by settlers from the Ukraine (Smekalova 2007).

The rich and interesting vegetation of Siberia (Altai in particular) and the Far East served as a source for domestication of quite a few fruit, forage and vegetable plants. The most important among them were wild onions, actinidia, magnolia vine, Manchurian walnut, Amur grape, Ussurian pear, Siberian apple tree, currant and gooseberry species, sea buckthorn, melilot, brome grass, red and lupine clover, sainfoin, vetch, etc.

13.3 Local crop populations originated in Russia

Analysis of the materials accumulated by VIR's plant explorers over many years of collecting, as well as comparative assessment of historical, ethnobotanical and archaeological data and references, confirm that despite the relative scarcity of plant resources in the Russian Plain (if compared, say, with the Caucasus), its territory, nevertheless, generated quite a few unique cultivated plants. Its natural vegetation undoubtedly contributed to agriculture local forms of wild caraway (*Carum carvi*), hop (*Humulus lupulus*), horseradish (*Armoracia rusticana*), and many forage plants (Sinskaya 1969). Landraces of horseradish may still be found in different regions of Russia.

Unique local populations of crop varieties, which have no wild relatives among the indigenous vegetation of the Russian Plain, could evolve there either from local (or imported) weedy plants (Vavilov 1924; Sinskaya 1969; Ulyanova 1997), or from crop seeds introduced from elsewhere.

The Russian north is the area of primary domestication for timothy grass (*Phleum pratense*). Also here was the origin of indigenous forms of awnless brome grass, meadow and red fescue, foxtail, bentgrass, cock's foot, Kentucky bluegrass and sloughgrass. Northern forms of these meadow grasses are distinguished by their special morphological, biological and economic characters. Many northern forms of clover (*Trifolium pratense*, *T. repens*, *T. hybridum*) and yellow medic (*Medicago falcata*) evolved in that region, not to mention that northern landraces of the latter emerged both from the northern meadow ecotypes of this species (known as *marusinsky* varieties) and from the ecotypes of the southern steppe. Landraces of *Melilotus albus* (sweet clover) are also represented within Russia by its northern and southern (steppe) ecotypes.

No less rich in diversity of meadow grasses and legumes is *the central forest zone* of Russia. For example, local forms of red clover (*Trifolium pratense*) originated in that region.

Cultivated rye (*Secale cereale*) was domesticated by Proto-Slavonic tribes in the 7th–9th centuries. Earlier findings exposed

uncultivated weedy rye. As far back as in the 19th and early 20th centuries, one could observe in the southern regions of Russia, especially in the steppes of the Ante-Caucasus, plantings of rye and wheat mixture (maslin crop). Pure cultivated rye appeared more to the north, in the forest zone of the Russian Plain, where environments were more favourable for its cultivation.

Oat (*Avena sativa*) also may be numbered among Slavonic crops. Local diversity and uniqueness of its forms can be matched with Chinese oats (in Western Europe another oat species, *A. strigosa*, was domesticated).

Barleys (*Hordeum* L. spp.) within the Russian Plain were domesticated earlier than rye and oats, and in the north earlier than even wheat. They came here probably from Western Asia and in Russia formed two groups of landraces: the Northern group, entering even into Scandinavia, and the West European one, widespread in the forest and forest-steppe zones of Russia.

Wheat also arrived in the Russian Plain from western and south-western Asia. Landraces of bread wheat (*Triticum aestivum*) are classified into several agro-climatic groups: Northern Forest, Forest-Steppe, Steppe-Volga and Steppe ones (Dorofeyev et al. 1979). There are two groups of local durum wheat (*T. durum* Desf.) varieties: with loose ears (*kubanka*) and with solid ears (*beloturka*). Russian durum wheats have won world-wide renown and are widely utilized not only in domestic breeding programmes, but also by breeders in the USA, Canada and other countries.

Emmer wheat (*T. dicoccon*), distributed from Asia Minor to the Volga Region, gradually moved northwards and then again retreated to the south, where one could find sporadic foci of this crop even in the early 20th century. By now, however, they have disappeared.

Millet (*Panicum miliaceum*), the oldest crop of the Russian Plain, was inherited by the Proto-Slavs and Scythians from the Tripolian culture and formed several ecogeographic groups in Russia.

Buckwheat (*Fagopyrum sagittatum*) came from Asia and could disperse over the Russian Plain by two routes: from the East (it had been used by the Sarmatians very early) or from Western Asia.

Pea (*Pisum sativum*) landraces, now completely ousted from the Russian territory, lingered in the north (near the Urals and in Komi) longer than elsewhere. A specific form of pea is known in the Volga Region as a weed in vetch plantings.

In *the northern and central areas of the Russian Plain*, faba beans (*Vicia faba*) were widely cultivated. Numerous landraces varied in seed shape, colour and size.

In *the European part of Russia*, common vetch (*Vicia sativa*) had greater diversity than any other leguminous crop. It had arrived

there, like other legumes, mostly from Western Asia and partly from Western Europe.

The central and southern areas of Russia are the place of origin for local cold-hardy varieties of apricot (*Prunus armeniaca* L.) and a number of apple, pear and plum landraces. North Russian apple and pear varieties are cold-hardy and undemanding as to soil, while the group of Volga apple-tree varieties demonstrate drought resistance and earliness.

Russian fibre flax varieties are of Central Asian origin (Zhukovsky 1964; Sinskaya 1969). Unique landraces of fibre flax (*Linum usitatissimum*) and hemp (*Cannabis sativa*) were cultivated in *the north-western areas* of the country. Russian fibre flax varieties served as a breeding source for cultivars produced in many countries.

In Russia, there are two agro-ecological groups of cultivated hemp (*Cannabis sativa*): Northern and Mid-Russian. Both may have developed from local weedy forms. The most interesting are the northernmost landraces – short, early-ripening and suitable only for oil production purposes.

There is no information yet on which species or forms were the ancestors of Russian oil-bearing sunflower (*Helianthus annuus*) varieties. Local populations most likely had in their pedigree the forms imported into Central Russia in the 18th century from the Netherlands, and possibly, around the same period, from Armenia. Local varieties were actively involved when breeding improved cultivars with high oil content.

Poppy (*Papaver somniferum*) had been known in *the Russian Plain* since the times of ancient Slavonic tribes. It was used for confectionary purposes. Until recently, old garden landraces were maintained in *the central and southern provinces* of Russia.

Russian varieties of mustard (*Brassica juncea*) spread into *the Volga Region* from Asia. Before domestication, they were weeds in flax, millet and cereal crop fields. Unique local forms belong to the endemic *B. juncea* var. *sareptana* Sinsk.

The *European part of Russia* was also native soil for original forms of onion (*Allium cepa*, *A. ascalonicum, A. fistulosum* and *A. schoenoprasum*), cucumber (earlier spread from Byzantium, later from Western Asia), water-melon (brought here in the 1st century AD by Turkic-Mongolian tribes) and pumpkin (came from Spain and the Balkans). Melons have comparatively limited distribution in the European part of Russia, but in some areas (in the North Caucasus in particular) they evolved into local varieties, early and late ones.

Beet (*Beta vulgaris*) had been winning Russian territories since the 11th–14th centuries. In the 16th century it was already a customary garden crop (Domostroy 1908–1910). In various regions of Russia,

in different times, local populations generated unique cultivated forms of radish, swede (*Brassica napobrassica*), bird rape (*Brassica campestris*), false flax (*Camelina sativa*) and other crops.

A number of crops developed into local variety populations in the Asian part of Russia as well. There are landraces of barley, divided into two groups – East Siberian and Far-Eastern (Bakhteyev 1956); oats, with the origin of its northern group in Altai and the eastern group in Mongolia (Mordvinkina 1936); and rye (Sinskaya 1969). Local winter rye landraces are more early-ripening than North European ones. The Altaic ecotype of spring rye, distinguished by its rapid growth at early phases of development, has unfortunately been lost as a crop. Few accessions are preserved in VIR's collection. Some authors (Pisarev 1960) argue that Siberian wheats descended from an ancient group of Chinese wheats, until recently having occurred in China as an admixture in plantings of modern cultivars. Local landraces of millet, Japanese millet and buckwheat also trace their origins to Mongolia or China.

13.4 Modern state of landraces in Russia

In recent years, VIR has continued the practice of collecting landraces of different crops. However, plant explorations of recent decades have confirmed that, unfortunately, a greater part of the Russian landrace diversity is not being maintained any more. The first to be lost were landraces of cereals, legumes, industrial crops and potato that had been cultivated on a large scale, as they were replaced with more high-yielding modern cultivars or destroyed by outbreaks of diseases. It is interesting that the best domestic crop cultivars of the second half of the 20th century were bred on the basis of VIR's germplasm accessions – primarily those of crop landraces. For example, the collection materials were used as breeding sources for more than 200 domestic cultivars of barley, oat and rye, 84 potato cultivars, and dozens of grain legumes, vegetables and industrial crops.

Several decades have completely changed the assortment of crops used in cultivation. Practically lost now are the traditions of growing such crops as winter false flax (*Camelina sylvestris* subsp. *pilosa* Zing.), spring bird rape (*Brassica campestris*), hemp, poppy, etc. Fortunately, many landraces are still preserved in VIR's collection, although part of them has unfortunately been lost. For example, some populations of wheat varieties, combining several sub-populations (eco-elements or lines) were regenerated in the same form as they had been collected – in mixtures, without separating their components. In the course of time, it led to the loss of some components.

Today it is almost impossible to find in Russia any landraces of cereals, industrial crops or potato. Nevertheless, there is a chance to encounter, however occasionally, landraces of vegetables, fruits, grain legumes or forage plants, especially in northern, mountainous or foothill areas – near isolated settlements or derelict farmsteads, far from crop production fields. The urgent need for such discoveries is obvious. The first step towards this aim should be the inventorying of crop landraces. Its results will help to work out targeted conservation recommendations for separate crops and for certain territories. Inventorying is to be accomplished by plant explorations planned on the basis of literary references, archaeological data, information contained in the databases of national and international genebanks, and materials preserved in archives, herbaria and live collections.

An illustration of such endeavours is the inventory of spring bread wheat landraces developed at VIR (Zuev 2008). A database was made for all old local varieties and populations. It contains the following information: taxonomic identity (including common and local names of varieties and forms); collection site (name of the settlement or location, altitude, geographic coordinates); date of collection; name(s) of collector(s); and data of the donor institution (if sent on a seed request). These data served for making up electronic maps of the regions explored by VIR's collecting missions (for individual regions). Such kinds of research not only yield information on the areas of collecting, plant collectors, details of plant distribution, but also serve as a tool of prognosis, facilitating identification of the areas where this or that local form of crop landrace might still be found.

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14. 'Swedes Revisited': a Landrace Inventory in Sweden

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14.1 Brief historic background

Sweden has a long history of research on plant genetics and plant breeding. When crop improvement began at the turn of the last century, the breeders' raw material consisted of landraces or locally adapted cultivars that were often collected from the nearby farmer's field. We should envisage the Swedish early-20th-century agricultural landscape as a mosaic of crops and cultivars, most of them locally improved and genetically variable landraces, very much like today's crops in marginal areas where agriculture has not undergone modernization. Some plant varieties had been introduced from abroad, such as Chevalier and Hanna barley, the Squarehead wheat, Golden Tankard and Red Mammoth fodder beets, but most of the crops grown were local selections.

This was before the rediscovery of Mendel's laws of heritability. The possibilities inherent in recombination, or crossing of genotypes, had not yet been exploited. Breeding meant selecting superior individuals from the mixture present in the landrace, further multiplying it to the stage where the amount of seed was large enough to be sold as a new variety. Now and then a new selection would be made from the released variety and marketed under a new name as an improvement, simply because the rules for uniformity were not as strict as under modern variety legislation.

With the arrival of varieties bred through recombination the traditional landraces gradually lost their importance in Swedish agriculture and by the 1950s they were basically no longer extant in cultivation. Thanks to the visionary work of some breeders, however, many of the original landraces were maintained and saved, both as testimony of the traditional agriculture and as a source of possibly new genetic variation that might be tapped anew. While this was especially true for the larger cereal crops, many other crops, such as vegetables, were not conserved to the same extent.

When the former Nordic Genebank was established in 1979 (NordGen as from 1 Jan 2008) much of the genetic stock, including traditional landraces, was provided by the breeding community itself. This included, among others, einkorn, emmer, spelt wheat

and lentils from the island of Gotland in the Baltic Sea, and oat, rye and barley from many parts of mainland Sweden. A few swede (rutabaga) and turnip cultivars were also provided. Over the years NGB has made several surveys to find and collect additional landraces, and by the end of the 1990s the collection contained some 300 accessions, including those of potato, *Pisum*, *Phaseolus* and local fruit and berry cultivars.

14.2 Programme for the diversity of cultivated plants

The programme for the diversity of cultivated plants (POM) was a new initiative in Swedish PGR work and was established as a national commitment in 2000. Through this programme, work on cultivated plants is to be better coordinated and developed. Sweden, together with 187 other countries, has pledged itself to conserve biodiversity by signing the UN's Convention on Biological Diversity. The country has also signed the FAO Global Plan of Action for the conservation and utilization of plant genetic resources. POM is seen as a vital instrument for the conservation and utilization of Sweden's plant resources in a sensible and sustainable manner.

A priority issue for POM includes a national inventory to be made of our cultivated plants and their relatives. A ten-year strategy has therefore been developed that lays down the priorities and technical details of how the inventory will be carried out. In 2000, small-scale inventories were made on a trial basis of three groups of very popular and well known cultivated plants with the aim of evaluating inventory techniques. The sample crops were introduced early daffodils and white narcissi (*Narcissus*), roses (*Rosa*) and turnips (*Brassica rapa* ssp. *rapa*). Since then, more comprehensive inventories of other cultivated plants or plant groups have been initiated throughout Sweden. These include fruit and berry crops, perennial ornamentals, ornamental bulb and tuber plants, forage crops, ornamental trees and bushes, vegetatively propagated crops, and cultivated roses. Plant material is currently being collected for evaluation and comparison before any final selection for long-term conservation in the national collection is made.

The first inventory, however, targeted a very critical group of crops, namely the vegetables. We know from historical documents such as garden literature and seed catalogues that the variety of vegetable cultivars was much larger in the late 1800s and first half of the 20th century. A sudden change seems to have taken place after World War II, however, when many of the older cultivars disappeared during a few years. The focus of the 'Seed Call' was therefore placed primarily on vegetables, annual ornamentals

and fibre plants, and was made as a concluding search for any redundant seed that could possibly still be around in the country. Other seed of interest was of course also welcomed. The call was carried out in collaboration with NGB and the Swedish seed NGO Sesam.

14.3 Methods

We used a wide spectrum of channels to reach the largest possible number of potential growers: media (TV, radio broadcasting, newspapers – both local and national, and garden magazines), exhibitions, relevant organizations (for seed growers, farmers, retirees), the regional organizations for agricultural outreach, the so-called 'book buses' (i.e. touring libraries) and many others. The appeal was also advertised at crop demonstration trials set up by various organizations.

Potential seed donors were asked to contact POM, to inform the organizers about their plant material and provide as much documentation as possible. This could include some of the following:

- Where, by whom and how long had it been grown?
- Was something known of its origin?
- Was it still being grown?
- The name of the cultivar, if available.
- The age of the seed.
- The information on the seed bag.
- Some particular traits or characteristics of the cultivar.

All seed that was obtained was carefully documented and sent to NGB for germination tests or seed multiplication, if necessary. Seed samples were also multiplied by Sesam. Although the call was planned to go on during 2002 and 2003 seeds still kept coming in during 2004.

Today all seeds are kept under long-storage conditions at NordGen in Alnarp, southern Sweden. Material has also been safety-duplicated at Svalbard. Some accessions are already freely available from the genebank but some still have to go through additional regeneration cycles before being available for distribution.

14.4 The findings

In all, seeds of 227 different seed samples came in from all over the country, except the northernmost part, Lapland. Apart from these, a large number of unspecified seed collections were sent in, the identity and origin of which were difficult or impossible to determine. Many of them were of the kind that early-20th-century

school pupils had to prepare as a compulsory topic in botany. However, due to the lack of documentation for this seed it was of little scientific value and in general non-viable. Finally, a number of original seed bags of named cultivars were also sent in. These seeds were also generally non-viable but nevertheless represent interesting reference material for future use.

Viable seeds, or bulbs in the case of *Allium*, were obtained from 175 accessions representing almost 30 taxa, some of which had not previously been collected by the genebank. These included common marigold (*Calendula officinalis*), sweet William (*Dianthus barbatus*) and rose campion (*Lychnis coronaria*). By far the largest number of seed samples obtained was of pea (*Pisum sativum* subsp. *sativum* and subsp. *arvense*), common bean (*Phaseolus vulgaris*) and broad bean (*Vicia faba*). Altogether 59 new accessions of garden or field pea, 25 common beans and 12 broad beans were obtained. This was not unexpected since these are self-pollinated crops that are easily regenerated. Furthermore, legumes generally have hard seeds that maintain their viability well even under less favourable conditions of storage. Somewhat more unusual crops included melon (*Cucumis melo*), tobacco (*Nicotiana tabacum*), garden orach (*Atriplex hortensis*) and thorn-apple (*Datura stramonium*).

Interestingly, 22 accessions were biennial root crops that require laborious storage of roots and replanting the following year in order to give seed. Fifteen swedes (*Brassica napus* var. *napobrassica*), six turnips (*B. rapa* var. *rapa*) and two fodder beets (*Beta vulgaris* var. *alba* and var. *conditiva*) were obtained, proving that still today there are growers who are sufficiently well-informed to be able to manage seed production of such crops. All swede accessions were obtained from the northern half of the country (north of 60 °N), indicating that the tradition of growing swedes is strongest in this part of Sweden. While only one turnip was received from central southern Sweden, the remaining five were also sent in from the north-western part. This may be associated with the fact that turnip growing has always been popular in neighbouring Norway, and seed exchange historically may have taken place across the border. The growing of swedes and turnips for centuries preceded that of potato cultivation, which was introduced only in the latter part of the 18th century. This may also explain why these crops have maintained their popularity in the areas mentioned.

Altogether 148, or 85%, of the accessions that came to POM through the 'Seed Call' can be classified as either landraces (locally adapted cultivars) or local populations. This was a surprisingly high figure considering the general belief that Sweden, from a genetic resources perspective, has been considered a 'poor' country and

possibly devoid of historical plant material. The basis for classifying landraces as distinct rests primarily on the source of documentation and to what extent this can be fully substantiated. Many donors provided photographs, receipts, seed orders, diaries and other verifiable documents that helped in this respect. As a result of the 'Seed Call' for material the NordGen collection of Swedish landraces now totals 568 accessions of 38 taxa.

14.5 Seed stories

The conservation of landraces and other traditional plant material is not only a matter of saving seeds or plants, but it is also about saving knowledge and memories. During the 'Seed Call' POM received a wealth of information explaining why this particular pea or swede cultivar had been maintained, perhaps for more than a generation or two. The guiding questions given in the information sent out led many donors to write down their personal reflections and experiences. This information, seldom valued or recognized, represents a central component in the conservation of our green cultural heritage.

Many of those responding to the 'Seed Call' were elderly people and very often retirees. A clear majority of the donors were women (69%) which probably reflects the fact that women have often been responsible for the vegetable garden and, therefore, also for maintaining seed stocks. These bearers of traditions also maintain in silence a rich cultural history, expressed and passed on by their hands. It is an ageing group of people, whose knowledge could very well be defined as 'near threatened' to use modern terminology. Their work and efforts to sustain our green heritage deserve to be documented and acknowledged.

14.6 Genetic analyses of pea

Due to the high number of pea cultivars collected as a result of POM, some of which had been grown for several human generations, we found it interesting to compare their variability with that already occurring in the genebank *Pisum* collection. Over the years cultivar names are obviously lost, and the only reliable method remaining at hand is that of using molecular markers. We decided to look at variation in microsatellite markers and therefore compared 34 genotypes from the 'Seed Call' with 46 others already stored at NordGen. We used eight primer pairs based on the work by Loridon et al. (2005) and analysed the data using cluster analysis and Nei's diversity index (Nei 1973). To summarize, the surprise finding from

the analysis was that many of the genotypes obtained through the 'Seed Call' represented new and previously unknown diversity. On the basis of only five primer pairs we concluded that 21 of the 34 genotypes were new and unique. The remaining 13 genotypes shared markers with either other 'Seed Call' genotypes or accessions already stored at the genebank. The analysis is currently being expanded using more primer pairs.

We find it interesting to conclude that Swedish pea diversity was significantly enriched through the activities of the 'Seed Call'. We may perhaps never find out the true identity of each of the collected pea cultivars because descriptive documentation about the varieties that were introduced around the turn of last century is scarce or even non-existent. A 'variety' introduced over 100 years ago was most probably not a pure line in the strict sense, thereby allowing for additional (local) selection and improvement. What we see today are possibly the descendants of those cultivars planted in gardens and fields at the end of the 19th century.

14.7 Publications

The stories and experiences of generations of growers have been compiled and described by Nygårds (2005) through interviews and much of the available documentation has been used. It is a long-needed and much welcomed recognition of those people who, idealistically, have contributed to the conservation of our genetic heritage.

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15. Landrace Inventory of the UK

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15.1 Introduction

It has been observed that field crop landraces are the rarest type of landrace in Western Europe (Hammer 2003). In the UK they were also the least studied and they form the main subject of this paper. Some fruit and hops have been covered by field surveys resulting in extensive *ex situ* collections at Brogdale (Palmer 1999) and the hop genebank at East Malling Research (P. Darby, 2004, pers. comm.). The NGO Common Ground has recently produced a Gazetteer of local apple varieties (Clifford et al. 2007). Vegetable heirloom varieties, maintained in home gardens and allotments, have also been surveyed (Stickland 2001). The heritage seed growers associated with the Heritage Seed Library assist in maintaining these heirloom and heritage vegetables. A selected list of extant historical vegetables and fruits was recently compiled by Stocks (2008).

Landraces and modern cultivars, in the form of F1 hybrids, can be seen as two extremes with many intermediate types (Wright and Turner 1999; Parlevliet 2007). Camacho et al. (2006) discussed the defining traits of landraces, such as a long history of cultivation, identity, heterogeneity, lack of formal breeding, as well as often being genetically diverse, locally adapted and associated with traditional farming systems. Also as pointed out by Negri (2007), landraces often have cultural associations with the communities in which they are maintained. Landraces can be identified as local varieties with local seed production on farm (Wright and Turner 1999). Almekinders et al. (1994) distinguished formal and informal seed sectors; in the informal sector landraces occur as farmer's varieties and as farm-saved seed. In the formal seed sector, local, traditional and modern varieties are present as varieties which are available in commerce, and are registered on National Lists. Both sectors should be included in an overview of landraces.

The UK has a long tradition of certifying local forage varieties, and many of these varieties were added to the National List when it was created in 1973. One of the first local varieties to enter seed certification was Kent Wild White Clover from the Romney Marsh in 1930 (Caradus 1986). The National List can therefore be viewed from a plant genetic resources perspective: which landraces and traditional varieties are listed and who are their maintainers?

15.2 *In situ* occurrence of field crop landraces and traditional varieties

Work in the UK on extant cereal landraces includes the Wright et al. (2002) assessment of Scottish landraces. The National Inventory of UK Genetic Resources for Food and Agriculture, commissioned by Defra in 2003, was carried out by the University of Birmingham as a desktop study (Scholten et al. 2004). Extant cereal landraces and local forages were prioritized and results are summarized on the UK Portal for Genetic Resources for Food and Agriculture (www.grfa.gov.uk). Associated with the inventory were pilot and follow-up studies (Camacho Villa 2003; Michailidou 2004; Lever 2006; Scholten et al. 2008; Scholten et al., in press). Simultaneously but independently, an assessment of the Scottish extant bere (barley) in cultivation was done as part of a genetic diversity study (Southworth 2007). Background information on Scottish landraces can be found on a Scottish Government website for landraces: www.scottishlandraces.org.uk.

15.3 Traditional wheat varieties kept as landraces

In southern England a tradition of thatching with wheat straw has survived. For this reason and associated with thatchers, a number of traditional, long-straw wheat varieties are kept as landraces: Maris Widgeon, Squarehead's Master, April Bearded, Rampton Rivet, Blue Cone, Little Joss, Rivet. Most of these are obsolete (no longer sold commercially) varieties, and are often selections (from selections) from landraces in the 19th century; many were, or are, periodically reintroduced from the John Innes genebank collection. Because their seed is no longer in commerce and seed has therefore to be generated on farm, these varieties can be viewed as traditional varieties kept as landraces. The one exception is Maris Widgeon, one of two pre-1973 wheat varieties on the UK National List. These two wheat varieties, Maris Widgeon and Maris Huntsman, are also maintained for their good milling quality. The scale of cultivation is on average two hectares as can be seen from the data presented in Table 15.1.

Table 15.1. Overview of traditional wheat varieties maintained as landraces.

Variety	Pedigree	Seed source	Number of farmers	Use	Scale (Ha)
Maris Widgeon	1960s	National List	80-110	Thatch, milling	
Squarehead's Master (Standard Red)	Early 20th century	Majority genebank	7	Thatch	2 –100
Rampton Rivet	1939	Genebank	3	Thatch	10
April Bearded	Landrace/ selection	Genebank	2	Thatch	10
Rivet	Landrace	Genebank	2	Thatch	10
Little Joss	1908	Genebank	1	Thatch	2
N59	1950s	Genebank	2	Thatch	

Bere, the Scottish barley landrace

Bere, a six-row barley landrace, described by Jarman (1996) as 'a living link with the past', is one of the oldest surviving landraces in the UK. An assessment of the current distribution of *bere* was carried out by Southworth (2007). On Shetland, *bere* cultivation in recent years has increased through a heritage project[3] of the Shetland Organic Producers' Group. On Orkney the local watermill[4] grows *bere* and produces *bere* flour for traditional biscuits. The Agronomy Institute, also on Orkney, has conducted research projects into marketing of bere (Martin et al., Chapter 26 this volume). On the southern Outer Hebrides *bere* is grown for fodder and will be further discussed in the section on cereal mixtures.

Cereal landrace mixtures

The southern Outer Hebrides form the largest area of extant cereal landraces in the UK with over 300 hectares of mixtures of *Avena strigosa*, rye (of unknown origin) and bere (Scholten et al. 2008). These are historical landraces with local cultivation and seed saving reported back over generations (Findlay 1956) and possibly centuries.

Local forages

Grasslands are the largest form of agricultural land use in the UK and forages are one of the major crops. Forage ecotypes have been collected extensively for *ex situ* conservation (Humphreys 2003). Many local varieties were produced by numerous local seed growers' associations until the second half of the 20th century (Sneddon 1980). Seven of these have survived: Kent Wild White clover, Kent perennial ryegrass from Romney Marsh, Scots timothy in the area around Stirling and Perth in Scotland; Essex Broad and Kersey White Clover, two local clovers

[3] www.organics.shetland.co.uk/.
[4] www.birsay.org.uk/baronymill.htm.

from eastern England and two local sainfoin varieties in southern England. Essex is the only surviving type of the English Broad-Leaved clovers and has been in trade for over 70 years. Kersey White Clover was developed from a local strain from Suffolk (Hawkins 1967). Scots timothy was threatened by extinction after World War II and a certification scheme was set up to market the landrace (Gregor 1971). Its cultivation as a hay crop is nowadays restricted to Perthshire (K. Pearson, 2008, SASA, pers. comm.). Seed production and the number of growers of all of these have decreased steadily over recent decades.

Sainfoin has been grown in England since the 18th century and there were two main sainfoin local types: common and Giant (Koivisto and Lane 2001). Only Cotswold common and Hampshire common could be found in 2003. The first is maintained by Cotswold Seed Ltd and used in Conservation Mixtures. The second, Hampshire common, has been continuously grown on an estate since 1730[5]. It was withdrawn from the National List in 1984 because the grower thought annual certification costs were too high and that it was unfair for a single grower to pay the same fees as commercial seed producers. An overview of current seed production is given in Table 15.2.

Table 15.2. Overview of extant forage landraces.

Local forage name	Scientific name	Maintainer	Tonnes/ year 2007	Number growers	*Ex situ* holding	Holding institute
Kent Wild White Clover	*Trifolium repens* L.	KWWCPRG[6]	0	2	1 or more	DARDNI[7]
Kersey Clover	*Trifolium repens* L.	Church of Bures	Low	Lower	1 or more	DARDNI
Essex Broad Red Clover	*Trifolium pratense* L.	Church of Bures	Low	Lower	1 or more	DARDNI
Kent Indigenous White Clover	*Lolium perenne* L.	KWWCPRG	15	4-5	1 or more	DARDNI
Scots Timothy	*Phleum pratense* L.	STSGA[8]	46	6	1 or more	DARDNI
Hampshire Common sainfoin	*Onobrychis viciifolia* Scop.	ex-NL	2	1	2	DARDNI USDA-PI
Cotswold Common sainfoin	*Onobrychis viciifolia* Scop.	Not NL	Not available	1	1	ECP-GR

[5] www.sustainable-cholderton.co.uk/.
[6] Kent Wild White Clover and Perennial Ryegrass Growers.
[7] Department of Agriculture and Rural Development Northern Ireland (UK).
[8] Scots Timothy Seed Growers' Association.

Traditional cereal varieties kept as landraces
During the National Inventory in 2003-2004 and subsequent fieldwork, some other traditional varieties kept as landraces were found. Two examples from Scotland are Murkle oat, a traditional *Avena sativa* variety from north-eastern Scotland, grown to provide straw to Orkney traditional chair makers. The second is an *A. sativa* cultivar from 1936, Monarch (Findlay 1956), kept by one farmer, who had inherited it from his father. It is also grown to provide high-quality straw to Orkney chair makers.

Brassica *field crop landraces*
Shetland cabbage, a *Brassica* landrace grown over centuries on the Shetland Islands, has shown a steep decline in cultivation over the last 30 years. In 2006 a research project at the University of Birmingham resulted in seed collection and an estimation of current cultivation and an assessment of threat for this century-old local cabbage (Lever 2006; Scholten et al. 2008). An overview of landraces present in Scotland is given in Table 15.3.

Table 15.3. Overview of extant field crop landraces and traditional varieties in Scotland.

Landrace	Region	Number of growers	Use
Bere (barley)	Orkney and Shetland	15-20	Flour, whisky, beer, feed
Cereal mixtures (*A. strigosa*, rye, bere)	Southern Outer Hebrides	100 – 250	Winter feed cattle
Shetland cabbage (*B. oleracea*)	Shetland	50	Winter feed, vegetable
Shetland oat (*A. strigosa*)	Shetland	Less than 10	Thatch, baskets, chairs
Orkney traditional oat (*A. strigosa*)	Orkney	2	Traditional Orkney chairs
Murkle oat (*A. sativa*)	Orkney, Shetland	2	Straw for chairs, seed
Monarch (oat) (*A. sativa*)	Orkney	1	Straw for chairs

15.4 UK National List of Plant Varieties

The UK National List of Plant Varieties contains landraces and/or traditional (pre-1973) varieties for which seed can be assumed to be available on the market. Present on the 2007 National List were five local forages (Table 15.2), a long-straw wheat, a pre-1973 barley preferred by Scottish growers, 38 potato varieties, many with

Scottish names, several Brassica field crops such as fodder kales, Swedes and one field pea (Defra and PVRO, 2007).

Many of these represent longstanding local cultivation, such as for Brassica field crops (Green 1999), and are associated with local seed growers' associations such as the Kent Wild White Clover and Perennial Ryegrass Seed Growers' Association (KWWCPRSG) and the Scots Timothy Seed Growers' Association (STSGA). Several names are long associated with local growing traditions: e.g. Evesham, Ormskirk, Cotswold, Durham and Offenham were named after areas of cabbage production (Oldham 1948).

With the UK's entry into the European Community in 1973 many traditional open-pollinated vegetable varieties, which were maintained as populations, were accommodated on the UK National List (B-list). Nearly all B-list varieties were well-known before 1973 and many originate from the 19th century.

The three largest maintainers of traditional or pre-1973 varieties on the National List are SASA, maintaining 124 of the total 437 vegetable varieties, SEERAD/DARD together maintaining 38 of 119 listed potato varieties, and a commercial English seed merchant, Church of Bures, who maintains all ten listed pre-1973 field crops (Defra and PVRO 2008). This increase in public maintainers should be seen against the background of a steady loss of pre-1973 varieties from the National List. The involvement of SEERAD and SASA (both Scottish Government) keeps older potato and B-list vegetables in the public domain and secures reproduction of definitive seed.

15.5 *Ex situ* conservation and seed availability

All UK landraces that have been discussed above, with the exception of rye and sainfoin, are represented with one or more accessions in one of the national germplasm collections. However, passport data are not always present. New collections have been created at SASA (Green et al., Chapter 24 this volume). Two of the three UK statutory variety testing centres conserve obsolete varieties: Agri-Food & Biosciences Institute Northern Ireland (AFBINI) and SASA, an overview of these collections is given by Green (1997). The relevance of these collections to conservation was shown by the example of Hampshire sainfoin, where only one accession was conserved (as an obsolete variety) in the statutory reference collection at AFBINI. The status of these collections concerning public accessibility and seed availability remains unclear; therefore seed of this landrace is not currently available.

15.6 Conclusion

A number of field crop landraces have been identified, some of these maintained on farm, and some by local seed companies registered on the UK National List. The identified varieties showed varying histories of cultivation. The oldest are probably the cereal landraces of the Scottish islands, Shetland cabbage and Hampshire common sainfoin. Others, such as the long-straw wheat varieties are obsolete, or are traditional varieties kept as on-farm saved seed. If the criterion of 30 years or one generation of seed saving on-farm, following Louette (2000), is applied, the Scottish and Hampshire varieties are 'true' landraces. They are mainly used as home-grown fodder, and are not maintained for heritage purposes. Barley forms the exception as it is also marketed as a heritage or niche product. In contrast, the obsolete varieties and the varieties listed on the National List are of more recent origin. Nonetheless, they represent local seed production histories and often longstanding local uses, such as traditional thatching material.

Local seed production of local varieties[9] is crucial to keep seeds available to growers. Concern about seed availability is witnessed in initiatives such as the heritage cereals project of a group of Shetland growers[10], instigated by a lack of local seed; the Local Biodiversity Action Plan for the Western Isles proposing to subsidize local seed production; or the Scottish Government stepping in as maintainer for traditional potato and vegetable varieties on the National List to keep seed available on the market, and the creation of the new Scottish Landrace Protection Scheme (Green et al., Chapter 24 this volume).

A more active role for genebanks can also be observed at the John Innes Centre, with an Open Day of the Growing Demonstrations of UK Cereal landraces, landrace selections and early cultivars from the BBSRC Small Grain Cereal Collections. The recent work on cereal landraces has highlighted them as part of the plant genetic resources of the UK and has stimulated conservation action and policy development, as described by Green et al. (Chapter 24 this volume).

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[9] In contrast to on-farm saving of modern varieties, reported for the UK by Brennan and Byerlee 1991.

[10] www.organics.shetland.co.uk/news.htm.

of Environment, Food and Rural Affairs (Defra grant GCO134). C.T. Camacho Villa, L.A. Lever and A. Michailidou MSc projects were funded by the University of Birmingham. The *A. strigosa* survey in 2006 was funded by the Botanical Society of the British Isles (BSBI).

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Section 3 - Case Studies

16. Tomato Varieties 'Muchamiel' and 'De la Pera' from the South-east of Spain: Genetic Improvement to Promote On-Farm Conservation

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16.1 Introduction

Tomato is the main vegetable crop in Spain, and furthermore, it is the horticultural crop with the highest value. South-eastern Spain is the most important area of fresh market tomato production in the country, and this production is almost exclusively based on modern hybrid varieties. However, there are still several traditional tomato landraces which are renowned for high quality. In fact, in local markets, traditional cultivars are sold for three to five times the price of the hybrid varieties. Cultivars such as 'Muchamiel', 'De la Pera', 'Valenciano', 'Morunos', and 'Flor de Baladre' types, are very popular in south-eastern Spain for their organoleptic fruit quality, and are still being cultivated by local farmers in small orchards. However, these landraces are severely endangered with the risk of extinction.

16.1.1 If appreciated, why then are tomato landraces being lost?

All these traditional cultivars are highly susceptible to several viruses, such as those caused by the ToMV, TSWV and TYLCV (Picó et al. 2002). Although the presence of the viruses in tomato fields varies from one year to another, their incidence strongly decreases the benefits obtained by farmers, and even makes the cultivation of landraces non-viable in many areas. The abandonment of these traditional cultivars would lead to an irreversible loss of genetic diversity. Commercial hybrid varieties with genetic resistance to the viruses have been developed, but these resistance genes have not been introgressed into local varieties, since they represent only a small seed-market share.

16.1.2 Tomato breeding and quality: opportunities for the promotion of tomato landraces

With the availability of tomatoes all year round and with the spread of long-shelf-life varieties, consumers began to complain about

fresh market tomato quality, and they frequently associate modern varieties with a lack of flavour. Although such an association has not been proven, some authors believe that poor flavour quality in tomato appears to be a result of breeding practices that do not select for flavour. Tomato breeding has played a major role in developing varieties adapted to the new agricultural and processing technologies. In tomato, to date more than 25 major genes for disease resistance have been reported, and many recently developed cultivars now possess multiple disease resistance attributes. In the breeding programmes, exotic germplasm has been almost exclusively used as the source for disease and insect resistance genes. The use of such unadapted material (wild tomato species) to improve a cultivar can be difficult because of linkage drag, the transfer of linked, undesirable loci with the gene(s) of interest. The amount of introgressed DNA varies among cultivars and lines. When too much unadapted DNA is introgressed into a cultivar, important agronomic traits can degrade to unacceptable levels. Modern hybrid cultivars of tomato have several introgressed DNA segments from different wild species. This could partially explain why today the quality of modern cultivars is criticized, and could be an opportunity for the promotion of tomato landraces based on their recognized quality.

16.2 Landrace diversity

The tomato (*Solanum lycopersicum* L.) was probably domesticated in Mexico, but the first transfer of varieties to Europe was made by Spanish explorers. Spain and Italy were the first European countries where the tomato acquired commercial importance. After its introduction, a wide range of local cultivars was developed, organoleptic quality being one of the main selection criteria. In order to contribute to the conservation of the genetic diversity harboured by these tomato cultivars from the south-east of Spain, we thought that we need to know more about what we were going to preserve, so special emphasis was placed on a detailed characterization of the variation at several levels, as follows.

16.2.1 Morphological variation

Although cultivated tomato has a very narrow genetic base, there is a huge diversity of cultivars which greatly differ in characteristics such as shape, firmness, solid soluble contents, aroma volatiles, etc. For example, Gomez et al. (2001) have found important differences for some colorimetric and physicochemical parameters among some closely related Spanish local cultivars,

and other authors have found strong effects of tomato genotype on foliar micronutrient concentrations.

16.2.2 Variation for micronutrient fruit content and other parameters

The micronutrient composition of fruits from different forms of two types of traditional cultivars, the 'Muchamiel' and the 'De la Pera' types, and several parameters related to fruit quality, have been characterized. These landraces are usually consumed at the breaker maturity stage (less than 10% of the fruit surface showing red colour). For this reason, analysis was performed at two different maturity stages. The strong differences found among the traditional tomato cultivars analysed, both for micronutrients and for the other quality parameters, confirmed the presence of considerable levels of genetic diversity among the six cultivars grown in the south-east of Spain (Ruiz et al. 2005c). In addition, a principal component analysis performed on the most discriminating parameters allowed us to differentiate among genotypes of the same type. By relatively simple chemical analyses, we were able to detect important differences among similar tomato genotypes that we are still not able to differentiate using molecular tools. In other experiments important differences between 'old' (landraces) and 'modern' (F1 hybrids) cultivars have also been found for their respiration rates and ethylene production, K, P, and Na contents and for organic acids profile (Ruiz et al. 2006). This knowledge could aid with the efficient conservation of traditional tomato cultivars.

16.2.3 Aroma variability

Tomato aroma is complex, probably a combination of more than 16 compounds give tomato its unique odour characteristics. However, reducing the number of compounds to a few with major contributions to aroma could increase the usefulness of volatile determinations in tomato. We have quantitatively determined volatile compounds with a major contribution to aroma in four traditional tomato landraces and one commercial F1 hybrid. One of the traditional cultivars was the most appreciated for flavour and overall acceptability in tests performed using a panel of 30 untrained tasters. The same cultivar showed significantly higher contents of the hexanal and cis-3-hexenal volatile compounds, which have been previously reported to be two of the most important contributors to tomato flavour. Based on a low number of fruits per cultivar, significant differences among very closely related tomato cultivars can be detected for volatile aromas, thus allowing the use of volatile determination as a possible tool for screening accessions of tomato.

Methods to analyse volatile compounds that need high amounts of tomato samples are not useful for selecting individual genotypes. As analysis of flavour compounds in the aromatic component requires expensive equipment and training, if volatile determination is going to be used as a tool in conservation programmes, a low number of samples should be needed. We have found significant differences among closely related cultivars for selected volatile compounds, using a low number of fruits per cultivar whose maturity stage had been visually judged. Results from these and others studies (Ruiz et al. 2005a; Carbonell-Barrachina et al. 2006) will help tomato breeders in maintaining and improving the traditional tomato cultivars ('Muchamiel' and 'De la Pera') by taking into account flavour as one of the main parameters of fruit quality.

16.2.4 Genetic diversity estimated using molecular markers

Modern genetic and genomic tools have been intensively applied to the tomato, but these techniques are not of much use yet for characterizing phenotypic differences among closely related cultivars. Using 19 SSRs that had been specifically selected for tomato cultivar characterization, we could not identify all the Spanish traditional cultivars under evaluation, although they clearly have different phenotypes (Ruiz et al. 2005b). This result confirms the narrow genetic background of the cultivated tomato and, in particular, the limited genetic variation exhibited by our collection of traditional cultivars. However, we were able to identify the three main types of cultivars using only four SSR markers. The discrimination power of different types of markers (SSRs, AFLPs, SRAPs) used in evaluating traditional cultivar diversity was similar (García-Martínez et al. 2006). Unique fingerprinting of the most morphologically similar tomato landraces could not be achieved using a single type of marker, but required a combination of several markers.

16.3 Improvement of traditional varieties: introgression of resistant genes

As already noted, the incidence of several viruses (mainly those caused by ToMV, TSWV and TYLCV) makes it difficult to cultivate traditional varieties. We have conducted a breeding programme for the introduction of three dominant genes (*Tm-2^a, Sw-5, and Ty-1*) that confer resistance to the three most relevant viruses in south-eastern Spain (ToMV, TSWV and TYLCV, respectively) into 'Muchamiel' and 'De la Pera' landraces. The genes *Tm-2^a* and *Sw-5* come from the wild tomato *Solanum peruvianum* L., and *Ty-1* originated in the

accession LA1969 of another wild tomato species, *Solanum chilense* (Dunal) Reiche. As a preliminary result of the breeding programme, we have obtained promising pre-breeding materials, which have to be further adapted to the specific agroclimatic conditions of different localities.

16.4 On-farm management

At present, more that 30 field assays are being carried out in different locations of the southeast of Spain (García-Martinez et al. 2008). Seed lots from the improved traditional varieties, with genetic resistance to several viruses, are being distributed to local farmers. Taking into account their own experience, farmers select the best plants in their own fields looking for specific adaptation. Special emphasis is being placed on trials conducted in organic farming conditions. The aim of the programme is to develop a range of cultivars, adapted to different environments including open field and protected cultivation, and composed of different genotypes, in order to maintain their ability to evolve under different selection pressures. The project is being funded by the Ministry of Education and Science. In addition, we are currently starting a project in collaboration with the Council of Muchamiel, the town which gives its name to the tomato variety, trying to involve local farmers, consumer associations and local restaurants. The goal is the preservation of the genetic diversity in this small area, through the recovery, conservation, improvement and use of local tomato varieties.

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17. 'Fagiolina' (*Vigna unguiculata* subsp. *unguiculata* (L.) Walp.) from Trasimeno Lake (Umbria Region, Italy)

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17.1 Introduction

Cowpea is an important grain legume throughout the tropics and sub-tropics, covering Asia, Africa and Central and South America, as well as parts of southern Europe and the United States (Singh et al. 1997). In Italy, cowpea is a minor crop and its cultivation is restricted to a very limited area. Both *V. unguiculata* subsp. *unguiculata* cv-gr. unguiculata and cv-gr. sesquipedalis (Maréchal et al. 1978; Pasquet, 1993a,b, 1997, 1999) are cultivated for seeds and for fresh pods (like French bean), respectively. Cowpea, domesticated in the sub-Saharan area around the second millennium B.C., was certainly cultivated by the Greeks in the 3rd century BC and by the Romans in the 1st century AD as Theophrastus and Pliny state (Chevalier 1944; Burkhill 1953; Purseglove 1976). The plant could have been introduced well before then in Italy, since trade in the Mediterranean area has been intensive since pre-historic times. In Umbria (central Italy) the species was possibly already introduced by the Etruscans, who already dominated the area in the 8th century BC and traded intensively with several Mediterranean countries. However, historical documents exist (see for example Giunta per l'Inchiesta Agraria 1885) that testify to cowpea cultivation in the Trasimeno Lake area in the 19th century.

This contribution reports on studies and actions that were undertaken to rescue the local cowpea population from the risk of extinction and allowed an increase of farms and area under which the crop is grown in the area.

17.2 The history of a rescue

In 1994 cowpea was prevalently cultivated for domestic consumption by a few families around the Lake and appeared to be a crop under severe risk of extinction. At that time only one farmer used to sell a few kilograms of cowpea at the local town (Perugia) market. Cowpea from Trasimeno Lake was in fact highly esteemed by a small group of local gourmets.

Financial support was initially given by Provincia di Perugia to carry out a) a morphological, organoleptic and genetic characterization,

b) *ex situ* conservation in DBA genebank, c) seed multiplication and distribution to farmers interested in reintroducing cowpea in cultivation and, in general, d) to increase farmer awareness about the importance of local biodiversity and the prospects offered by this crop.

The area was explored, approaching farmers in a friendly manner and explaining the reason for the visit. An interview followed, to gather information on the farming family, the farm and the other cultivated crops.

Seed samples of cowpea (as well as of other landraces) were only collected when farmers declared their materials have been cultivated for ages in their families without exchanging seed or buying it on the market (Tosti and Negri 1997).

The morpho-physiological and genetic characterization showed that clearly distinguishable cowpea types were present in the area (Negri et al. 2000; Tosti and Negri 2002, 2005).

Among the molecular markers used to carry out genetic characterization, AFLP (Amplified Fragment Length Polymorphisms) and SAMPL (Selective Amplified Microsatellite Polymorphic Locus) were particularly useful in the analysis of the limited genetic diversity present in the cowpea population from Trasimeno Lake (Tosti and Negri 2002). In addition, the entire Trasimeno cowpea population was found to be a structured population in which a substantial differentiation is maintained at the subpopulation (i.e. farmer population) level. This recommended the approach of maintaining the entire population on-farm (Tosti and Negri 2005).

The presumed better quality of cowpea from Trasimeno Lake in comparison with commercial materials was tested in an *ad hoc* experiment. The results showed significant differences between the different types of cowpea from Trasimeno Lake and a variety commonly found on the market with respect to organoleptic characteristics (taste and visual appeal) and nutritional traits (crude protein content and total carbohydrate percentages on dry matter) (Negri et al. 2001).

The results of the above-mentioned research were presented to farmers and farmers' associations in a series of meetings and seminars during which seed samples from multiplication were also distributed.

These activities triggered a virtuous process of on-farm conservation since in a few years an increase of the area under cowpea cultivation was observed.

Meanwhile one skilled farmer developed an almost completely mechanized cultivation method for this crop that, when cultivated

using the traditional system, requires a great deal of labour (especially for the cropping and the cleaning of the product) and consequently has a high cost of production. He was able to sell the crop to a famous restaurant and outside the region.

In addition, the Fagiolina of Trasimeno Lake provoked the interest of Slow Food which included it among its *Presidia*. This cowpea has now become famous even outside Umbria and is served as a must in many top restaurants.

The market price of the small, white-seeded type has greatly increased in the regional capital (Perugia) (from 6 euros/kg in 1994 to the present 20-22 euros/kg). However, other types of cowpea are also cultivated and often sold as uniform lots or mixtures, locally.

A 'Consortium' of Fagiolina growers has been established in order better to commercialize the crop. Also worthy of note is that some farmers introduced the crop in Umbrian areas which are outside the Trasimeno Lake area.

Currently, an area of about 10 hectares (variable from year to year) is cultivated under this crop around the Lake, the farmers still have a significant income from it and the potential exists to widen the market further. Cowpea from Trasimeno Lake appears to have escaped the risk of extinction and we can define the first steps of its on-farm safeguarding as a success.

17.3 Enhancing the promotion of on-farm conservation in the area

Quality labels, such as Protected Designation of Origin (PDO), can cover food coming from crops belonging to the cultural and biological heritage of a certain area, produced, processed and prepared in a given geographical area using recognized know-how. Increasing the added value of a product, the award of quality labels can encourage production in a rural development context and consequently favour on-farm conservation of the landrace from which production comes.

On the other hand, products that have a rich market need to be protected to safeguard local heritage and farmers' interests on one side, and consumers on the other side. The PDO, better than other quality marks, suits both purposes.

In 2005, Regione Umbria through the Parco Tecnologico Agroalimentare of Umbria, that is the responsible body for product certification in the Region, funded a project for the 'Characterization and normalization of Trasimeno cowpea products'. Aims of the project were, in order, a) to evaluate the possibility and methods for applying for the PDO, b) to evaluate the strategy to certify the

cowpea identity and its belonging to the environment of Trasimeno Lake and then c) to prepare a 'disciplinaire' (special application document) for applying for a PDO.

Once it was decided that there was the possibility to gain further advantages by covering the product with a PDO, all the other planned steps were undertaken. In respect to point b) a study was carried out which, by using molecular markers on a wide sample, showed that all cowpea types from Trasimeno Lake are distinguishable from commercial cultivars and from landraces from other regions (Negri and Polegri, in press). By confirming through genetics that cowpeas from Trasimeno belong to the particular cultural identity of the human population living around the Lake, this finding enhances the possibility of certifying the product as 'typical' of the Trasimeno Lake and offers the opportunity to protect both the producers and the consumers from fraud.

As for point c) a round table was set up in order to prepare a PDO disciplinaire through a participatory approach. Farmers belonging to the Consortium, anthropologists, food scientists, economists, agronomists, geneticists and experts on quality certification met several times, discussed each single issue to be included in the disciplinaire and reached an agreement on them. Finally the disciplinaire was completed in all parts, redacted and made ready for submission.

Although the Consortium played an active part in preparing the disciplinaire and did not sustain any cost at all for it, it is still evaluating the convenience of undertaking all the administrative steps that will lead to having the PDO quality label. Farmers appear to be especially concerned with costs linked to each year's product certification which has a relatively high incidence on the few tonnes produced yearly. They face the entrepreneurial decision to increase production further and personally invest in crop marketing, but they seem irresolute. The process is stagnant at present.

17.4 Lessons learnt

Public sustained and concerted actions appear to be a tool for saving genetic resources at risk that have the potential to gain a market. However, farmers may not show the enterprise spirit necessary to make a typical and high-quality product from local genetic resources a real business. In addition, the rescue through publicly sustained efforts of all genetic resources (i.e. landraces) maintained on-farm, which are still consistently found in Italy, appears to be an impossible task. Farmers and gardeners themselves should decide to maintain the biological and cultural heritage represented

by the landraces they inherited from their parents. However, they are often unaware of the importance of these genetic resources, while in addition several socio-economic factors greatly hamper on-farm conservation in Italy (cf. Negri 2003). To have some hope of preserving diversity maintained on-farm for the wealth of future generations, there is a need to increase awareness of its importance at every level.

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18. The 'Farro' (*Triticum dicoccon* Schrank) from Monteleone di Spoleto (Valnerina Valley, Umbria)

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18.1 Introduction

Hulled wheat, known in Italy as 'farro', includes three predominantly self-pollinated cereal species: einkorn (*Triticum monococcum* L., 2n = 2x = 14), emmer (*T. dicoccon* Schrank, 2n = 4x = 28) and spelt (*T. spelta* L., 2n = 6x = 42). In Northern Europe spelt is the most widespread while emmer is more widely spread in the Mediterranean basin. *T. dicoccon* originated in the mountains of the Fertile Crescent, where its wild progenitors are still present. Domesticated emmer was widely distributed from Northern Africa through most parts of Europe and the Mediterranean area to Central Asia (Szabo and Hammer 1996).

In Italy emmer cultivation began decreasing from the beginning of the 20th century when intensive breeding activities produced more productive varieties of both durum (*T. durum* Desf.) and bread wheat (*T. aestivum* L.). Emmer wheat cultivation decreased drastically during the 1960s and was confined to marginal areas. However at present, the area cultivated with emmer has increased up to 2000 ha (Pagnotta et al. 2005), due to a renewed interest in natural and healthy food and in organic agriculture. Emmer in fact has a high protein (ranging from 8.5 to 21.5%, Stallknecht et al. 1997) and fibre content. Furthermore it is traditionally grown, without the use of synthetic fertilizers or pesticides. Its cultivation is of some importance especially in the marginal areas at high altitude, where its low input requirements and cold resistance make the crop economically convenient. Highlands of Garfagnana (Tuscany), Valnerina (Umbria Region), Leonessa (Lazio Region), Tronto Valley (Marche Region) Aterno Valley (Abruzzo Region), Aniene Valley (Lazio Region), Molise Region, Dauno Appennine (Campania Region) and Lucano Appennine (Basilicata Region) are the main production areas (Falcinelli 2006).

In Italy emmer cultivation is based on landraces that show good agronomic performance and environmental adaptability. They are able to compete well with weeds and to exploit areas with poor soils, so that they can be cultivated in low-input agronomic systems.

The morpho-physiological and genetic characterization of farro from Monteleone di Spoleto has shown that this population is distinct from

other landraces and can be considered a composite variety originated by continuous on-farm conservation (Barcaccia et al. 1998; Porfiri et al. 2001; Torricelli et al. 2002; Torricelli and Falcinelli 2007), in other words it is a genetically heterogeneous population. This heterogeneity results in phenotypic interactions that provide gains in performance and in mutual buffering or homeostasis that give steady performances not only in conventional, but especially in organic farming. In addition, the diversity of emmer wheat can be considered a useful gene reservoir for durum and bread wheat breeding programmes for organic and conventional farming (Sharma et al. 1981).

18.2 Economic aspects and PDO (Protected Designation of Origin) mark of 'Monteleone di Spoleto' emmer

According to interviews, emmer is cultivated on about 120 hectares in farms generally smaller than 20 hectares. On average, the total production of 'Monteleone di Spoleto' emmer is assumed to be 180 t per year and half of this production comes from just one farm.

The traditional use of emmer is the whole grain, used for soup dishes. However, product diversification developed in recent years has made it possible to increase income from emmer cultivation. Emmer is now processed in order to obtain flour, which allows farmers to produce and commercialize a wide variety of biscuits, cakes, pasta, flakes, soups and bread types. Although emmer bakery performances are not comparable to those of white wheat, consumers are increasingly appreciating these new products. The products are all packed in air-tight packets weighing 500 g for a price of 2.5-3 euro each. The pack carries information about the origin and special qualities of emmer and suggests recipes. When sales take place directly on the farm, consumers are able to appreciate the contact with the farmers, the beautiful landscape and, obviously, the lower cost of the product. However, small processing local industries exist that are able to commercialize emmer products on a wider market. This is another important source of value for these marginal and low-populated areas.

On farm, with the necessary investment, further products have been developed from some of the waste processing materials, representing about 50% of the total harvest weight. The seed hulls are sold, after a selection and cleaning process carried out on the farm, to specialized Italian companies, in order to produce different kinds of anatomical pillows. Revenues obtained from this sale are approximately equivalent to the average net wage of an employee in the area (about 10 000 euros per year). The chaff is also used as pellets for heating the farmers' houses.

Nowadays the 'Monteleone di Spoleto' emmer has undergone a successful economic invigoration thanks to some farmer initiatives. In October 2002 seven local farmers constituted themselves into the 'Association of Monteleone di Spoleto Emmer'. The Association, with the collaboration of the Department of Applied Biology (University of Perugia), of agriculture associations and of other local institutions, promoted the procedure to obtain the PDO (Protected Designation of Origin) mark. The PDO 'disciplinaire' strictly defines the area of cultivation and production of 'Monteleone di Spoleto' emmer: the area must be at an altitude higher than 700 m asl in the territory of Monteleone di Spoleto, Poggiodomo, Cascia, Sant'Anatolia di Narco, Vallo di Nera and Scheggino Municipalities in the Valnerina Valley. In order to guarantee the origin of the product, every phase of the production process should also be monitored to document inputs and outputs.

PDO will increase the added value of emmer and protect both consumers and producers.

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19. Grindstad Timothy: the Landrace that Became a Major Commercial Variety

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19.1 Introduction

Cultivated meadows, established from seed, first came into common use in Norway from around 1860. Earlier the farmers had only harvested forage from natural meadows. This new farming practice first came into use on the larger farms in south-eastern Norway. The seed they used was imported from other European countries, and timothy accounted for about 70% of the imported seed.

The imported seed generally resulted in meadows with higher yields, and timothy also responded much better to fertilizer than the natural meadows. But the timothy meadows were often severely damaged due to winter kill. These varieties were poorly adapted to the growing conditions in Norway. The farmers soon found that by producing their own seed from a small part of their meadow they got a more winter-hardy meadow in the next generation. The national production of forage seed therefore increased rapidly. As an example, a total of 1125 t of forage seed was used in 1890 of which only 350 t was imported (Vestad 1952).

Timothy and red clover, the main forage crops, are cross-pollinated species. In cross-pollinated species a population consists of a large number of different genotypes, each with slightly different characteristics and growing performance. Under a given climate and growing condition some genotypes will be better adapted than other genotypes. These adapted genotypes will produce more seed than the less adapted genotypes, resulting in an improvement in the next generation. In this way local cultivars developed after several generations of forage production and seed production in the same location.

Before 1950 several local cultivars existed in Norway, mainly in timothy and red clover, the two most commonly grown species (Vested 1952; Wexelsen 1951). A few of these local cultivars were distributed over a larger geographic area. Two such local cultivars were Grindstad timothy and Molstad red clover. Here we will give the short story of Grindstad timothy which was developed from a local cultivar to a major timothy variety.

19.2 The Grindstad story

The Grindstad timothy was developed on the Grindstad farm in Rakkestad. Rakkestad is located in the south-eastern part of Norway.

The first information we have about the use of timothy on the Grindstad farm is from the 1860s. At that time the neighbouring farm, Haslem, was used as an agricultural school. It imported seed of timothy from Scotland for use at the farm. The owner of Haslem was the nephew of the owner of the Grindstad farm. It was therefore quite natural that seed of the Scottish timothy was also spread to the Grindstad farm. It is likely that the Grindstad variety originated from this seed source. (Tollef Grindstad pers. comm. 1998 and 2009).

The first seed of Grindstad was sold in the 1890s. In the accounting books for 1898 one can find that the farm had an income of 69 NOK from the sale of Grindstad.

In 1914 the Royal Norwegian Society for Development started to organize forage seed production in Norway. After this date the seed production of Grindstad increased. In 1916 the first registered seed was sold. That year is considered as the 'birth year' of the variety. From that year and until today the Grindstad variety has been maintained on the Grindstad farm.

The seed of the Grindstad variety was maintained the same way as on other farms that produced their own seed. The normal practice was to set aside the best part of the meadow for seed. This could be done after one to a few years with forage production. The farmers used this seed to establish new meadows. In this system the plants best adapted to the local climate and management practice gave the highest seed yield and thus moved the population mean for adaptability up for each generation.

The timothy was used to produce hay. Commonly the farmers had one main harvest. The meadow was harvested rather late compared with today's standards. The regrowth was normally grazed. This was quite a gentle management of the meadow without any strong selection.

Over time and many generations Grindstad adapted to the climatic conditions and the management practice at the Grindstad farm.

In the early 1960s new scientifically developed varieties were approved which showed better yield results than Grindstad. This was first and foremost due to the variety 'Forus' that was approved in 1964. Forus was developed in the south-western part of Norway. Forus was the variety the farmers wanted to use and seed production of Grindstad dropped to a minimum in the mid-1960s.

Sometime in the early 1960s, Carl Fredrik Grindstad, the father of the present owner, changed his management of Grindstad to improve the variety. He had been inspired by a lecture by Professor

Erling Strand from the Agricultural University of Norway about crop improvement. Erling Strand helped Carl Fredrik Grindstad to change his management system.

Up to this period the most common practice to conserve the forage was as hay. It became more common to conserve the forage as direct cut silage. The use of silage increased from the early 1960s. The grass was cut with a flail harvester and put directly into the silo with a preservative without any pre-drying. The farmers also started to harvest the forage at an earlier development stage, and the number of cuts increased. This new management practice was a lot tougher for the grass sward.

In the new management system the Grindstad timothy was seeded in year 0. In years 1 and 2 the meadow was cut for silage and in year 3 they harvested seed. This seed was used to establish a new meadow in year 4 and so on. Each selection cycle lasted four years. This new management stressed the plants a lot more than the traditional hay harvest.

The first years after they started this management practice the Grindstad meadows were severely thinned and poor looking. The present owner, Tollef Grindstad, says during these years he was not very proud to live on the Grindstad farm. The Grindstad meadows looked poor for two to three selection cycles. The timothy plants were subjected to a severe selection pressure. The Grindstad timothy responded to this treatment and over the years the plant stand started to improve.

In the early 1980s Grindstad timothy started to give good results in the official variety tests.

In 1987 a second selection site close to Hamar was added. The winter climate at this location is more severe than in Rakkestad. The seed of Grindstad harvested on the Grindstad farm was sent to the Bjørke farm where a new meadow was established. This meadow was also harvested with three cuts per year, for two years, and seed was harvested the third year. This seed was sent back to the Grindstad farm where it was established and the cycle started again.

From the seed harvested at the Grindstad farm pre-basic seed was sent to Felleskjøpet for production of basic and certified seed.

Today Grindstad is the best timothy variety in southern Norway and in parts of Sweden and Finland. In 2008 more than 60% of timothy seed sold in Norway was of Grindstad.

19.3 The future

In 1993 Norway joined the UPOV Convention (the International Union for the Protection of New Varieties of Plants). The objective

of the Convention is the protection of new varieties of plants by an intellectual property right. To be approved on the Official Variety List in Norway all varieties, old and new, have to follow the regulations of UPOV. The varieties have to confer to the DUS requirements. A variety has to be distinct, uniform and stable.

The Grindstad variety has changed over time because of the method used to maintain it. Grindstad did not meet the 'stable' requirement of UPOV. Because of this requirement the Grindstad variety has now been 'frozen' as it was three years ago, and further development has started on a new breeding population that follows the same management practice as the 'old' Grindstad variety did for more than 40 years. This breeding population has got a new name and is kept separate from the Grindstad variety.

In a few years time a 'New Grindstad' may be entered into the official variety testing. And some time in the future a new variety from the Grindstad farm may be approved. But the 'New Grindstad' will get strong competition from the breeding companies in the Nordic countries, Boreal, DLF-Trifolium, Svalöf Weibull and Graminor. In any case the Grindstad variety will probably still be on the market for several years to come, with a good chance to celebrate its 100 years anniversary in 2016.

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20. On-Farm Management of Vegetables in Switzerland

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20.1 Introduction

Switzerland is a rather small country, composed of regions with very different climatic, soil and geographical conditions. This is reflected in high genetic variability expressed by the high number of landraces of different crops which have been cultivated in Switzerland.

As in most countries, decrease of the cultivation of landraces started very early. For cereals, this decrease started around 1930 and, as from 1950, hardly any landrace was still being cultivated. Most of these landraces have been collected and are conserved in the national genebank of Agroscope Changins-Wädenswil (ACW). A recent inventory of fruit trees showed that a high number of local varieties are still available. Their conservation is mainly assumed by private organizations in orchards distributed all over the country, with financial support from the Swiss government. The Swiss Commission for the Conservation of Cultivated Plants (CPC) carries out conservation of seeds and plants in accordance with the quality standards developed in their concepts for conservation of plant genetic resources.

The situation for vegetables and seed legumes was slightly different. Until 1980, several seed producers were active but their number progressively decreased. At the same time, more and more traditional varieties were replaced by F1 hybrid varieties. Agroscope-ACW collected these old and traditional varieties from 1980 onwards. Two types of varieties were collected, the old commercial varieties or varieties selected by individual seed producers and varieties from home gardens. At present, 252 varieties are on the positive list, in other words, varieties which have been selected in Switzerland or have been important for the development of a region and are conserved in Switzerland. For 126 varieties, the status still has to be defined and a duplicate check carried out by cultivating all the varieties of the same species in one trial.

There is still an interest in growing old varieties of vegetables and grain legumes. Three seed producers are specialized in

commercializing this type of variety. They are producing organic seeds, mainly for home gardens. One organization, Pro Specie Rara is stimulating on-farm conservation of all kinds of crops and especially vegetables and grain legumes. This conservation is carried out by volunteers, 'seed savers', and coordinated by a few paid professionals.

Some concrete examples of on-farm conservation of varieties, traditionally cultivated in a specific region of Switzerland, will be described in this contribution.

20.2 'Cardon épineux de Plainpalais'

In order to obtain more detailed information about the on-farm conservation of cardoon (*Cynara cardunculus* L.), Mr François Grosjean, farmer and seed producer in Geneva, was interviewed. He continues multiplying many varieties selected already by his father, especially cardoon. Only members of the family manage the 3.5 hectare farm.

In the past, he used to produce seeds for seed-sellers in Geneva. However, this business has been given up, because more and more markets and gardeners are buying F1 hybrid varieties. F. Grosjean is still selling seeds in neighbouring France. Since the local market of fresh vegetables is flourishing, he reconverted to direct-sale, selling his local varieties.

20.2.1 Origin

Already known by the Romans, cardoon was introduced by the Huguenot refugees in the Geneva region in the 16th century. It seems that it was not spread further north. Later, market gardeners selected the best plants for multiplication. The efforts undertaken since the end of World War II have allowed the selection of the variety 'Cardon épineux de Plainpalais'.

20.2.3 Varieties

About 15 varieties are present in the world, but their uses differ. In Geneva, the leaf stems are prepared for a typical meal, eaten at Christmas time. In other countries, cardoon is used in cooking, rather like a seasonal plant. In Geneva, the most important variety is the 'Cardon épineux de Plainpalais' also known under the name 'Cardon argenté de Plainpalais'. The leaves are brilliant green on top and silver matt underneath. F. Grosjean also multiplies a second landrace, the 'Cardon non épineux de Genève', which he selected. This landrace is a 'spineless' cultivar, which is much easier to handle.

20.2.4 Culture

The cardoon is sown or planted in May. Each plant requires an area of 1 m^2. In October/November the cardoon is blanched to soften the stems, i.e. it has to be covered with a black plastic bag or to be placed in a cellar in the dark for two to three weeks.

F. Grosjean explains his method: three weeks before selling, each plant is dug up and replanted in a special Handmade cardoon shelter. To hold it in place, each plant is fastened to branches of *Salix viminalis*, cultivated at the border of the field. Cultivation of cardoon requires little specialist cultivation, but a lot of manual work.

20.2.5 Selection

Cardoon is an allogamous biennial plant and can reach 1.5 to 1.8 m in the second year. To maintain these local varieties, the best plants are chosen for multiplication and are put aside during winter. In spring, they are replanted in the field. The flowers with the seeds are dried and threshed with a traditional machine.

20.2.6 Production today

Cardoon is a typical Genevan vegetable. Since 7 October 2003, the variety 'Cardon argenté de Plainpalais' benefits from the label 'Protected Designation of Origin (PDO)'. This label guarantees local production, in a given geographical region and using traditional methods. Cardoon is sold in different forms: fresh, blanched, precooked in jars or ready to warm up. In the Geneva region about 7 hectares are cultivated and produce approximately 100 to 130 t per year. The production is decreasing because the culture requires a lot of manual work, which cannot be mechanized. Cardoon is actually cultivated only by farmers who are passionate about the crop.

20.3 'Küttiger' carrot: history

The 'Küttiger' is one of the last carrot landraces (*Daucus carota* L.) still cultivated on-farm in Switzerland and is locally produced by farm women in the Region of Aarau, especially in the village of Küttingen. This local carrot has been passed on from generation to generation for many decades. Since 1978 the association 'Küttiger Landfrauenverein' maintains this landrace.

20.3.1 Cultivation background on-farm

In the past, carrots have been used as fodder carrots for horses and sold in Zurich, improving farmers' incomes. One part was stored over the winter time and eaten as vegetables. Aged farm women of the village have managed the production and multiplication. Today,

the 'Küttiger Landfrauenverein' produces about 800 to 1200 kg of carrots annually. The lower quality is still used as fodder and the rest is sold as a vegetable on the traditional carrot market, on the first Wednesday in November. The crop survives because of its intensive aromatic carrot taste, which is highly appreciated in this region.

20.3.2 Landrace description

The 'Küttiger' carrot has a white-yellowish conical shape having well-defined shoulders and tapering to a point at the tip, as is typical for primitive carrots (Archetype). The average weight of one carrot is 150-160 g.

20.3.3 Cultivation practice

In former times, 'Küttiger' carrots have been sown in February between rows of barley. When the barley was harvested, the carrot plants were about 15 cm high. Carrots in earlier times were bigger because they were mainly used as forage. Today, the carrots are sown later, in May/June. They are cultivated in heavier and stony soils, compared with modern varieties, which are sown preferably in sandy soils.

20.3.4 Selection

When the crop is harvested in autumn the best carrots are kept separate and stored until spring in an excavated hole in the garden and protected against mice with walnut leaves. Up to 50 plants are selected and replanted in April for seed production. Seed plants are usually grown in a garden to avoid cross-pollination. In July the ripe seeds are kept in a dry location until complete desiccation, before being threshed and cleaned.

20.4 Some garden vegetables

The great changes brought to agricultural systems after World War II acted as a powerful leveller and changed the way to produce and exchange food, especially vegetables. Mainly biennial allogamous vegetables used to be multiplied locally by specialized small companies and distributed by seed peddlers. After 1980, most of the vegetable seeds were imported and seed multiplication was abandoned. As a result, local vegetable landraces have disappeared. But some relicts still can be found in some regions or on family farms.

In the region of Nyon (Lake of Geneva) a few garden centres still sell seedlings of the famous lettuce 'Grasse de Morges' (*Lactuca sativa* L.). The multiplication of this variety is no longer carried out

in this region. This local variety survived because people are used to this vegetable; it is a softer lettuce than normal varieties found on the market.

In Grindelwald (Canton Bern) an aged woman still conserves a Swedish turnip (*Brassica napus* ssp. *napobrassica* L.), which used to be cultivated by her grandmother. This is a very special variety, with a long blue tuber. This is very remarkable because turnip is an allogamous plant!

At all times private home gardens cultivated beans (*Phaseolus vulgaris* L. var. *vulgaris*) for self-sufficiency. Beans are easy to grow and provide excellent nutritional value. This is why a large number of old traditional varieties remain in different regions of Switzerland. Popular are both uses: dry (pulse) and green bean (vegetable). In the Berner Oberland region, the variety 'Brienzer Chrugler' is a traditional old pole variety, productive and healthy with green, lightly mottled pods. In the Rhine Valley, the local bean 'Schweflerbohne' was sown between rows of maize and treated as a half-high pole bean, the plants twining round the maize stems. The 'Schweflerbohne' is a sulphur-coloured bean, which is usually dried, and seeds used for soup in winter time. The culture of 'Schweflerbohne' nearly disappeared because of virus problems. Today, the virus has been eliminated and healthy seeds have been given back to the local people.

20.5 Conclusion

Labels such as 'PDO', as for the cardoon in Geneva, can help in saving local vegetable production and local varieties. They also help consumers to identify crops as cultural or biological heritage material within a limited geographical area. But achieving and maintaining these labels require a lot of energy as well as financial support.

Traditional cultivars are highly esteemed due to their excellent quality and are not normally known outside their production area. Generally, small farmers or gardeners grow these varieties marginally. These growers continue to cultivate these crops mainly for cultural food traditions (e.g. *Cynara cardunculus, Daucus carota* and *Phaseolus vulgaris*).

Often landraces and local varieties are grown and maintained by old people. Few young people appreciate their biological and cultural importance. This makes it difficult to ensure or increase their cultivation, which would be important to conserve plant genetic resources. Another limitation to a more intensive use of landraces is the perception that modern cultivars are better producers. It is

also important to note that not many vegetable and seed producers, farmers and farmers' associations, were aware of the importance of the use of local landraces.

There is no information exchange, no support for multiplication and no support for promotion. Increasing vegetable producers' awareness about particular landraces and their importance seems a priority action to be carried out for on-farm conservation in Switzerland.

CPC and its members will help them and stimulate the on-farm conservation of vegetables and legumes with their coordination work, characterization and evaluation of plant genetic resources.

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21. Thatching with Long-Straw Wheat in Relation to On-Farm Conservation in England

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21.1 Introduction

Even today the popular image of rural England would include country cottages with thatched roofs. Thatch is again becoming seen by architects and the construction industry as a contemporary sustainable roofing material. Farmers represent the start of the supply chain for this specialist market, but it is important to understand the composition of this market so that necessary information on associated factors such as relevant policy frameworks is presented to provide context. This case study aims to present an overview of this specialist market in terms of its size, structure and scope before going on to consider the role of the farmer and the specific crops that are grown. Finally details are given of on-farm conservation and interactions with the *ex situ* plant genetic resources sector that are increasing opportunities in this sector.

21.2 Historical background

The use of plant materials as a roofing material has been traced back many centuries. A number of plant species have been employed largely depending on what was readily available in a particular locality. Cereal straw was used throughout England with heather (*Calluna vulgaris*) and sedge (*Cladium mariscus*) used in upland regions in north England and water reed (*Phragmites communis*) in East Anglia and particularly in Norfolk (English Heritage 2000). The best documentary and material evidence dates back to the late mediaeval period (Letts 1999) and strongly supports the view that straw from a range of cereals was used, including wheat, barley, oats and rye. Up until the early 1800s thatch remained the primary roofing material in England but the advent of improved rail transport systems led to more durable roofing materials such as clay tiles and slates from Wales becoming more widely available. The number of thatched properties in 1800 has been estimated at 957 246. This number is thought to be comprised of around 60% long-straw thatch, with the other types of thatch, i.e. combed wheat reed (west country), water reed (accessible wetlands) and heather thatch (northern counties) making up the rest. By 1862-3 the number had fallen slightly (841 861) but this masks considerable

regional variation with reductions in the order of 63% in the south-west and south-east and an increase of 42% in East Anglia (English Heritage 2000). The main losses were in heather thatch which was virtually wiped out. Both water reed and combed wheat reed thatch numbers are thought to have remained fairly stable, long-straw thatch was the big winner throughout most of England in the major arable cereal counties. There has never been a tradition of West country combed wheat reed in East Anglia, the Midlands or the southern counties so it is quite possible that 80% of the 841 861 buildings were long-straw thatched. The numbers went into steep decline at the beginning of the great agricultural depression (early 1870s), gathering pace through to World War I. Following World War II there were far fewer people available to work the land although expectations for self-sufficiency in food production were high. This coincided with rapid advances in farm mechanization and with it the expectation of reduced costs. The size of the farm labourer work force continued to fall rapidly as people moved to the cities looking for more secure and better paid jobs. These changes affected thatching in a number of ways. By 1960 the number of thatched properties had fallen to 34 662 and long-strawed thatch represents some 10% of this figure (English Heritage 2000).

21.3 Types of wheat used for straw thatch

There are two types of wheat that have been used for thatching and are still in use today. Firstly, rivet or coned wheat (*Triticum turgidum)* and secondly bread wheat (*Triticum aestivum).* Both types produce acceptable straw and thatchers and growers each have their own particular preferences. A comment from one thatcher states that "The straw from rivet wheats is of superior quality for thatching and lasts longer" while another said "That might be so but the rougher nodes make them harder to work with".

There are two methods used for thatching that differ in both the preparation of the straw and the method of application. Both types of wheat are suitable for either method. These methods reflect different local traditions among thatchers in different parts of the country that have existed for hundreds of years. Each method results in strikingly different looking roofs as a result (Table 21.1).

21.4 Current market and regulations

There are estimated to be in the order of 30 000 thatched properties in England today. These include cottages, barns and other farm buildings, windmills, watermills, churches, vicarages, shops, inns and garages as well as many civic buildings including libraries, village halls, bus

Table 21.1. Wheat thatching methods, their distributions and appearance.

	Long-straw	Combed wheat-reed
Method	Bundles of harvested wheat run through threshing unit which bruises the stems.	Wheat is combed by running the grain bearing part of the stem through combs to pull off the ears and thus harvest the grain.
Distribution	Southern England, East Anglia, the Midlands, Northumberland and the Boarders.	South-west England (Devon, west Dorset, the Blackmore Vale in Somerset / Dorset and parts of Cornwall).
Resulting Thatch	Shaggier/ softer texture, Gabled ends and eves. Often of steeper pitch. Mixture of heads and butts showing on the surface of thatch.	Dressier/ neater and more rounded. Cut to shape and no eves or eves. Butt ends of stems on surface of thatch.

shelters, bandstands and even a pedestrian bridge. Because of the increasing age of many of them, high proportions are now given listed status, which offers a degree of protection. Any proposed maintenance is subject to the approval of local authority conservation officers. Guidelines on thatch and thatching (English Heritage 2000) outline the expectations and basis on which any renovation, conservation or remedial work can be carried out. These guidelines are used by the various local authorities around the UK to help in dealing with cases in their particular regions where the aim is to preserve the character of properties in terms of their own integral history and that of the locality in which they are located. Separate consideration may be required in the case of conservation areas or national parks, e.g. Broadland in Norfolk (1993) and the New Forest in Hampshire. The clear message from all these guidelines is that any change of thatching material or method of thatching may well require listed building consent that requires replacing 'like with like'. Thatching is an expensive option and local authorities are charged to provide clear documentation as to their particular planning policies and guidelines and examples from Devon (2003) and South Cambridgeshire (2007) District Councils are two such examples.

The difference in materials and methods employed by thatchers is only one example of the great diversity of this market. It is estimated that there are still in the region of 800 thatchers in business in England today, belonging to upwards of ten associations. Even today thatch is a subject that generates many differing and at times opposing views as to approaches and policies. An analysis of this situation is outside the scope of this case study but serves to underline how deeply emotive thatching is within rural England.

The fire risk of thatch is a significant concern. Even today reports of thatched buildings catching fire will make the regional news. The Globe Theatre in London offers an interesting illustration of the topic. The original theatre built in 1598 was co-owned by William Shakespeare and was the theatre where many of his plays were first

performed. It is generally thought to have been thatched in water reed but archaeological evidence of a sample of thatch found on a dig at the original site plus descriptions of the thatch before the fire suggest wheat straw was also used. The original theatre lost its thatched roof in 1613 following the firing of a canon during a production of Henry VIII. Following the Great Fire of London in 1666 in which an estimated 13 000 largely timber-framed and thatched buildings were lost, thatch roofs were banned in perpetuity in the city of London. This ban was only lifted in 1994 when plans for the New Globe Theatre based on the original design were granted. Better building regulations and the introduction of improved fire retardants have resulted in more local authorities beginning to allow thatch to be used on new buildings. The number is modest but is responsible for a 5% rise in the number of thatched buildings.

21.5 On-farm conservation

In the 1830s Le Couteur described some 150 named wheat landrace varieties (Le Couteur 1836). In the 1920s and 1934 John Percival built up a unique collection of some 63 wheats from across the UK. These were characterized and classified along with notes and references to many more that were already by that time no longer available (Percival 1934). These covered a range of different types from early landraces through selections to the new varieties of the day that were the result of deliberate crossing of different forms. Many of the earlier landraces and landrace selections had a local reference within their names such as villages e.g. Chidham, Browick or county names such as Devon Red Rough Chaff, Montgomery Red, and Essex Victory. It is also important to note the number of wheat varieties that were coming from the near continent. There has always been an interest in material from other regions and both Le Couteur and Percival made selections from fields of crops in other countries. Particularly prevalent are references to France, Belgium, The Netherlands, Germany, Sweden and occasionally Spain. The interest was mutual and a good number of English wheats were grown on the near continent (Vilmorin-Andrieux 1880). Le Couteur and Percival's collections provide a clear baseline from the recent past as to the diversity of wheat cultivars during this important time of transition in the wheat crop in England. The rapid changes in farming following World War II resulted in the majority of these older forms being dropped from production and rapidly falling out of common knowledge. An assessment of landrace wheats extant in the UK in 2003 recorded just three that were used for thatching (Table 21.2) (Scholten et al. 2003).

Table 22.2. On-farm conservation of long-strawed landrace wheats grown for thatching in England.

Scholten et al. 2003			
Variety	**Number of farmers**	**Hectares**	**Location**
Squarehead's Master	7	221	S. England
Rampton Rivet	3	10.2	S. England
Rivet	2	10.2	
April Bearded	2	10.1	S. England
New information			
Victoria d'Automne	1		East Anglia

While this was not an exhaustive survey it does provide a stark example of how quickly landrace material falls out of common use. With such small numbers of farmers maintaining these landraces they are increasingly vulnerable to seed failure as farmers mostly sow all their seed and lack the capacity to store seed for more than a few years. Indeed, in more than one case in the 2003 assessment, the landrace crops reported had originated from an *ex situ* collection in the recent past.

To date some 50 examples of English wheats pre-World War II have been successfully identified through literature searches (Le Couteur 1836; Vilmorin-Andrieux 1880; Percival 1934; Zeven 1990) as represented in the BBSRC small grain cereals collection based at the John Innes Centre. In response to the assessment by Scholten et al. in 2003, a series of small drilled plots of these wheats were grown for assessment and growers and thatchers invited to look at the material and make selections of lines that they might be interested in evaluating themselves. The husbandry of these plots is similar to how they would have been managed, i.e. under reduced nitrogen and at low planting densities. This encourages a more open and airy canopy as the crop comes into head and keeps the stems thin and stiffer as a result. The scheme has been running for some three years with a number of landraces being taken up by farmers for evaluation. Year-on-year assessment for lodging is providing useful data to help in the selection process. Farmers are also interested in any local connection associated with the material, which might help in marketing the produce for thatching or seed. It is too early to tell whether these older lines display any features that will result in their wide-scale use for thatching or possibly other purposes but they have a chance. They are also being assessed for their suitability for trialling under organic farming regimes. Another approach involves the growing of mixtures of different cereals (wheat and rye) known traditionally as maslin, as was practised in mediaeval times (Letts 1999). New maslin mixes based on different landrace cereals are being investigated with a view

to monitoring variation in harvested straw in different years and the longevity of the resulting thatch (John Letts, personal communication).

On-farm conservation of long-strawed wheat for thatching is therefore benefiting from the proactive engagement with the *ex situ* genetic resources community, which offers the opportunity to access a range of older forms that have fallen out of common knowledge in recent decades. The market for the product remains steady and is underpinned by strong regulation and farmers' expertise although the threat from cheaper imported straw is causing concern in some quarters. The implementation of the recent seed legislation concerning conservation varieties is intended to support such niche markets as old long-straw wheats. The growing move towards more sustainability within the farming sector includes the increasing use of locally produced materials, and the savings in associated transportation costs and lowering of inputs in crop production may translate into an increase in numbers of farmers becoming involved in this sector. The crop remains a challenge but to farmers with long-term expertise in this area this is nothing new.

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22. Regional and Crop-Specific Survey: Grapevine Landraces in Douro and Colares, Portugal

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22.1 Introduction

The Mediterranean Region is the grapevine's primary centre of diversity (Zeven and de Wet 1982) and Portugal is a high priority for landrace conservation, probably because it is one of the European countries where landraces are still grown traditionally (IPGRI 1998). The richness of Portuguese landraces and the high genetic erosion to which they are subject are recognized in the national biodiversity strategy and action plan (Ministry of Agriculture, Fisheries and Forestry 2001). However, a comprehensive list of grapevine landraces, their distribution and characterization does not exist and implementation of measures to preserve traditional knowledge is considered low priority (ICN 2001).

Grapevine production is of fundamental importance to the Portuguese economy (Ministry of Agriculture, Fisheries and Forestry 2005). However, in recent years selection has tended to be focused on a small number of bred varieties, which has resulted in high levels of genetic erosion. Currently in Portugal the general list of grapevine varieties (European Regulation No. 3369/92, 24 November) recognizes 345 named varieties compared with 1482 found by Pinto-de-Menezes (1889), which suggests a significant loss of genetic diversity. Moreover, only 45 varieties are routinely involved in selection work meaning that approximately 300 further varieties are underutilized. Historically each farmer used to grow a mixture of vine varieties but this is becoming increasingly rare (Eiras-Dias et al. 1998). The occurrence of fires, a natural phenomenon in Mediterranean climates, highly exacerbated by human interference, is another factor threatening grapevine diversity (Davis et al. 1994). Portuguese *V. vinifera* L. germplasm is currently conserved *ex situ* by four national institutions (IPGRI 2005).

This chapter aims to illustrate the production of a regional and crop-specific inventory, focusing on grapevine landraces in Portugal regions of Douro and Colares. Furthermore, the survey aims to promote on-farm conservation of grapevine and raise the profile of agro-biodiversity conservation and use within the Portuguese National Biodiversity Action Plan (ICN 2001), to provide a sound foundation for future diversity assessment as part of meeting the CBD 2010 target (CBD 2004) and by illustration to indicate how a regional and crop-specific inventory can be undertaken.

22.2 Materials and methods

The choice of Douro and Colares regions (see Figure 22.1) was based on the relatively high number of landraces expected to be present, based on local specialist's viticultural knowledge (J.E. Eiras-Dias, Torres Vedras, 2005, personal communication). Douro region occupies about 250 000 hectares with variable sized

Figure 22.1. Map of mainland Portugal showing Douro and Colares regions.

properties and has a diverse climate and edaphic composition (Filipe et al. 1998) stretching back to ancient times (Cincinnato da Costa 1900; Sequeira 1938). Within the region two administrative regulations, the 'Casa do Douro viticulture registry' and the 'plan for integrated rural development of Trás-os-Montes' regulate wine quantity, safeguard the regional wines' distinctiveness and promote modern viticulture, but the latter is limited in application to five specific varieties, bred by public and private companies (Filipe et al. 1998). Colares is a much smaller wine-producing region, typically with small farms of < 1 ha, sandy and clay soils, and a Mediterranean climate with a strong Atlantic influence (Filipe et al. 1998). Again historical records indicate ancient and highly diverse grapevine cultivation (Cruz 1908; Barros 1938; Cincinnato da Costa 1900; Paulo 1992). However, in recent years there has been a decline of the favoured sandy soil (Barros 1938; Filipe et al. 1998).

Within the two target regions farms were selected to ensure diverse locations in terms of altitude, soil type and climatic conditions, but actual farms within each distinctive ecogeographic area were selected randomly. Each farmer was interviewed using mixed questionnaires of open and closed questions (see Appendix 22.1). Diversity on individual farms within regions and between regions was measured in terms of richness and evenness of landraces, using the Shannon Weiner index of diversity (Shannon 1948). Descriptive analysis using SPSS Version 10.0 (SPSS Inc., Chicago, Illinois, USA) was undertaken using t-test and a similarity matrix of farms' landrace composition was built, calculating simple matching coefficient based on the presence or absence of each landrace. Mantel's test (Mantel 1967) was used to measure the correlation between these matrices, based on 250 permutations of the data, using NTSYS (Version 2.0) software.

22.3 Results

A total number of 86 grapevine landraces were found, 71 in Douro and 20 in Colares (see Appendix 22.2). Table 22.1 shows that considering both regions 46.51% of landraces were restricted to a single farm, while four landraces were found to grow on more than 20 farms. This strong hierarchical spatial distribution of landraces has been found elsewhere in previous studies (Tesfaye and Ludders 2003) with a small number of very common landraces throughout the regions and a larger number of rarer landraces, revealing landraces' relative importance to farmers, which is closely related to a differential dispersal of landrace material.

Table 22.1. Grapevine landraces distribution.

	Douro		Colares		Both Regions	
Number of Landraces Grown by Farmer	Landrace number	Percent Landraces	Landrace number	Percent Landraces	Landrace number	Percent Landraces
1	33	46.48	11	55	40	46.51
2 – 10	31	43.66	9	45	39	45.35
11 – 20	3	4.23	0	0	3	3.49
> 20	4	5.63	-	-	4	4.65
Total	71	100	20	100	86	100

In both regions the number of landraces cultivated is higher than the number of modern cultivars. Colares region has the highest percentage of modern cultivars (23.08%) while the percentage area cultivated with landraces (66.96%) and the Shannon Wiener diversity index (2.37) are higher in Douro (see Table 22.2). At farm level, Colares region has on average 4.50 cultivated landraces per farm, significantly lower than the average in Douro which has 9.33 landraces per farm. Significantly higher mean values are obtained for the average Shannon Wiener diversity indices for Douro (1.80) (Table 22.2). Although overall Douro region has a larger number of landraces, the area cultivated is dominated by just four landraces. Both the Colares and Douro regions retain significant landrace richness. Although Douro region has higher overall landrace diversity, previously unrecognized landraces were found in Colares, indicating high unexplored diversity in this region.

Table 22.2. Grapevine landraces richness and evenness.

	Colares		Douro		Both regions	
	Farm Av.	Region	Farm Av.	Region	Farm Av.	Region
Total number of surveyed varieties	5.10*	26	10.33*	85	9.12	103
% area cultivated with landraces (ha)	85.45	32.36	89.63	66.96	88.66	65.96
Richness	4.50*	20 (76.92%)	9.33*	71 (83.53%)	8.21	86 (83.50%)
Shannon Wiener Index	0.99*	2.07	1.80*	2.37	1.61	2.44

Note: *significant difference of means at 5% level with t-test.

The correlation between geographical distance between farms and landrace compositional similarity calculated using Mantel's

test was significantly negative (r = -0.19276; p = 0.0199). This agrees with the fact that 67.44% of the farmers admitted to exchanging grapevine vegetative material, preferably with neighbouring farmers, as was also found elsewhere by Sperling and Loevinsohn (1993) (see Figure 22.2).

Factors influencing on-farm landrace diversity

Landrace diversity on-farm was found to be influenced by several factors, which are often interrelated. In agreement with Gauchan et al. (2005), selling grapevine products to a cooperative enhances the likelihood of high on-farm landrace diversity, as farmers have a market for variety mixtures, which diminishes specialization pressures. Selling grapevine products to a main commercial market is highly correlated with larger total cultivated area and high grapevine income, since farmers not aiming to sell to this market have smaller cultivated areas and cultivate other crops besides grapevine.

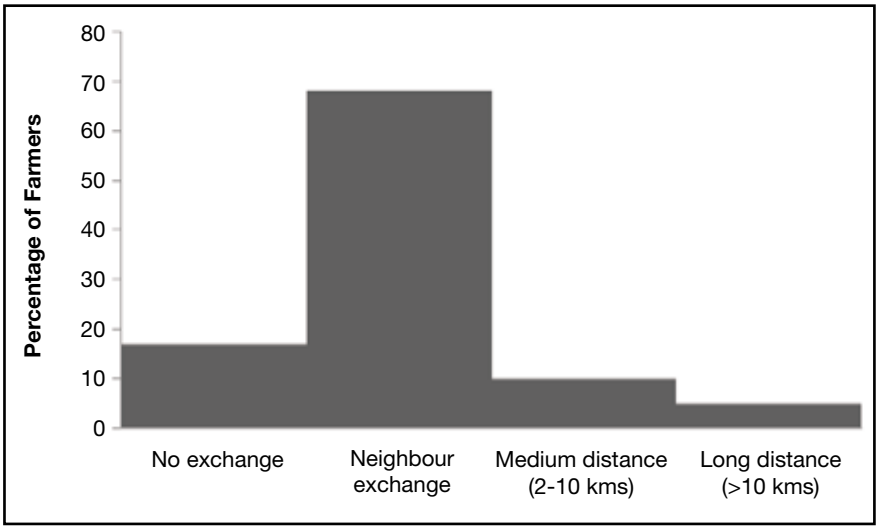

Figure 22.2. Farmer exchange of grapevine.

The farms' physical heterogeneity was found to be associated with higher on-farm landrace diversity, as found by Gauchan et al. (2005). Especially in Douro region, the range of conditions and abiotic pressures makes landrace diversity an unquestionable advantage, with each variety being adapted to different agro-environmental niches. However, in contrast to the study by Negri (2004) farmers who use herbicides and/or pesticides are more likely

to cultivate a high number of landraces, particularly in Douro. Gauchan et al. (2005) argued that this may facilitate the cultivation of diverse varieties with different biotic and abiotic susceptibilities and requirements. Moreover, increased farmer association with non-governmental organizations is linked to low on-farm landrace diversity, and this may be explained by the fact that the majority of non-governmental organizations in Douro are promoters of integrated production. Farmers with higher levels of education were less likely to maintain landraces, particularly in Douro. It was also noted that farmers interviewed who had higher education were usually engineers in agricultural sciences who also performed more effectively at selling their produce in the commercial market.

Inventory of farmers' motivations for cultivating landraces
In Colares the majority of farmers cultivate grapevines as a leisure activity, without profit being a critical motivation (see Figure 22.3). However, in Douro wine quality is the most common motivation for landrace cultivation (see Figure 22.4). This region has a long history and tradition of recognized wine quality, and strong administrative procedures to maintain that quality. However, the three motivation categories, heirloom value, external reasons and preference to cultivate landraces without having any specific justification make up 42.3% of farmers' reasons for continued landrace cultivation.

Perceived threats and proposals for grapevine diversity maintenance
The major threat to continued landrace diversity is labour scarcity, labour cost and ageing farming population. In Colares the bulk of farmers (70%) plan to maintain grapevine landrace production, however, 80% think that when they retire landrace production will not continue. The ever-increasing property value due to urbanization and tourism pressure is a strong disincentive for grapevine cultivation and the continued cultivation of landraces. However, it was thought that 'tourist' value could be used to maintain grapevine diversity through links to agro-tourism projects. Maintenance of landrace cultivation by some farmers is also threatened by the rise of farm-level costs associated with maintenance of diversity, cultivating multiple landraces is more time-consuming and involves attention to laborious local regulations associated with certain historic landraces' cultivation. Therefore, it is perhaps pertinent to question in this case the link between the maintenance of traditional farming systems and the landrace diversity maintained within them. It would appear, as was found in Greece by Nikolaou (2003), that local legislation enacted to secure landrace diversity may be having the opposite effect.

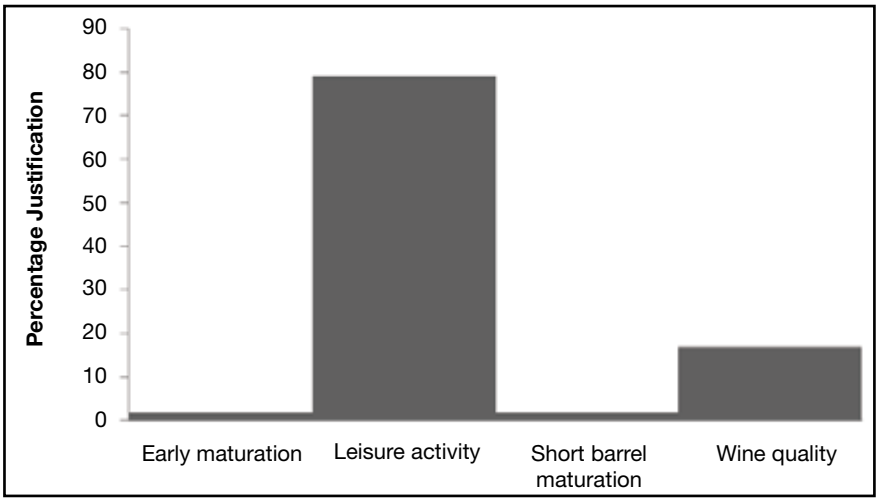

Figure 22.3. Farmer's motivation for growing landraces in Colares.

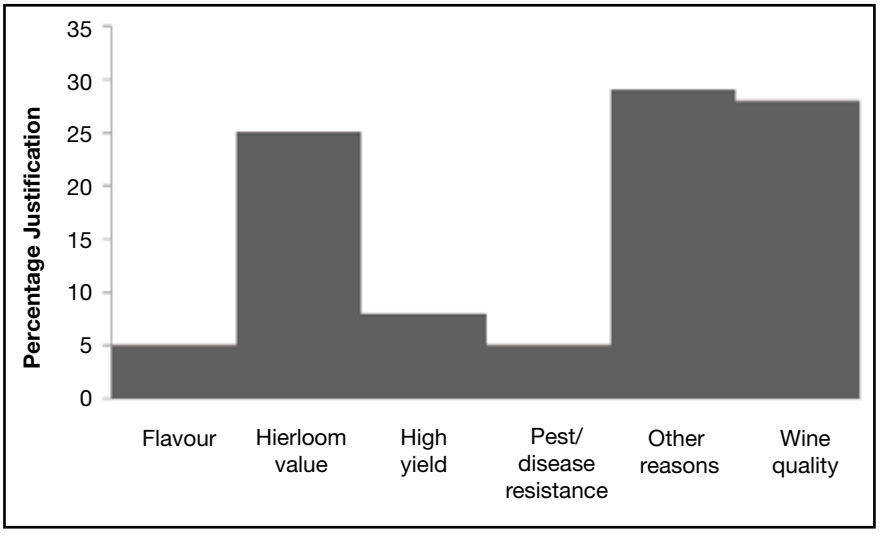

Figure 22.4. Farmer's motivation for growing landraces in Douro.

In Douro the majority of farmers (54.6%) believe grapevine production will be continued on their property after they retire. However, the most visible threat to grapevine diversity is increased farmer specialization on a few landraces that are easily marketable. The selection of these landraces is associated with regional administrative procedures, varieties' availability in nurseries, outstanding wine quality provided by some varieties and absence of knowledge of alternative varieties.

Many small-scale farmers often refer to the possibility of quitting grapevine production or consider growing more modern varieties to face decreases in grape unit selling price and rises in labour price. Although economic incentives for traditional agricultural landscapes exist they do not include grapevine landrace cultivation. However, although this strategy could work initially, it would not be sensible to rely entirely on subsidies because of their intrinsic lack of sustainability, and tourism in the astonishing landscapes linked to agro-tourism may offer a better model for conservation of genetic diversity.

Farmers were questioned about *in situ* and *ex situ* conservation of grapevine diversity but demonstrated no knowledge of any on-going activities locally or nationally. Following a literature review (ICN 2001, 2005; Ministry of Agriculture, Fisheries and Forestry 2001) it was found that *ex situ* collections of grapevine germplasm are held by the four Portuguese institutions and 69 of the 86 surveyed landraces are already conserved *ex situ* but 17 landraces currently remain without any form of conservation. Although further efforts are needed to confirm the distinct identity of these landraces, considering the small samples used in this research due to time constraints, this result indicates that more conservation efforts are needed to assure the maintenance of such a diverse heritage.

22.4 Discussion

Landrace diversity was found to be still relatively high in both surveyed areas, it was distributed according to spatial abundance hierarchical patterns and there was evidence of short distance exchange nets. On-farm diversity is positively correlated with a weak relationship between farmers and markets, farm agro-ecological heterogeneity and ease of farmer access to farming materials. The farmers' motivations for landrace cultivation are primarily hobby leisure interest and wine quality in Colares and Douro respectively. The major threats to landrace maintenance, which are closely related to the identified motivations, are in Colares the lack of interest of younger generations combined with low economic rewards, and in Douro specialization in a few successful marketable varieties. The surveyed landraces were found to be in both regions 'under-conserved' and there is a need for urgent targeted *ex situ* and *in situ* on-farm conservation action. Further details of the analysis and discussion can be found in Cardoso and Maxted (2008).

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Appendix 22.1. Questionnaire used to collate landrace-associated knowledge from farmers.

1. Interviewer identification and contacts

1.1. Name:

1.2. Address:

1.3. Telephone: 1.4. E-mail address:

Region: _____ Questionnaire number: _____

2. Farmer identification and contacts

2.1. Name: _____

2.2. Address: _____

2.3. Village: _____ 2.4. Telephone: _____

E-mail address: _____

3. Farmer information

3.1. What is your age range? ☐20 – 30 ☐31 – 45 ☐46 – 60 ☐More than 60

3.2. Gender: ☐F ☐M

3.3. What is your education level?

☐Basic level (1st to 9th grade)

☐High school (10th to 12th grade)

☐Higher education (University or Technical Institute)

3.4. What are your income-generating activities?

☐Farming alone

☐Mainly farming and others additionally

☐Mainly others and farming additionally

4. Grapevine varieties

4.1. What area is cultivated with grapevine? _____ m^2

4.2. Which grapevine varieties do you grow? (see following table)

4.3. What is the area cultivated by each variety? (see following table)

4.4. How did you obtain them? (see following table)

		Names of cultivated varieties	Cultivated area (m^2)	Source			
				Government	Private company	Other farmer	Vegetative material selected by you from plants you grew previously
Modern varieties							
Landraces	1						
	2						
	3						
	4						
	5						

4.5. How do you distinguish this variety?

1. _____
2. _____
3. _____
4. _____
5. _____

5. Details of grapevine landraces cultivation

	Varieties				
	1	2	3	4	5
5.1. Do you know where this variety is grown in the country?					
• Only in this region					
• In a couple of regions (number)					
Specify: _____					
_____					
• All over the country					
5.2. How long has this variety been grown in general?					
5.3. How long have you been growing this variety?					
5.4. What do you use this variety for?					
• Wine production					
• Table grapes					
• Raisins					
• Other (specify)					
5.5. Does the cultivation of this variety require any special procedure in comparison with the modern cultivars? (tick if yes)					
5.5.1. If yes, specify.					
_____					
_____					
5.6. Does the cultivation of this variety require recruitment of extra personnel in comparison with the modern cultivars? (tick if yes)					

5.7. What are your reasons for growing this variety?

• Good market price by unit					
• Good yield					
• Resistance to abiotic stresses					
- Altitude					
- Climate					
- Soil type					
- Water stress					
• Resistance to pests and diseases					
• Competitive ability					
• Good characteristics for wine production					
• Others					

Specify: _____

_____

6. Farm and farming system details

6.1. What is the total cultivated area (grapevine and all the other crops)? _____ m^2

6.2. Is the area where you grow grapevine homogeneous (time and/or space) in terms of:

6.2.1. Climate ☐ Yes ☐ No

6.2.2. Altitude ☐ Yes ☐ No

6.2.3. Soil type ☐ Yes ☐ No

6.2.4. Water availability ☐ Yes ☐ No

6.3. Do you apply fertilizers on the area cultivated with grapevine? ☐ Yes ☐ No

☐ On all the cultivated area ☐ On modern varieties area

☐ On landraces area ☐ On some landraces area

6.4. Do you apply herbicides on the area cultivated with grapevine? ☐ Yes ☐ No

☐ On all the cultivated area ☐ On modern varieties area

☐ On landraces area ☐ On some landraces area

6.5. Do you use an irrigation system on the area cultivated with grapevine? ☐ Yes ☐ No

☐ On all the cultivated area ☐ On modern varieties area

☐ On landraces area ☐ On some landraces area

6.6. Do you use mechanization on the area cultivated with grapevine? ☐ Yes ☐ No

☐ On all the cultivated area ☐ On modern varieties area

☐ On landraces area ☐ On some landraces area

7. Production and market accessibility

7.1. How do you market the products of your farm (see table)?

	Self-consumption	Sell on a local market	Sell to a cooperative	Sell on a main market
Grapevine products				
Other products				

7.2. What is the importance of grapevine income among all the products on the farm?

☐ Main income ☐ Median income ☐ Low income

7.3. The income generated by grapevine modern varieties is:

☐ Higher than the income generated by grapevine landraces.

☐ Similar to the income generated by grapevine landraces.

☐ Lower than the income generated by grapevine landraces.

7.4. Characterize the accessibility between the farm and the nearest selling place in terms of distance and/or road quality.

☐ Easy ☐ Moderate ☐ Difficult

7.5. Characterize the facility of access to farming materials (pesticides, herbicides, machines, irrigation devices)

☐ Easy ☐ Moderate ☐ Difficult

8. Information and material flow

8.1. Do you take advice from:

☐ Agronomists from governmental institutions

☐ Other farmers

☐ Non-governmental institutions

8.2. Are you part of some kind of farmers' association?

☐ No ☐ Yes, specify:_____

8.3. Do you have any external incentives to grow any specific traditional grapevine variety?

☐ Government

☐ NGO

☐ Others, specify:_____

8.4. Do you exchange grapevine material with other farmers?

☐ Neighbours ☐ Moderate distance ☐ Long distance

9. Time perspective

9.1. What varieties do you know your neighbours grow?

_____

9.2. Are there any varieties that were grown historically but no longer?

_____

9.3. When and why did they disappear?

_____

9.4. If you opted not to grow existing landraces, list which landraces and the reasons.

_____

_____

9.5. As regards grapevine varieties grown on your farm, what are your plans for the future?

☐ Undecided

☐ Maintain as it is now

☐ Grow more modern varieties

☐ Grow more landraces

9.6. When you stop farming what are the plans for the farm?

_____

_____

_____

Appendix 22.2. Grapevine landraces recorded.

Landrace Name	Known Synonyms	Berry Colour	Number of Farms	Region
Alfrocheiro	Alfrocheiro Preto	Red	1	Colares
Alicante Branco	Uva Rei, Boal de Alicante, Boal Cachudo (Douro) Branco Conceição, Pérola	White	1	Douro
Alicante Rosa	Not present in the synonyms list	_	1	Douro
Alvarelhão	Brancelho, Brancelhão, Pirraúvo	Red	2	Douro
Aragonez	Tinta Roriz, Tinta de Santiago	Red	23	Douro
Arinto	Pedernã, Arinto (Bucelas), Pé de Perdiz Branco , Chapeludo, (tirar), Azal Espanhol, Azal Galego, Branco Espanhol, Arinto (Anadia)	White	4	Colares (3) Douro (1)
Barca	Tinta da Barca	Red	6	Douro
Bastardo	Bastardinho	Red	3	Douro
Bastardo Branco	No known synonyms	White	1	Douro
Bastardo Roxo	No known synonyms	Rosé	1	Douro
Boal	Not present in the synonyms list	-	1	Colares
Branco Guimarães	No known synonyms	White	1	Douro
Calmão	Not present in the synonyms list	_	1	Douro
Carrega Tinto	No known synonyms	Red	1	Douro
Castelão	João de Santarém, Periquita, Castelão Francês	Red	2	Douro
Cerceal Branco	No known synonyms	White	3	Douro
Côdega De Larinho	No known synonyms	White	5	Douro
Cornifesto	Cornifesto Tinto	Red	2	Douro
Cruzinha	Not present in the synonyms list	_	1	Douro
Diagalves	Formosa, Carnal, Dependura, Formosa Dourada, Fernan Fer, Murecana, Pendura	White	6	Colares (1) Douro (5)
Dona Branca	No known synonyms	White	4	Douro
Donzelinho	Not present in the synonyms list	_	1	Douro
Donzelinho Branco	No known synonyms	White	1	Douro
Donzelinho Tinto	No known synonyms	Red	1	Douro
Espadeiro	Espadeiro Tinto, Padeiro, Cinza, Espadal	Red	1	Douro
Estreito Macio	Estreito ou Rabigato	White	1	Douro
Farrampilho	Not present in the synonyms list	_	1	Colares
Fernão Pires	Maria Gomes	White	8	Colares (2) Douro (6)
Ferral	No known synonyms	Red	3	Colares (1) Douro (2)
Flor Do Douro	Not present in the synonyms list	_	1	Douro

Landrace Name	Known Synonyms	Berry Colour	Number of Farms	Region
Folgasão	No known synonyms	Red	2	Douro
Galego	No known synonyms	Red	1	Colares
Galego Dourado	No known synonyms	White	2	Colares
Gorda	Tinta Gorda	Red	1	Douro
Gouveio	Verdelho (Douro)	White	7	Douro
Jampal	No known synonyms	White	3	Colares
João Pais	Not present in the synonyms list	_	1	Colares
Lourinha	Not present in the synonyms list	_	1	Douro
Malvasia	No known synonyms	White	6	Colares
Malvasia De Lisboa	Not present in the synonyms list	_	1	Douro
Malvasia Fina	Boal (Madeira), Boal Branco (Algarve), Arinto-do -Dão, Assario Branco, Arinto Galego, Boal Cachudo (Ribatejo)	White	25	Douro
Malvasia Preta	Moreto (Dão)	Red	4	Douro
Malvasia Rei	Seminário, Assario (Alentejo), Listrão, Pérola (Alentejo), Moscatel Carré, Grés, Olho de Lebre	White	2	Douro
Molar	No known synonyms	Red	4	Colares
Moreto	No known synonyms	Red	3	Douro
Moscatel	Not present in the synonyms list	_	2	Colares
Moscatel De Hamburgo	Not present in the synonyms list	_	5	Douro
Moscatel Galego	Not present in the synonyms list	_	6	Douro
Moscatel Galego Branco	Moscatel (Douro), Moscatel de Bago Miúdo	White	4	Douro
Moscatel Nunes	Moscatel Branco	White	2	Douro
Moscatel Preto	Not present in the synonyms list	_	2	Douro
Mourisco	No known synonyms	Red	17	Douro
Mourisco De Semente	No known synonyms	Red	3	Douro
Pinheira Roxa	No known synonyms	Rosé	1	Douro
Preto Martinho	No known synonyms	Red	4	Douro
Rabigato	No known synonyms	White	1	Douro
Rabigato Franco	Rabigato Francês, Rabigato Branco	White	1	Douro
Rabilonga	Not present in the synonyms list	_	1	Colares
Rabo De Ovelha	Medock, Rabigato (Vinho Verde), Rabo de Gato, Rabisgato, Rabo de Carneiro	White	1	Colares
Ramisco	No known synonyms	Red	6	Colares

Landrace Name	Known Synonyms	Berry Colour	Number of Farms	Region
Ratinho	Boal Ratinho, Branco sem Nome, Malvasia de Tomar, Boal Doce	White	1	Douro
Roxo Flor	Roxo de Vila Flor	Rosé	1	Douro
Rufete	Tinta Pinheira, Penamacor	Red	5	Douro
Santareno	Santarém	Red	6	Colares
Sarigo	No known synonyms	White	1	Douro
Semilão	No known synonyms	White	1	Douro
Síria	Crato Branco, Alva, Posto Branco (Douro), Côdega, Alvadurão do Dão, Roupeiro	_	9	Douro
Sousão	Sousão Forte, Sousão de Comer, Sousão Vermelho	Red	2	Douro
Sultana	Not present in the synonyms list	_	1	Douro
Tinta Aguiar	No known synonyms	Red	1	Douro
Tinta Barroca	No known synonyms	Red	27	Douro
Tinta Carvalha	No known synonyms	Red	9	Douro
Tinta Corada	Not present in the synonyms list	_	1	Douro
Tinta Francisca	No known synonyms	Red	3	Douro
Tinto Cão	Padeiro (Basto), Tinto Mata	Red	8	Douro
Tintureira	Not present in the synonyms list	_	1	Colares
Touriga Fêmea	Touriga Brasileira	Red	1	Douro
Touriga Franca	Touriga Francesa	Red	26	Douro
Touriga Nacional	Preto Mortágua, Azal Espanhol	Red	16	Douro
Trincadeira	Tinta Amarela, Trincadeira Preta, Crato Preto, Folha de Abóbora, Mortágua, Espadeiro (Setúbal), Torneiro, Negreda, Castelão (Cova da Beira)	Red	15	Colares (1) Douro (14)
Uva Melão	Not present in the synonyms list	_	1	Douro
Uva Tinta	Not present in the synonyms list	_	1	Douro
Uvas Sem Carunha	Not present in the synonyms list	_	1	Douro
Verdial Branco	No known synonyms	White	1	Douro
Viosinho	No known synonyms	White	5	Douro
Vital	Boal Bonifácio, Malvasia Corada	White	3	Douro

23. Community-based Landrace Conservation: Lentils of Eglouvi, Lefkada

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23.1 Introduction

Eglouvi is one of the highest mountain communities of the island of Lefkada, Greece, at an altitude of 730 m with a higher cultivated area at 800-950 m. The climate is wet Mediterranean, having mild winters with increased rainfall (700-900 mm/year) and very hot summers with cool breezes. The island and communities' relative isolation make it one of the most important areas for on-farm conservation in the country (FAO 1996) and it is also listed in the areas for Diversity of Landscapes (Stavropoulos et al. 1992).

Although the community maintains a range of important landraces, e.g. cabbage, grass pea, grapevine and durum wheat, it is most famous for the *Eglouvi lentil* landrace, a mixed population belonging to *Lens culinaris* M. subsp. *microsperma*. The first record of the landrace appeared in historical data around 1717 (Rontoyiannis 1980) but its presence in the area is much older. Since 1992 it has been conserved *ex situ* at the Institute of Fodder Crops in Larissa and ICARDA facilities (collection number ILL 293) where it has been used in breeding programmes. It is included in the official lists of landraces facing genetic erosion (MINAGRIC 1994 as amended in 2001).

In the summer of 2003 the landrace was surveyed to identify current cultivation in the community and review on-farm conservation activities and the socio-economic profile of the farmers (conservators) using criteria defined by Campagne (1996) and Abdelhakim (1997) including: description of the farming practices, seed exchange system, constraints and identification of on-farm conservation priorities. An Integrated Rural Development Programme was being implementation on the island (ECOPLAN 2000) that could be used to implement a complementary approach to on-farm conservation as outlined by Maxted et al. (2002).

23.2 Methodological approach

The method of Almekinders and Louwaars (1999) was adapted and a joint survey questionnaire for baseline and seed system survey was used, consisting of both structured and open-ended questions. The questionnaire included questions on the general structural

characteristics of the farmer household and more specific questions related to the farming and seed system. Finally, a simple descriptive statistical analysis was applied. Literature was collected from the local public and private libraries of the island, and official documents of the local authorities such as the Directorate of Agricultural Development of Lefkada Prefecture and the Municipality of Karya.

A preliminary estimation of the possible sample size using data from the 2001 National Statistical Service and a study from the University of Thessaly (1997) based on MINAGRIC Farmer Records proved inaccurate as during site visits a significant number of producers were not found to be included in the official list. Almekinders and Louwaars (1999) proposed a selection of every fourth or fifth house in the village or along the road, and in case of absences the neighbouring house could be selected. However, only three farmer interviews could be carried out each day because farmers were in the fields for much of the day and unavailable for interview. In addition, there was extensive common-farm management between families and relatives but here one person practically managed the common farm units.

As a result, within the community 12 managers were interviewed, representing 19 official farm holdings. It was essential to establish trust with the landrace growers as there were conflicts and competition between farm units within the community, so the choice of the key-informants was of major importance. It was felt essential to include a few young farmers from the community to be able to assess the likely continuity of the on-farm project and younger farmers were selected because they: (i) had not participated in any of the community conflicts and were persons of trust, (ii) they were practical farmers and had available time for on-site visits to fields, (iii) they were enthusiastic since the survey was an opportunity to learn more on the issue, (iv) they were employed part-time by the municipality so could use the equipment and contacts, and (v) they had received some higher education so were able to understand the purpose and methodology. Criteria (iii), (iv) and (v) became necessary following initial failures of farmer interviews.

The survey took place just post-harvest, when the grain was already stored and it was noted that the grain of fields from different localities was usually stored separately. Thirty-three landrace sites were identified altogether and the names of producers recorded. All sites were visited so as to identify possible pedo-climatic differences that could lead to different ecotypes and 10 000 - 20 000 seed samples were taken from stored seed from eight diverse sites and collected for *ex situ* conservation to ensure maximum genetic diversity and sent to the Greek Genebank. It was noted that 'wild

lentil' plants also appeared in mid-March, particularly in stony soil with Phrygia vegetation.

Indigenous knowledge was primarily obtained through open discussions with the producers in the evenings in small coffee shops. Indigenous knowledge from women was acquired through interviews at the farmers' homes; often groups of women were interviewed collectively. Some specific questions on the past uses of the landraces in the area, the way landraces were cooked and on popular sayings can be considered part of the indigenous knowledge collection.

23.3 Results

23.3.1 Diversity maintenance: household description, cultivation and seed system

The average age of landrace-growing heads of households was 66 years and there was no producer younger than 42. The education level was low: half of the producers had finished only primary school and 25% had had just a few primary classes. Nearly 67% of the households contained no children, with a mean family size of 2.4 persons, and more than half of the households did not have any obvious successor to maintain landrace production. Almost all households had additional sources of off-farm income (64% from one and 27% from two sources per household); in total 82% of landrace maintainers earned some off-farm income. Most of the women's income was generated from handicraft production. Given the average age of landrace maintainers, retirement pensions were an important income in 45% of the households. Finally, 69% of the households were reliant on both retirement pensions and subsidies provided by relatives working outside the community.

About 40 years ago a commercial lentil cultivar of unknown name and origin was introduced into the community and is usually grown in adjacent fields to the landrace. Based on seed colour, locals used the distinction 'white' or 'blonde' for the cultivar and 'black' or 'dark' for the landrace. All farm holdings and producers were growing the landrace and about half were also growing the cultivar. The main reasons for retaining the landrace were the high income from sales, its good taste and boiling quality and family tradition, but the cultivar had higher productivity and was preferred by market clients due to its lighter colour and its colour and shape homogeneity (see comparison in Table 23.1).

The lentil landrace was cultivated on at least 33 fields of the plateau, with specific place-names and great soil diversity (in soil

texture, structure, aspect, altitude, humidity, orientation) even over very small distances (< 50 m). There was significant parcelling of land per producer (3 – 20 parcels/producer) with most parcels (i.e. plots) ranging from 0.1 – 0.3 ha. The average number of lentil fields per producer was 5.25 and the average parcel area was 0.2 ha. The average distance from household to field was approx. 3.6 km on a rising road. There was no irrigation or field exchange between producers. Soil was considered the major factor for a good, tasty product and thus, fields were classified into two categories according to the quality of the produced grain: good-quality fields (*kalopso* = gives good boiling grain) and bad-quality fields (*kakopso* = gives bad boiling grain). Up to 1998 farming was practised using horses and human labour, without agrochemicals; however as a result of a. rural exodus, b. advanced age of maintainers and c. higher income expectation, extensive mechanization has recently been introduced.

Table 23.1. Producer evaluation of the lentil varieties' characteristics.

Characteristic	Preference for landrace	Preference for cultivar	No preference
Drought tolerance	20%	40%	40%
Boiling time	0	0	100%
Tastiness	80%	0	20%
Productivity	0	100%	0
Yield consistency	0	20%	80%
Disease resistance	20%	60%	20%
Earliness in maturity	0	100%	0

Lentil cultivation begins in early August with a deep ploughing using a tractor, as it is believed that when exposed to the sun, soil becomes more fertile and less weedy. Seed is sown by hand in late February to March depending on rainfall. Commonly last year's seed is sown but sometimes a mixture of the last three years' seed. Pre-sowing herbicides and two to three post-emergence hand weedings are practised. Grasshoppers have been the main pest and soil-borne diseases affecting the seedlings were the main diseases. There was no use of phyto-sanitary products except copper. Usually a 1:1 lentil / fallow rotation system was followed, but sometimes a wheat / lentil or oat / lentil rotation was followed.

Harvesting took place in early to mid-June. Harvested plants were left in the open to dry and fully mature for three to four days, covered with plastic at night and aerated every day. After cutting,

winnowing and sieving, seeds are processed with an insecticide against weevils and stored in barrels or plastic air-penetrable sacks at the warehouse or in-house under ambient conditions. One producer wished to gain organic certification and export to niche markets, and he kept seed in plastic, air-vacuum bags without insecticide. The storage period varied from one to three years maximum, depending on the annual yield, the seed colour deterioration and financial obligations of the household.

The maintainer's first priority was to be seed-sufficient for the following year. Seed from bad-quality fields was usually sold to other producers at a slightly lower price than the producer (marketed) price, e.g. in 2003 the local seed price was 4-4.5 €/kg when the landrace marketed price was 5 €/kg. However, in recent years only big producers were seed-sufficient while smaller producers have tended to sell out their entire annual production due to financial obligations and the high market price.

Maintainers over millennia have improved the landrace by annual bulk selection of certain seeds primarily selecting on shape and colour. Selection occurred during sieving for storage and usually very small (diameter < 5 mm) and/or black seeds were discarded by hand and sieve. It was believed that black seeds tend to give plants with more black seeds. A few producers used to select taller plant types and the best-filled grain plants in the field, but this practice has recently been abandoned. The seeds of the landrace and cultivar varieties were harvested separately, threshed, winnowed, cleaned and stored. The grain from the bad-quality fields was separately harvested and stored in bulk, usually with grain from other bad fields, and was used for next year's seed.

23.3.2 Market system

Lentil marketing for both landrace and cultivar seed was organized by the producers through an informal network of clients, mainly people of good financial status from the island or local cities. A significant amount of the production was given to cover social obligations e.g. gifts to doctors or bank employees. Maintainers repeatedly claimed "this lentil opens big doors". The landrace has high iron content[11], exceptional taste and great reputation throughout Greece. In 2003 the landrace market price was 5 €/kg (with prices of 8.8 €/kg obtained by niche markets in Athens), when the average commercial variety price in the supermarkets was below

[11] The popular saying "*Your head is ironed from lentil*" relates the landrace's high iron content with someone's stubbornness.

1 €/kg. An effort to enter global organic niche markets in Munich, New York and London has recently been initiated by younger local producers. The cultivar has also been commercialized in the same way and using the same networks, provoking confusion among clients. Producers were selling the cultivar to visitors on site and to tourists, but kept the landrace for their standard and better clients. Historically, the landrace was used for medicinal purposes, lentil mixed with vinegar was used for sore throat and water from boiled lentils combined with honey was used to heal deep wounds and give relief from irritation (Kontomihis 1985).

23.3.3 Traditional customs: the lentil festival of Eglouvi

The major annual event within the community is the lentil festival held on the celebration day of Saint Donatos (6 August), which involves folkloric dances, while elder women with traditional costumes serve the landrace lentils with olives and salted sardines to visitors. Most locals participate in the preparations and offer a small part of their grain for the festival. The festival historically attracted more than 500 visitors to the community annually, but their numbers are gradually decreasing in recent years.

23.3.4 Conservation issues

The seed flow within the community, the low out-crossing rate of the plant together with the cultivation of the two varieties in adjacent fields, can be considered as promoting the evolution of the landrace (Jarvis et al. 2000). Even the seed selection procedure and the high degree of mixing of seed from different fields during harvesting and sowing each year has been considered as assuring that all fields planted from a single seed source will maintain their genetic structure (van Rheenen et al. 1993). However, the discarding of black and very small seeds demonstrates farmer selection to meet the market demand. The main factors that could negatively impact on landrace diversity are the poor storage conditions, rapid climate change in the area, the advanced age of the producers and the decrease in the number of households. In addition, a recent and important factor is the expansion of tourism development from the coastal to the mountainous communities and thus, the change in land use because of holiday home and hotel construction on traditional landrace growing fields. Consequently, it seems the landrace faces extinction rather than partial genetic erosion.

The goal is to ensure that the maximum possible range of genetic diversity of the landrace continues to be maintained within the local farming system (Maxted et al. 1997; Brush 1999; Jarvis et al.

2000). However, there is a strong desire for development within the community and it will be difficult to balance on-farm conservation with this development. In addition, general cultivation practices are themselves evolving and in marginal communities like Eglouvi the farming sector is changing rapidly and radically. Traditional farming is no longer a 'way of life'. Even the small-scale grain grower in marginal areas is, according to the scale of the business, becoming professional and highly focused (Blair 1998). Therefore, it must be acknowledged that the cultivation of the traditional landrace by the Eglouvi community will inevitably change with time and it is good that the diversity is already held *ex situ* as a safeguard in the national genebank, but several proposals can be suggested which could help to ensure the survival of landrace diversity:

- The creation of a simple, low-cost, community seed bank would buttress the security of the seed source for the local community.
- There is a need to establish baseline information on genetic diversity against which future genetic erosion of the landrace might be assessed, the study would also identify the degree of distinction of the landrace and therefore might help to promote its further breeding use.
- Associated with the establishment of the genetic diversity baseline there is a need to use the field inventory data reported here to monitor the field cultivation of the lentil landrace.
- The factors impacting seed quality and production (e.g. soil differences, the correlation between field quality and seed characteristics and quality, storage conditions) should be investigated to assess the potential for improved income generation through lentil cultivation and storage condition improvement.
- There are a few agricultural drawbacks with the landrace e.g. susceptibility to soil-borne diseases and *Ascochyta* sp. and there is potential for participatory plant breeding improvement to overcome these production problems which could significantly improve farmers' income and therefore landrace security.
- The landrace should be registered under Commission Directive 2008/62/EG of 20 June 2008 as a 'conservation variety' to help underscore its worth as a national resource and promote utilization. Associated with this, any local on-farm conservation plan should help discourage the conversion of traditional lentil fields to construction development, since each new holiday home built decreases the land on which the landrace can be grown.
- The application of Certification as Product of Designated Origin status would help safeguard the niche market for the landrace both within Greece and on the global market.

23.4 Discussion

The study found general 'difficulty' in obtaining agricultural data and gaining information on agricultural policy from all authorities (central, regional and local). Preliminary identification of the precise number of lentil producers in the community was impossible due to the inaccuracy of regional and national data. Also at the beginning of the survey, farmers tended to be cautious or unwilling to provide information related to landrace cultivation and their socio-economic status because they felt any information imparted might be used against them by the government. Thus the bulk of the information was obtained in open discussions and then only after three or four days of familiarization between the farmers and the researcher. However, group discussion meant that certain senior figures in the community tended to dominate the discussion, and therefore once familiarity was established group discussion was followed by the researcher interviewing maintainers in their homes. Even in the personal interviews some landrace maintainers gave false answers on sensitive issues (e.g. herbicide application, external income), thus the mix of group and personal interviews with cross-checking of information was necessary to obtain the truest picture of lentil on-farm maintenance.

Landrace lentil production by the Eglouvi community on the island of Lefkada, Greece is a rare and excellent example of community-based on-farm conservation and maintenance in Europe that has survived for millennia. However, the evidence of this survey is that it is a production system in crisis and the continuation of traditional cultivation is in the balance. It seems likely that unless actions like those outlined above are taken urgently then cultivation will cease in the next 10-20 years. The community-based cultivation of the landrace has been one of the defining criteria of the community for generations and the community will be much the poorer for the loss of this linkage with its cultural history. In terms of plant genetic resources conservation it remains unclear how unique the Eglouvi lentil landrace is, but the fact that germplasm is available in the national genebank means it will not be lost entirely for future use. However, so many of these intimate community / traditional commodity ties are currently being almost carelessly broken, that together they do matter and they are important if we are to retain our agro-cultural resource and the 'healthy' link with our rural past and ancestors – *as milk does not just come from factories so lentils do not just come from supermarkets*!

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24. Scottish Landrace Protection Scheme

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24.1 Introduction

Survey work undertaken for the compilation of the UK National Inventory of Plant Genetic Resources for Food and Agriculture (Scholten et al. 2004) commissioned by the Department of Environment Food and Rural Affairs (Defra), identified a small number of landraces which are still being grown and used in agriculture today, five of which are currently grown in Scotland.

Bere barley (*Hordeum vulgare* L.) and black or small oat (*Avena strigosa* L.) are both grown in the Northern and Western Isles, Hebridean rye (*Secale cereale* L.*)* is grown in the Western Isles, Shetland cabbage *(Brassica oleracea* L. var. *capitata)* is grown in the Shetland Islands and 'Scots Timothy' (*Phleum pratense* L.) is grown in central Scotland near Stirling (Figure 24.1).

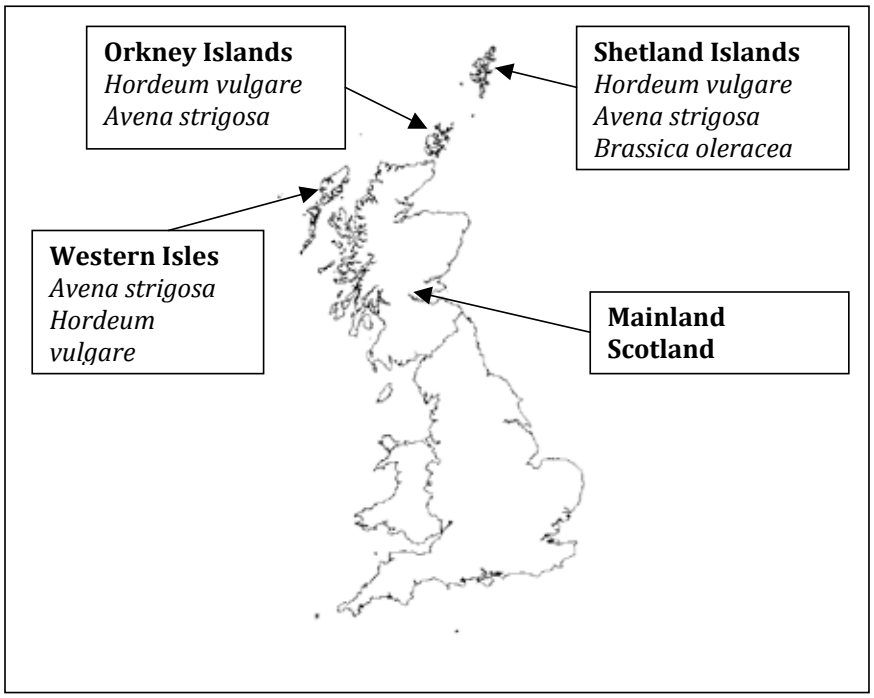

Figure 24.1. Distribution of extant Scottish landraces.

Whereas many 'traditional varieties' are already conserved and described, there is little up-to-date information on Scottish landraces. With the exception of 'Scots Timothy', seed of which is certified in Scotland, information about the current distribution of Scottish landraces, the number of growers, the area of production or the quantity of seed produced is piecemeal, as such information is not collected for official statistics. Without this information it is difficult to know whether the production and use of landraces are declining and whether their genetic diversity has been adequately conserved. This lack of information and knowledge is not only a Scottish but a UK-wide concern, and is also pertinent to the conservation of traditional varieties (Maxted 2006). The continued use of landraces is dependent either on their suitability for local growing environments or on the demand to supply niche markets.

24.2 Current use of Scottish landraces

Scottish landraces are associated with local tradition and culture and are grown in the Northern and Western Isles of Scotland; with the exception of the Western Isles where cultivation is substantial, the number of growers is small. On parts of the Western Isles, the production of landraces is integral to the maintenance of the Machair, a rare coastal habitat with alkaline, manganese-deficient soils. Here, landraces are often grown in mixtures, usually small oat, rye and bere barley, to produce forage and grain for winter feed for cattle; the proportion of the species sown may vary from year to year and with the different growing areas, resulting in a very complex, ever-changing population diversity.

Many Scottish landraces are grown for forage production to feed animals over the winter months. However, bere barley grain is also grown for the production of whisky and beer (Martin and Chang 2007), and the flour from the milled grain is being used for making bannocks, bread and biscuits. Bere flour contains magnesium, zinc and iodine and significant amounts of folate, thiamine and pantothenic acid and is thought to have potential as a functional food (Theobald et al. 2006). On Orkney and Shetland the straw of *A. strigosa*, locally known as black oat, is used for traditional crafts such as making Orkney chairs and baskets, and for thatch to cover the roofs of heritage buildings (Scholten et al. 2008). These uses demonstrate that landraces have potential for developing niche market products with regional branding, while meeting the requirements for low-input, sustainable farming.

24.3 Recent research

Prior to the work on the UK National Inventory, Wright et al. (2002) considered the diversity and potential of bere barley and other landraces, and recommended several areas of research for traditional crops in Scotland. Unfortunately few of these areas of research have been developed, so little information has been published.

Until recently, relatively few samples of seed had been collected and stored in *ex situ* collections, and passport and characterization information was limited. In 2004, seed samples were collected from the Scottish Islands to study the genetic analysis of bere barley populations (Southworth 2007). In 2006, a survey of landraces on the Shetland Islands was undertaken which identified growers of bere barley, small oat and Shetland cabbage (Lever 2006); seed of Shetland cabbage was collected and sent to SASA for *ex situ* storage. In the same year, a field survey of *A. strigosa* was carried out on the southern islands of the Western Isles to verify its occurrence and to compare Hebridean and Shetland strains (Scholten et al. 2008). In 2008, seed samples of cereal mixtures were collected in the Western Isles by Maria Scholten and sent to SASA for storage in *ex situ* collections.

Southworth (2007) raised awareness of the considerable diversity in bere barley populations, both between the different island groups (Shetland, Orkney and the Western Isles) and within each island group. The extent of this diversity was probably not previously understood and raises the issue of how we should conserve such diversity and encourage continued low-input, sustainable production.

24.4 The Scottish Landrace Protection Scheme: *ex situ* conservation

The Scottish Landrace Protection Scheme (SLPS) was set up in 2006 to conserve seed of Scottish landraces in *ex situ* collections and to provide growers with a safety deposit system for the seed they donate. Growers may donate a sample of seed from each generation over a period of several years. Seed samples received are cleaned, tested for germination and assessed for seed health before being dried at 15% RH and 15 °C, and conserved in long term (-22 °C) storage conditions. The grower receives information on the quality of each sample of seed submitted and, in the event of harvest failure, can request the return of some of her/his donated seed to continue growing the landrace. As seed is only returned to the original donor, it is locally adapted to the donor's growing conditions. Growers are asked if they wish to participate in the

SLPS, and whether they give consent for general distribution of donated seed to third parties (Table 24.1). In addition to SLPS participation and consent for general distribution, passport information about the donor and each seed sample is also collected (Table 24.2).

Table 24.1. SLPS form for seeking SLPS participation and Consent for General Distribution.

Collector's sample number:

PARTICIPATION IN THE SCOTTISH LANDRACE PROTECTION SCHEME

I want seed of the variety/varieties listed below to be included in the Scottish Landrace Protection Scheme ☐ YES ☐ NO

CONSENT FOR GENERAL DISTRIBUTION

I give my consent for seed of the variety/varieties listed below to be freely available for distribution to third party users ☐ YES ☐ NO

Varieties to which this agreement applies:

e.g. Shetland cabbage (2006 harvest)
e.g. Bere barley (2007 harvest)
e.g. Landrace mixture (2007 harvest) bere / rye / small oat / other (please indicate)

Signed…….. Date…….

PRINT NAME……..

ADDRESS……....

……..

POST CODE…….

TEL. ……....

E-MAIL……...

Donor names and contact details will be treated as confidential information, but will be held on computer at SASA for management of the SLPS.

Table 24.2. Passport information sought from the collector or donor of seed samples submitted for participation in the SLPS (EURISCO passport descriptors are indicated in brackets).

Genus & Species e.g. *Brassica oleracea* (GENUS; SPECIES)
Species Mixture e.g. Mixture: *Hordeum vulgare/Secale cereale/Avena strigosa* (in order of prominence)
Common Name e.g. Shetland Cabbage (CROP NAME)
Common name mixture e.g. Mixture: Bere barley/Hebridean rye/Black oat (in order of prominence)
Collection date (COLLDATE)
Collector name
Collector sample number (COLLNUMB)
Donor
Donor Address (COLLSITE; LATITUDE; LONGITUDE)
Donor Phone number
Donor E-mail
Donor wants protection in the SLPS?
Donor agrees to sample being made available for General Distribution?
Harvest Year
Area of crop grown
Density of plants grown
Notes

To qualify for participation in the SLPS, each sample should have sufficient viable seed to enable the future monitoring of germination and seed quality, for characterization (morphological and molecular) and evaluation, for re-supplying the donor in the event of crop failure (the quantity is dependent on size and quality of the original sample), safety duplication and for possible emergency regeneration at SASA. The minimum quantity of viable seed required to meet these tasks is defined for each landrace species and is applied to all populations submitted for SLPS participation (Table 24.3).

Table 24.3. Shetland cabbage: minimum sample size for participation in the SLPS.

Viable seeds	Requirement
1 000	Sample monitoring: germination and/or seed health tests
1 000	Safety duplicate sample for emergency regeneration at SASA
1 500	Characterization (field and molecular)
1 500	Return to grower in the event of crop failure
5 000	**Minimum sample size for participation in the SLPS**

Once seed is received at SASA, it is registered and additional passport information is recorded. Once the 1000 seed weight has been determined, the number of viable seeds is estimated by multiplying the seed weight of the sample by the percentage germination (Table 24.4). Seed additional to that required for SLPS participation can be made available on request for *bona fide* use (breeding, research, education, etc.), if consent has been given by the donor.

Table 24.4. Passport information recorded on seed samples received at SASA for participation in the SLPS (EURISCO passport descriptors are indicated in brackets).

Sample receipt date at SASA (ACQDATE)
Sample name (ACCENAME)
Unique SASA identity number (ACCENUMB)
SASA accession number (for multiple samples within one unique identity number)
Official Seed Testing Station Number
Stock (sample quantity recorded as seed weight)
1 000 seed weight
Germination %
Germination test: % dead
Germination test: % abnormal
Germination test date
Assumed Seed Number based on 100 seed weight
Assumed Viable Seed Number
Seed diseases
Pest infestation of sample
Notes

The maximum size of seed samples that can be stored for each grower/donor is limited by storage space and the size of storage containers in the seed store. Where seed of landraces is supplied as a mixture, the components of the mixture are identified and sampled separately, weighed, tested for germination and examined for seed health. The relative proportion of each component is also recorded. Regeneration of seed would normally take place where the seed was originally produced to ensure unwanted selection pressures do not change the population, but emergency regeneration can be undertaken at SASA as a last resort, using part of the submitted sample. Further information on Scottish landraces and their accessions stored in *ex situ* collections at SASA, may be found at www.scottishlandraces.org.uk along with details of the newly formed Working Group on Scottish Landraces and Traditional Varieties.

24.5 Shetland cabbage

The first seed samples submitted for participation in the SLPS in 2006 (Table 24.5) were of Shetland cabbage and were collected from most areas of the Shetland Islands (Figure 24.2). The area of cultivation and the number of growers are in steep decline and the use of Shetland cabbage is threatened (Scholten et al. 2008). In addition, one commercial grower is selling plants to other growers, which may further reduce the genetic diversity, if the diversity of the plants sold does not reflect that grown across the islands.

Table 24.5. Shetland cabbage: SLPS participation.

Number of growers	17
Number of seed samples received	25
Samples with insufficient viable seed for SLPS participation	6
Samples qualified for SLPS participation	19
Samples with consent for general distribution	19

Figure 24.2. Distribution of seed samples of Shetland cabbage collected in the Shetland Islands.

In 2008, 19 Shetland cabbage accessions were grown and their morphology was characterized at SASA. Visually the diversity within populations was considerable compared with modern cultivars, but it was more difficult to determine the diversity between populations, though it was clear that some populations had distinguishing traits. Preliminary analyses of morphological and molecular characterisation data have been undertaken, but further work is needed to summarize the results of this research. Seed quality of the accessions collected/donated was variable and some accessions did not have sufficient numbers of viable seeds to qualify for SLPS participation (Table 24.6).

Table 24.6. Shetland cabbage: Seed quality of samples submitted for SLPS participation.

% Germination	**No. of samples**
Nil	1
1% – 39%	3
40% – 59%	6
60% – 79%	5
80% – 100%	10
Approximate number of viable seeds (calculated)	**No. of samples**
< 5 000	6
5 000 – 10 000	8
10 ,000 – 15 000	3
20 000 – 30 000	2
30 000 – 40 000	5
> 40 000	1
1 000 seed weight (range)	**2.43g to 4.65g**

24.6 Cereal landraces

Prior to 2008, the SASA cereal landrace collection contained 43 accessions of bere barley, ten accessions of small oat and two accessions of Hebridean rye. In 2008, a further six bere barley, 13 small oat and 12 rye accessions were collected by Maria Scholten, most of which were harvested as mixtures. Fifteen seed samples of cereal landraces have been submitted for participation in the SLPS; some of these have been harvested from a single species, but most have been received as landrace mixtures with varying proportions of small oat, Hebridean rye and bere barley (Table 24.7). Occasionally common oat (*Avena sativa L.*) and *Triticale* may be a component in these mixtures.

Table 24.7. Cereal landrace samples collected/donated in 2008.

Landrace/mixture	No. samples	SLPS participation	Consent for general distribution
Bere barley	4	4	2
Small oat/rye	8	8	8
Small oat/rye/barley	3	3	3
Small oat/rye/*Triticale*/barley	1	1	1
Common oat/small oat	1	0	0

The components of the seed samples received as mixtures are identified and a sample of each is tested for germination and, if necessary, seed health. The sample is stored as a mixture. At the time of writing, eight of the 13 cereal landrace mixtures collected and submitted for participation in the SLPS have been tested for germination and the proportion of each component landrace determined. The predominant landrace grown in mixtures in the Western Isles is small oat, with rye and bere barley occurring in smaller percentages. Germination of individual landraces in the mixtures is variable, but where the predominant sample is poor, the other landrace components also tend to be poor.

Little is known of the diversity or origin of the small oat and Hebridean rye currently grown on the Scottish islands, so morphological and molecular characterization of the SLPS samples is planned as part of a current SAC research project on landraces.

24.7 How many seed samples need to be collected to conserve diversity?

When landraces are grown in different localities, each population adapts to the local environmental conditions over a period of time. This adaptation can be very specific; following a harvest failure in the Western Isles, seed of bere barley was sent from Orkney, but did not grow well, as the plants were not adapted to the sandy, low-nutrient soils of South Uist. This was confirmed by research (Southworth 2007) which concluded that the bere barley samples grown in the Western Isles were different from those grown in the Northern Isles and that the diversity within island groups could only be maintained by *in situ* conservation at the different sites. This means that if we are to conserve the genetic variation in *ex situ* collections, seed needs to be collected from the sites where different populations are grown. Samples should also be collected from each site over several years, to gain an understanding of how the populations change with time.

24.8 Conclusion

Landraces are probably the most threatened component of UK crop biodiversity at least partially because they are maintained by farmers, subject to commercial constraints, rather than conservationists. In addition, many of these farmers are an ageing population. In some areas the number of growers is declining as upcoming generations of farmers are working part-time in other jobs or are using modern cultivars. The survival of landraces is dependent on their continual regeneration *in situ*; if seed harvest fails, the landrace can be lost.

If we are to develop a strategy for the conservation and utilization of the extraordinary diversity within landraces, we need to understand how quickly landrace populations are changing over time, how many samples of seed are representative of all populations grown, the degree to which seed is exchanged between growers and whether such exchanges threaten or broaden diversity. Some of these questions will be addressed in a current SAC research project on Scottish landraces, but to gain a better understanding, further seed collection is essential for *ex situ* conservation and research.

The introduction of the Scottish Landrace Protection Scheme has addressed the need to conserve landrace diversity by acquiring representative seed samples for storage in *ex situ* collections. It also provides information on local growers and a seed deposit and withdrawal system, which will guarantee availability of locally adapted seed for future *in situ* production. The accessions collected can now be characterized and evaluated with a view to developing a long-term strategy for the conservation and sustainable use of these landraces.

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25. On-Farm Conservation of Crop Landraces in Georgia

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25.1 Introduction

Georgia is well-known for its diverse environment (a wide range of climates, soils and altitude zones) and for high variability in cultivated plants. This region belongs to the Western Asian centre of origin of cultivated plants. During the long history of Georgian agriculture, local farmers carefully selected plants and seeds for planting and developed numerous farmer-selected varieties, which are well-adapted to local conditions in all the three major groups of crops (field crops, vegetables and perennials).

The process of agricultural diversity reduction, which was observed globally in the 20th century, affected Georgian agriculture severely. Not only has the plant diversity been reduced, but also the level of utilization of the indigenous crops. Not long ago, among the widely cultivated crops in Georgia were Italian millet, millet, rye and endemic wheat varieties, among cereals; chickpea, lentil, beans and peavine among legumes; and flax, from oil and fibre plants. At present, these crops are ousted from the local farming systems. Predominantly cultivated are maize and wheat from the cereals, and haricot beans from the pulses. Such a low level of diversity could not but tell on the population's diet, especially in rural areas.

The UNDP/GEF project on Recovery, Conservation and Sustainable Use of Georgia's Agrobiodiversity was launched in 2004. It was developed to remove some of the important impediments to sustainable use of agro-biodiversity, which included scarcity of seed and planting material, unfamiliarity of the farmers with the importance of agro-biodiversity, low farmer access to markets, poor information on production technologies for indigenous crops and absence of links between farmers and researchers. The project has been implemented by the Biological Farming Association 'Elkana' in southern Georgia, in the Samtskhe-Javakheti region.

25.2 Agricultural biodiversity significance in Georgia

Georgia lies on the southern boundary of Europe, between the Greater and Lesser Caucasus and the Black Sea, an area defined by Conservation International as one of 25 biological 'hotspots' on earth. Georgia, with 23 soil-climatic zones in only 69 700 km^2 possesses

unique plant diversity and species composition. Georgian agriculture has a long history and can be traced back to the 5/6th millennium BC, when Kartvelian (Georgian) tribes began to domesticate basic crops such as wheat, barley, oat, rye, grain legumes (pea, chickpea, lentil, faba bean), fruit species (plum, cherry, quince, common grape) and various other crops. Georgia has a rich flora, in terms of both wild species (more than 4 200) and crop species (about 100 families and 350 local species of grain crops). There are numerous endemic cultivated taxa, such as *Staphylea colchica*, *S. pinnata*, *Triticum carthlicum*, *T. karamyschevii*, *T. macha*, *T. timopheevii*, *T. zhukovskyi* and *Vitex agnus-castus*. The list of valuable crop genetic resources in Georgia also includes: *Secale ketzchovelii, S. moharium* and *S. segetale*. Georgia presents a rich diversity of fruit trees. This group of plants is composed of more than 100 species of seed and stone fruit trees, nuts and wild berries. Among others of particular importance, the group includes *Amygdalus communis, Cerasus mahaleb, Malus pumila, Pyrus communis,* and *Cydonia oblonga*. With regard to grapes, there are about 500 local varieties recorded, but only 300 still exist in live collections in scientific research institutes and peasant farms.

25.3 Root causes of agro-biodiversity loss in Georgia

The Georgian agricultural sector was well developed during the communist period and used to export products to other Soviet republics and countries of the world. Within the Soviet system of inter-republic distribution of responsibilities, Georgia was mainly a producer of high-quality fruits and tea. This specialization had a negative impact on indigenous crop varieties. In a period of 70 years, introduced varieties predominated in family plots and collective farms while endemic, rare and threatened varieties were restricted mainly to research and agricultural extension centres. Consequently, information about local varieties became restricted to the technical staff of research and extension centres and the few families that kept indigenous crop varieties.

The process of agro-biodiversity loss became more intensive after the collapse of the former USSR, because the state breeding stations that had kept indigenous crop varieties for experimentation and selection were hard hit by the collapse of the Soviet system and the sudden and major decrease in state funding. Valuable collections and stocks of endemic varieties began to erode fast. Simultaneously, farmers found themselves with introduced varieties for which they were unable to purchase the necessary amounts of agro-chemicals and to provide with sufficient water. Research and state breeding stations did not have the capacity to assist farmers in adopting local

varieties for *in situ* preservation. Even though local varieties would have performed much better than introduced ones in conditions of reduced agro-chemicals and water inputs, they were just not available for planting.

25.4 Local initiative to preserve indigenous crop varieties

The first activities for the preservation of indigenous crop varieties in Georgia started in 1996. This was a joint effort of scientists from the Institute of Botany (Department of Cultivated Flora) and the Biological Farming Association 'Elkana' – a Georgian non-governmental organization (NGO) established in 1994, to maintain the seed collection of the Institute through reproduction on plots of the Elkana member farmers. Cooperation among farmers, scientists and extension workers proved to be successful not only in maintaining the seed collection but also in interesting the farmers in the crops of their ancestors. The experiences of the cooperative effort triggered the development of a farmer-based concept of indigenous crop variety preservation in Georgia, which was finally financed by the Global Environmental Facility through the United Nations Development Programme.

The project – Recovery, Conservation, and Sustainable Use of Georgia's Agrobiodiversity – was developed to remove barriers to the sustainable use of agricultural biodiversity, by means of a combination of *in situ* and *ex situ* measures. It has been implemented since 2004 with financial support of GEF/UNDP and co-financing partners from Germany – EED and Misereor; from the Netherlands – OxfamNovib, Cordaid and Avalon; and from Switzerland – the Swiss Development Agency for Cooperation and HEKS/EPER.

25.4.1 Methodology

The project did not imply protection of the entire spectrum of plants important to agriculture that are threatened with extinction. Rather, the project approach was to develop a replicable model of agricultural biodiversity protection for a group of the selected local varieties in one region of Georgia, which could be used as a strategy in other regions or for other crops and varieties. The project started with testing different approaches and tools to recover and preserve selected species in the Samtskhe-Javakheti region.

The project focused its efforts on conservation and sustainable utilization of threatened crop landraces that showed a potential market and/or good adaptation to local soil and climatic conditions. These included local varieties of wheat, flax, lentil, grass pea, chickpea, cowpea and faba beans. The landraces selected by the

project were well adapted to situations of scarcity of agro-chemical inputs and to the presence of biotic and abiotic stresses (e.g. disease, extreme temperatures, lack of moisture, etc.) and therefore could contribute significantly to farmers' food security. It is worth noting that prior to the start of the project, Elkana field teams interviewed local farmers in the targeted region identified the main constraints to preservation of the local varieties and identified the improvements needed to enhance their sustainable utilization. They also identified farmers who were interested in growing the traditional varieties and would like to cooperate with the project. To address the threats and root causes of agricultural diversity loss in the Samtskhe-Javakheti region, Elkana concentrated its technical and financial resources along four main avenues of action.

Establishment of sources of primary seed and planting material for the selected landraces

The project has identified seed material stored in the Institute of Botany and has established a demonstration and seed multiplication plot in the region. Office and farm infrastructure have been developed at the site and the necessary machinery and equipment have been purchased. The seed materials obtained from the Institute's collection have been multiplied on the plot and distributed to farmers who were interested in participating in the project. In addition, seed has been stored in the seed depository at Elkana's head office in Tbilisi. At the same time an inventory of landraces and wild relatives has been carried out.

Strengthening of a local farmers' association as the main vehicle for production and distribution of seed material and experience sharing

Farmers involved in the project have established a farmers' association to facilitate seed multiplication and distribution of targeted landraces. They have agreed to enter into the seed multiplication system by returning 1.5 times the original amount of seed distributed to them. One unit of the returned seed material has been used for incorporating new farmers and/or further multiplication, while the remaining part has been stocked as a security fund (in case of future poor harvests). In order ultimately to run the production and distribution of seed material of selected landraces, the farmers' association members have been trained by Elkana in seed fund management and record keeping.

Assistance to farmers in accessing markets

The project has carried out a study to define the markets, and five legume landraces have been proposed for sales. In addition, farmers and farmer groups interested in commercial production of selected

landraces have been identified and linked with a local distributor company, which sells these crops to supermarkets. The company pays to farmers a 10% higher price than the existing market price for beans; at the same time the company buys products directly from farmers, skipping the intermediary and maximizing price returns at the farm level.

Support to cooperation among farmers, scientists, local authorities and state and private breeding establishments in exchanging best methods and practices

Elkana has made considerable information available at all levels and through different media. Advisory handouts for each crop are prepared and distributed to farmers. Information workshops, farmers' days and promotional events are organized regularly. High-quality promotional material, including recipe books, calendars and publications have been produced and distributed. A database and web page have been established and are regularly updated.

25.4.2 Project outcomes

The project has achieved some considerable successes. Notably, important landraces have been identified in cooperation with researchers, and a seed multiplication and demonstration plot has been established. The plot is used for research, education and extension purposes. In addition, seeds maintained in collections are regularly renewed on the seed multiplication plot. At present up to 250 accessions are preserved in the Elkana seed depository. Seed material of 17 cereal and five legume crops have been exchanged with the National Seed Bank. Through the project's efforts the following landraces have been reintroduced into farmers' fields: cereals – *Triticum carthlicum* Nevsky, *T. aestivum* L. and *Hordeum vulgare* var. *nudum*; legume crops – *Cicer arietinum* L., *Vicia faba* L., *Lens culinaris* Medic., *Vigna unguiculata* (L.) Walp. and *Lathyrus sativus* L.; and flax, *Linum usitatissimum* L.

Prior to the project, seed material of local landraces was not available to farmers. The project has established a seed multiplication system to encourage local farmers to join the agro-biodiversity programme. Having started with 12 farmers in 2004, the project unites 152 families directly involved in the on-farm conservation programme at present. These farmers are engaged in a regional farmers' association 'Farezi' established in the frame of the project.

Establishment of a farmers' organization has facilitated active involvement of local farmers in the project implementation. Furthermore, the farmers' organization has been found to be an

efficient tool for strengthening capacity and skills of local farmers. Institutional capacity of the farmers' organization has also been strengthened through participation in the project.

The use of landraces with their ability to produce good harvests without the need for expensive chemical inputs, and their tolerance to drought, local crop pests and diseases is also likely to have significantly reduced the farmers' exposure to risk. Investment is low and the crops are ideally suited to the growing conditions. Most of the farmers use local crops for their own consumption. The reintroduction of the landraces has also improved the nutritional intake of farmers with the addition of a greater range of pulses. Local farmers appear to prefer the landraces for their subsistence needs; some farmers even sampled the initial seed material before deciding to plant. Several groups of farmers have already emerged that sell their produce on local markets. Although yields are lower for the landraces, they attract a higher price.

The project collected and documented traditional knowledge on the uses of indigenous crops. A recipe book was published and widely distributed to raise consumer awareness. In addition, dishes prepared from local varieties have been promoted through food tasting events and media. As a result, demand for indigenous varieties is growing at the local market.

25.5 Conclusions

As mentioned above, the project did not imply protection of the entire spectrum of plants important to agriculture that are threatened with extinction. Rather, the project approach was to develop a replicable model of agricultural biodiversity protection for a group of the selected local varieties in one region of Georgia, which could be used as a strategy in other regions or for other crops and varieties.

Four years of project implementation have shown that the sustainable use of agro-biodiversity requires community-driven *in situ* and on-farm initiatives supported through supplies of seed and planting materials, knowledge dissemination, marketing efforts, publicity, and cooperation with research and governmental structures. The approaches and instruments developed by the project are at present being tested in two other regions of Georgia.

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SECTION 4 – PROMOTING LANDRACE USE

26. New Markets and Supply Chains for Scottish Bere Barley

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26.1 Introduction

The Agronomy Institute (AI) for Northern Temperate Crops is involved in developing new crops for the Highlands and Islands of Scotland and identified several possibilities in a market-led study in 2002. One of these was bere; a barley (*Hordeum vulgare* L.) landrace which was still being grown in Orkney. Bere was selected because of its traditional association with the area and its potential for niche market commercialization. This was considered to be high because it was already being grown to supply a small market for meal (flour) and had been used in the past for beer and whisky production. Continued commercial growing of bere was also very desirable for cultural reasons and for it to remain a productive component of the local farming system, providing it with a base for *in situ* conservation.

To commercialize bere, several key tasks would need to be undertaken:

- Documentation of the history and uses of bere to help identify new markets and provide information for growing the crop and marketing bere products
- A study of farmer knowledge about the crop to provide initial guidelines for growing bere and to identify priorities for agronomy research
- An agronomy research programme to investigate constraints identified by farmers and support commercial production
- Characterization of the unprocessed and processed grain to help new product development
- Identification of new bere products with end-users and the development of supply chains to provide them with bere
- Obtaining funding for the above activities.

The following sections summarize progress made by AI with the above tasks since 2002.

26.2 A history of bere

Bere is a very old barley landrace and is one of very few which is still grown in the UK (Scholten et al. 2007). Most modern barley is grown for malting or animal feed but bere is unique amongst UK barley in being grown for milling and, in Orkney, bere meal (flour) is still used in a few bakery products such as bread, biscuits and bannocks (a type of scone). Although the market for bere is small, numerous historical references show that it once played an important role in the economy of the Highlands and Islands.

The origins of bere are obscure and it is not clear when or where the crop was first grown. Historical accounts refer to bere as "Bygge" or "Big" which probably originated from "Bygg", the Old Norse for barley, suggesting that bere, or an early form of it, may have been introduced to the UK by the Vikings (Jarman 1996). One of the earliest written references to bere comes from Fitzherbert's 1523 *Boke of Husbandry* where it is described as having "small cornes and lyttle flour". Bere was also referred to as Scots Bere or simply 'corn' and in the 19th century and early part of the 20th century several types – Common, Black Four-row, Buchan, Victoria and Winter White Bere – were still available or referred to (Pringle 1874; Wright et al. 2002). How these types are related to today's bere is not known, but Buchan Bere was most suited to Orkney (Pringle 1874).

Bere has been intimately associated with Orkney for hundreds, possibly thousands, of years. It was a versatile crop which provided meal for baking, malt for brewing and distilling and straw for animal bedding and thatching (Newman 2006) and was often used for paying land rents. It was also an important Orkney export (Thompson 2001). Bere was of considerable economic importance in Scotland's Western Isles during the 18th and 19th centuries when large quantities were supplied to the Campbeltown distilleries (Pacy 1873; Glen 1970; Barbour, 1997). This may have been encouraged by the lower tax on bere malt than barley malt because of its lower alcohol yield during distillation. In the 18th century, Scotland's celebrated national poet, Robert Burns, mentioned bere (which he called "bear") in several poems – his poem 'Scotch Drink' refers to its use in whisky while 'Bannocks O' Bear Meal' refers to the bannocks which are still made in Orkney from bere.

Bere was also grown more widely in the UK and has been equated with *Haidd Garw* or 'coarse barley' which was grown on upland soils in Wales (Hunter 1952). Significant areas were grown in Ireland in the 1800s (Lewis 1837) and the improved variety, Victoria Bere, originated from a selection made in Belfast Botanic Gardens in 1836 (Lawson & Son 1852). Bere was taken to North America, where European settlers on the east coast found that bere

from Scotland grew better than two-rowed varieties (Briggs 1978) and a question about Bere is included on the 1848 Canadian census form (AllCensusRecords 2007), and probably reflects transport of the crop to Canada by Scottish settlers.

There is little information tracing the decline in the cultivation of bere in the Highlands and Islands. Ellis (2002) suggested this may have started with the agricultural improvements of the 18th and 19th centuries which included liming, allowing the use of less acid-tolerant, but higher-yielding varieties than bere. In Orkney, the decline coincided with a change in farming as large areas of grass were established for beef production which expanded around the middle of the 1800s (Thompson 2001). Barley books from Orkney's Highland Park distillery recorded the last purchase of bere in 1925. By the end of the 20th century, only about 5-15 ha of bere were grown in Orkney, Shetland and Caithness (Jarman 1996), but it is also still grown by crofters on North Uist, Benbecula, South Uist and Barra in the Western Isles (Scholten et al. 2007). In Orkney, its recent survival in commercial production is largely because of the outlet for bere meal provided by Barony Mills. Other recent commercial products made from bere include a single batch of whisky distilled at Edradour Distillery in 1986 for Michel Couvreur (Martin and Chang 2008) and a limited-edition beer produced by Orkney Brewery in 1990. A tradition of using Bere for making 'home brew' (beer) still survives in parts of Orkney.

Although bere is probably the longest cultivated type of barley grown in the UK, little has been documented about its agronomic characteristics. It is a six-row barley (Jarman 1996), but it has also been described as irregularly four-rowed (Percival 1910). It is susceptible to frost damage and so is planted late in the spring, after which it makes rapid growth and, although traditionally one of the last crops sown, it was usually the first to be harvested (Wright et al. 2002). As a result of its rapid growth (Percival 1910), it has been described as a 90-day variety (Jarman 1996). It is reputed to be tolerant to acidic soils (Wright et al. 2002) but also grows on more alkaline sandy coastal soils (machair) derived from beach sands (O'Dell 1935; Scholten et al. 2007). Bere is susceptible to both powdery mildew disease (*Blumeria graminis* f.sp. *hordei*) (Wright et al. 2002) and leaf stripe (*Pyrenophora graminea*) (Cockerel 2002) and has weak straw (Peachey 1951) making it very susceptible to lodging.

From the above review of the history and uses of bere, the following have been of particular importance for AI's market development work:

- It was very valuable to find a well-documented connection between bere and the early whisky industry on the west coast of Scotland (Pacy 1873). The Scottish whisky industry is one of

very high value (exports worth almost £2.5 billion pounds in 2007) and is based on about 125 distilleries ranging considerably in size. Product differentiation is an important marketing tool and niche products are frequently made, particularly by smaller distilleries which can produce low-volume production runs. The concept of a niche whisky produced from bere, therefore, seemed very promising.

- References to bere in the poems of Robert Burns are potentially very valuable for marketing because of the esteem in which he is held in Scotland and other parts of the world. They also help to emphasize the importance of bere in Scotland's day-to-day life in the past.
- The linking of bere to a possible Viking introduction strengthened its connection with Orkney and Shetland which were settled by the Norse at the end of the 8th century and ruled by them until 1468 when Orkney and Shetland became part of Scotland. In the future, this link could be a valuable marketing tool.

26.3 Farmer knowledge of the crop

To identify recent farming practices with bere and priority research areas, seven farmers who had grown bere in Orkney since the 1980s were interviewed in 2003 about the practices they had used and the main problems encountered with the crop. Although the sample was small, it included most Orkney farmers who had recently grown bere.

Most farmers (five) used a seed rate of 157 kg/ha although this ranged from about 138 to 184 kg/ha. The most recent and reliable grain yields came from fields grown for Barony Mills. From 1998 to 2003, yields from a 1.6 ha field in Birsay ranged from 2.8 to 3.8 t/ha at 15% moisture content and averaged 3.1 t/ha. This was achieved with few inputs – in only one year was herbicide used, no fungicide was applied and only low levels of fertilizer were used (N, P and K at 34, 68 and 68 kg/ha, respectively). A second field in the same area yielded an average of 2.7 t/ha from 1999 to 2001 and a third field yielded 3.1 t/ha in 2002. None of the other farmers had used higher levels of fertilizer on bere and some had grown it without fertilizer or without nitrogen. The only agrochemicals used were herbicide (one grower) and growth regulator (one grower). When questioned about pests and diseases, only one grower had noticed any (powdery mildew) and none thought these a constraint. Most (four) had followed the traditional practice of planting bere around the middle of May but one contractor had planted two fields earlier, in late April and early May.

The main problems mentioned with bere were crop lodging (four farmers) and low yields (three). Apart from believing that lodging contributed to low yields, farmers stressed that it made harvesting more difficult and time-consuming. They (four) also mentioned the long, irritating awns which made it unpleasant to work with, but recognized that the introduction of combines for harvesting had made this less of a problem.

Increasing yield was identified as the main priority for agronomy research, since this (2.8-3.8 t/ha) was much lower than that obtained in Orkney with modern barley (ca. 6.0 t/ha) receiving inputs like herbicide, fungicide and fertilizer. Farmers would only grow bere if it gave comparable financial returns to modern barley and yields indicated this would require a price about twice that of modern barley. It was considered unlikely that new end-users would pay such a high premium and therefore increasing bere yield was necessary to make the crop more attractive to both growers and end-users. It was also decided to investigate control of lodging as this would facilitate harvesting. Although not identified by farmers as an issue, planting date was also included in the research programme because most farmers plant barley before the end of April, considerably earlier than the traditional, mid-May date for bere.

26.4 Agronomy research results

The agronomy research programme started in 2002 and is still going on. It initially focused on the effects of planting date, seed rate and inputs such as fertilizer and fungicide on yield and the effect of growth regulator on lodging.

Compared with the traditional mid-May planting date, earlier planting (before the end of April) resulted in a substantial increase in yield (ca. 18%) and 1000 grain weight (TGW), and this is now promoted as an important cultural method for increasing the yield and quality of bere. Early planting is also encouraged for malting because it results in lower grain nitrogen and higher TGW (Conry and Dunne 2001), the former being associated with a higher alcohol yield on fermentation and the latter with a greater potential malt extract (Cochrane and Duffus 1983). It is uncertain what the benefits of mid-May planting would have been in the past, but it might be related to bere's susceptibility to heavy, late frosts. Previously, these may have been more common, and the possible loss of an early planted staple crop may have been an unacceptably high risk for farmers in earlier times. Alternatively, the ability of bere to produce a crop in a short time when planted late – Walker (1812) mentions a crop which was ready for reaping after 85 days – may have allowed a better use of labour on other farm activities.

Seed rate (between 130 and 190 kg/ha) did not have a significant effect on yield. It is therefore currently recommended to use a seed rate of 160 kg/ha for bere, giving a seed population of about 530 seeds/m².

Bere has not shown a large yield response to mineral fertilizer and no benefit has been seen from applying more than about 50 kg/ha each of N, P and K. In the first year after ley, lower levels of N are sufficient and care is needed because too much nitrogen exacerbates lodging.

Fungicide and growth regulator treatments have often, but not consistently, increased yields, usually in the region of 5-11% when applied individually. In combination, they may increase yields by 15-22% but their use is not always cost-effective. Although growth regulator has been shown to reduce bere straw length significantly, it has not always prevented lodging, particularly when the weather after ear emergence has been wet.

Economic analysis of a trial in 2005 which included fertilizer, fungicide, growth regulator and planting date treatments, showed that the single strategy giving the highest net profit was early planting.

As a result of the agronomy research programme, recommendations have been developed for Bere which rely on earlier planting, the use of modest levels of fertilizer, and herbicide application between growth stages 1.4 and 3.2. This has resulted in higher and less variable yields and a higher-quality product. For example, compared with the average farm yield in the farmer practices survey (3.2 t/ha), almost 20 ha of bere was grown in Orkney in 2007 with an average yield of 3.7 t/ha. The trend for increased prices of oil and farm inputs seen in 2007/8 may help to make low-input crops like bere a more attractive option for those farmers who are receptive to growing them.

26.5 Characterization of the processed and unprocessed grain

26.5.1 Analysis of minerals and vitamins in bere flour

Bere grown in Orkney in 2002 was ground into flour by Barony Mills, a water-powered mill operated by the Birsay Heritage Trust. The resulting wholemeal flour and white flour, obtained by sieving, were analysed for vitamins and minerals by UKAS-accredited laboratories (Theobald et al. 2006).

Calcium, iron, magnesium, phosphorus, potassium and zinc were present in greater concentrations in wholemeal than in white bere flour (Table 26.1), suggesting that they are located predominantly in

the outer layers of the grain. In contrast, concentrations of chloride, copper, manganese, iodine and sulphur were similar in wholemeal and white flours, suggesting that they are predominantly found in the endosperm. Selenium and sodium were not detected.

Table 26.1. Mineral and vitamin content of bere wholemeal and white flours.

Minerals	Wholemeal flour	White flour	Vitamins	Wholemeal flour	White flour
Magnesium (mg/100g)	110	80	Thiamine (mg/100g)	0.50	0.52
Phosphorus (mg/100g)	410	333	Riboflavin (mg/100g)	0.06	0.05
Potassium (mg/100g)	410	320	Niacin (mg/100g)	0.50	0.52
Chloride (mg/100g)	117	111	Tryptophan/60 (mg/100g)	2.5	2.3
Iron (mg/100g)	6.1	5.6	Vitamin B6 (mg/100g)	0.22	0.21
Zinc (mg/100g)	2.4	2.0	Total folates (µg/100g)	107	105
Calcium (mg/100g)	40	30	Pantothenic acid (mg/100g)	1.0	1.0
Copper (mg/100g)	0.59	0.55	Biotin (µg/100g)	1.7	1.4
Sulphur (mg/100g)	120	110	Vitamin E (mg/100g)	0.51	0.45
Manganese (mg/100g)	1.3	1.3			
Iodine (µg/100g)	60	60			

The thiamine, riboflavin, niacin and tryptophan/60, vitamin B_6, pantothenic acid and folate contents of wholemeal and white bere flours were similar (Table 26.1). Concentrations of vitamin E and biotin were slightly higher in wholemeal flours. As is the case for other cereal flours, vitamin A (as retinol or β-carotene), vitamin B_{12}, vitamin C and vitamin D were not detected.

Knowledge of the nutrient profile of bere flours could be used to incorporate them into food products aimed at having a beneficial impact on the diet of specific target groups in the UK. For example, bere flour has quite high levels of folate and so consumption of bere products could contribute to the folate supplementation which

is currently recommended for women during the early stages of pregnancy (Department of Health 1992). There could also be the potential for developing functional foods based on bere. Although bere flours are a source of minerals and vitamins, cooking is likely to influence their nutrient profile and this would need investigation before making health claims for bere products.

26.5.2 Baking properties of bere flour

The flours described in the previous section were used for baking trials in which wholemeal or white bere flours were mixed, respectively, with wholemeal or white wheat flours at inclusion levels of 0, 10, 20, 30, 40 and 50%, using a standard recipe and procedure. The final bread products were analysed for loaf height and volume.

For wholemeal bread, these both decreased with increasing levels of bere but for white bread this did not occur until 20% inclusion. With both types of bread, crumb colour became darker as more bere was added. The trials indicated that a commercially acceptable loaf could be produced using white flour with up to 20% inclusion of Bberere flour.

26.5.3 Malting characteristics of bere

Prior to using bere for brewing and distilling, samples were sent for micro-malting. Two samples were micro-malted by Bairds Malt in 2004 and showed high total nitrogen (1.90-1.95% dm) and low predicted spirit yield (351-354 l/t). A third sample micro-malted by Crisp Malting Group in 2005 also had high total nitrogen (2.18% dm) and a low dry extract (283-286 l°/kg). Modern malting barley varieties have low grain nitrogen (< 1.65%) which is associated with high dry extract (about 310 l°/kg) and high alcohol yield on distillation (about 410 l/t). Varieties like bere would not normally be used because they increase the cost of alcohol production.

26.6 Development of bere products and supply chains

26.6.1 Bere beer

For the production of beer, bere malt was produced from Orkney bere in 2005 and used for product development in 2005/6 by Valhalla Brewery, Unst, Shetland. The manufactured malt was considered to have "a unique balance of flavours, characterized by malty, sour, sweet, astringent and dry notes" (B. Johnson, Crisp Malting Group, 2007, personal communication). Valhalla Brewery launched the beer, 'Island Bere', in 2006 using a recipe which

retained the characteristic bitterness of bere but did not allow this to dominate the beer. Valhalla Brewery (www.valhallabrewery.co.uk) markets its products with a strong Viking image and so its use of bere, which was possibly introduced to the UK by Norse settlers (Jarman 1996), is very appropriate.

26.6.2 Bere whisky

The Institute has been involved in two projects to develop bere whisky. The first was with Isle of Arran Distillers in 2004 when 19 t of Orkney bere was malted and then distilled at the Lochranza distillery on Arran. The new-make spirit was considered very different on the nose compared with the main stream barley variety Optic and "was not so sweet orangey / citrus" (G. Mitchell, Lochranza Distillery, 2004, personal communication). The spirit was stored in Bourbon casks and by May 2007 had taken on "a nice fruity aroma, pears, apples and some citrus flavours. It also has a nice floral appeal along with the vanilla odours from the wood" (G. Mitchell, Lochranza Distillery, 2007, personal communication).

The second whisky project involved collaboration with Bruichladdich distillery on Islay and a small number of growers on Orkney and Islay. Within the project the Institute has organized a supply chain for bere and in 2007 and 2008 supplied Bruichladdich with 59 t and 68 t, respectively, of Orkney bere. Dunlossit Estate on Islay supplied 18 t in 2007. The distillery will use the bere spirit to develop specialist bere whiskies. The distillery considers the quality of the spirit extremely good with an excellent texture "like glycerine", while on the nose the spirit is "fresh and fruity with notes of lemsip, wild mint, rhubarb, pear drops and with cereal notes underpinning the bouquet" (J. McEwan, Bruichladdich Distillery, 2008, personal communication). Analysis of the financial beneficiaries of the project indicated that there were many more than those who grew the bere – in particular:

- Other farmers and contractors who provided services such as grain drying, seed dressing, sowing, spraying and harvesting
- Suppliers of agricultural inputs
- Hauliers involved in grain and malt transport
- Maltsters and their employees
- Distillery staff.

The value of these extra payments was about 1.6 times that of the purchase price of the grain, showing that the economic impact of even relatively small commercialization projects with landraces can have significant benefits for the wider community. This is particularly the case with the bere whisky and beer projects which involve remote island locations with small populations (Unst, Arran

and Islay had populations of 720, 5 058 and 3 457, respectively, in 2001), where there are limited opportunities for generating new income but where most earnings are spent within the communities.

26.6.3 Development of a bere supply chain

To produce the quantities of grain required by Bruichladdich, AI had to develop a supply chain for bere. The main components in this are: i) the production of bere seed, ii) the commercial growing of bere, and iii) the processing of grain after harvest.

Bere seed is produced by AI on fields where no other types of barley have recently been grown. After harvest, it is dried to 14% moisture content and stored in a dry, vermin-proof barn. It is then cleaned to remove light grains and dressed with Raxil S (20 g/l tebuconazole and 20 g/l triazoxide) to protect against seed-borne diseases, particularly loose smut (*Ustilago nuda*) and barley leaf stripe (*Pyrenophora graminea*). Samples of each year's seed are sent to Science and Advice for Scottish Agriculture (SASA) where they are tested for germination percentage and health and stored in the germplasm collection under the Scottish Landrace Protection Scheme.

Apart from AI, a small number of Orkney farmers (three or four per year) and Dunlossit Estate on Islay grow bere for the Bruichladdich supply chain and these are provided with seed and recommendations for growing the crop. At harvest, Orkney farmers deliver their bere to the Institute which then dries and stores it until it is sent for malting. This is necessary because few farmers in Orkney have grain drying and storage facilities.

26.6.4 Discussion

The cost of producing alcohol from bere is approximately twice that of using a modern malting variety because of the higher price of bere grain and its lower spirit yield. Malting costs may also be higher if the quantity of grain is less than the batch size of malting bins. In remote areas like Orkney and Shetland, the transportation costs of both grain and malt can be very high, particularly for the small quantities used in new product development. As a result, alcohol products from bere need to retail at higher prices than those produced from modern varieties. For consumers to pay these prices, marketing based on heritage may help, but most importantly, the taste of these new products must be attractive and distinctive. Although the initial indications are very promising, it will only be after about eight to ten years from distillation that the quality of the Bere whisky will be known because this is the typical minimum maturation period for a malt whisky.

It has not been a problem in Orkney to find a small number of growers prepared to plant 1-3 ha each of bere per year because a realistic price has been offered for the grain – approximately one and a half times that of local feed barley. In addition, farmers have the benefit of the straw for which there is a ready local market. With straw yields of about 5 t/ha (fresh weight) this can add an additional £85-200/ha to the crop's value, depending on local availability. Most farmers, however, are not interested in growing bere because it is still considered a difficult crop to grow and farmers would only be persuaded by a significantly higher price.

26.7 Research funding

Although AI has funded significant parts of this research itself, there has been support for commercialization projects from the regional development agencies and programmes mentioned in the Acknowledgements section, indicating recognition of the commercial potential of bere.

26.8 Conclusions

The conviction underpinning AI's research and development work with bere is that the long tradition of using bere for flour and malt production indicates that these products have quality attributes which should make them attractive for niche markets. AI is therefore working to develop these markets so that bere can be grown commercially on farms in Orkney and continue to make a useful contribution to the farming system. This diversifies farm income and also that of end-users like bakeries, breweries and distilleries and creates employment across these sectors. Consumers also benefit by having access to new or traditional products. It is likely that the most effective way of retaining bere within the Orkney farming system is to develop markets which offer a premium for it.

Through commercializing bere and marketing food and drink products based upon it, opportunities have been created to raise awareness (Martin and Chang 2007, 2008) about this landrace amongst diverse groups – growers, end-users and consumers. For many, this has been their first introduction to the term 'landrace' and so the commercialization process has provided a valuable public relations opportunity to demonstrate the practical value of landraces and the importance of conserving them.

As a result of the Institute's work on developing beer, whisky and grain markets for bere, the area dedicated to this crop increased from 5 ha in 2000 to about 30 ha in 2008. However, most of this area is

being grown for whisky and if this outlet ceased, there would again be only about 5-10 ha of bere grown on Orkney. AI is, therefore, still trying to expand the market for bere meal.

By providing farmers with markets for bere, the crop is also being given an opportunity to continue to develop as a landrace under the selection pressures of both today's changing climate and modern agricultural practices (e.g. mechanization and the use of a low level of inputs). As such, the Institute's work is probably better described as focusing on 'continued cultivation' than '*in situ* conservation' and it must be expected that, over several years, this is likely to result in the Institute's bere diverging from the material which was originally obtained in 2002. Since samples from each year's seed are stored with SASA, there will be an opportunity in the future to investigate this.

Compared with growing modern barley varieties, there are environmental benefits from growing bere because it is grown with fewer inputs. In Orkney, agriculture is dominated by grassland for livestock, and arable areas provide an important habitat for a number of plant and animal species – fields of bere, therefore, add visual diversity to the landscape and also help to increase on-farm biodiversity.

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27. The Origin and Special Cultivation Features of the Northern Local Potato Strain 'Puikula'

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27.1 Characteristics of Puikula

'Puikula' is an old local potato strain from the northern part of the Nordic countries. It is late-maturing, and has long and strong stems and small leaflets. The stems and white flowers contain anthocyanin colour. The long, almost banana-shaped, tubers are white-skinned. The flesh colour is bright yellow and the dry matter and starch contents are high.

27.2 Origin

The first evidence of potato growing in Finland is from 1727 (Varis 2001). There are very few pieces of written information on 'varieties' used from that time. However, it is known that during the 1770s in Sweden a variety which closely resembled the modern form of 'Puikula' was cultivated. According to the descriptions of that time the strain had many names, one of them was 'French'. So it is believed that the Puikula was brought to Sweden from France and from Sweden further to Finland.

The potato blight, the disease that Puikula is very sensitive to, came to Europe in 1840s. As a consequence, Puikula vanished from cultivation in southern Sweden due to high infection pressure of potato blight. However, the cultivation of this potato strain had already spread towards the north. In the 1850s it was already cultivated in the provinces of Västerbotten and Norrbotten and from there it spread slowly to Finnish Lapland and across the Gulf of Bothnia to the province of Central Ostrobothnia in Finland. In the early decades of this century it was the oldest and the most important variety in Lapland. In 2006 the cultivation of Puikula covered about half of the commercial potato growing area in Lapland.

27.3 The special features of cultivation in the north

The variety 'Puikula' is a very late cultivar. Its dormancy mechanism is so strong that it is almost impossible to sprout it during the storage period in winter. This means that it has very good storing

properties, but requires a very long sprouting time in the spring before planting. The proper time is 60 to 90 days compared with other varieties, which need two to four weeks sprouting time in the spring.

The early development of the plants in the summer is slow. The stems and leaves must be almost fully developed before the initiation of tubers can occur. Thus Puikula behaves as a typical short-day variety in the long-day environment. On the other hand it can utilize quite well the best growing period at the beginning of August. Puikula's yield potential is high, but the growing season in the north is always too short and therefore the tubers are always harvested immature. Although the yield is low the immature harvesting date gives the tubers their special taste, which is lost if the tubers are fully mature.

The variety needs careful cultivation techniques, because it is very sensitive to stress factors. A visible stress indicator at harvest is the anthocyanin colouring of the tuber flesh. This can be caused by such factors as poor weather during the growing season, too short sprouting time in the spring or too heavy nitrogen fertilization.

27.4 The present status

In 1997 the 'Puikula' grown in Lapland was registered as Lappland's Puikula in the European Union under the terms of Protected Designation of Origin. This designation (PDO) can be assigned to a product which has a fixed association with a geographical region, and whose quality or characteristics are essentially or exclusively sourced from a specific geographical area. The production of the product must also take place in the region to which its name refers. The PDO designation has drawn a lot of attention to this local potato strain from the north and allowed it to become a popular landrace product in both Finnish homes and professional kitchens.

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28. Farm Seed Opportunities: a Project to Promote Landrace Use and Renew Biodiversity

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28.1 Introduction

Farm Seed Opportunities (FSO), a specific targeted research project in the FP6 European programme (2007-2009), was conceived to support the implementation of seed regulations on conservation varieties (directive 98/95/EC and new directive 2008/62/EC for agricultural species). For this purpose, FSO has been developing coherent definitions of the different kinds of varieties cultivated in farm fields following a survey and evaluation of practices at the national level. Even though the project aims mainly at responding to the needs of European policy makers, it will also significantly contribute to the recognition of the role of farmers in conserving diversity through the use of landraces and the breeding of new varieties. FSO took into account participatory plant breeding (PPB) experiences for organic or low-input agriculture, with the goal of proposing regulation scenarios that recognize and encourage on-farm varietal innovation and selection.

Partners in the project included diverse stakeholders concerned with the conservation and use of varieties that do not fit the DUS (Distinction, Uniformity, and Stability) criteria of the current seed regulations. Participants were researchers involved in organic

agriculture (FiBL and LBI), genetic resources (CGN, IGSA and INRA), seed quality (PRI) and participatory plant breeding organizations (IIED and WUR), organic farmers' organizations (AIAB) and seed networks (RAS and RSP). The partners from IIED and WUR (WU, PRI and CGN) have extensive experience, including policy research, in developing countries.

28.2 Varieties, farmers and agriculture in Europe

28.2.1 Background

According to the dictionary, the word 'variety' means at the same time 'diversity' and a part of this diversity. Both meanings can be encountered within the field of agronomy and plant breeding. Before modern plant breeding was established, landraces were developed by farmers, with specific characteristics that made them distinguishable from each other. Diverse local growing environments, agronomic conditions and cultures made this variation in landraces possible. Since 1900, as modern plant breeding practices were increasingly adopted, these variable landraces were gradually replaced by more uniform cultivars that often had higher yields. The industrialization of agriculture has changed our vision of fields and plants, for both scientists and farmers. Even if the F1 hybrids of maize did not produce substantial increases in yield during the first three decades of the 20th century, the phenotypic uniformity of the cultivars developed was recognized as progress (Duvick 2001; Bonneuil 2007). The farmers living in the Corn Belt of the USA appreciated uniformity for machine harvesting but "furthermore, a field of corn in which all the plants are alike, each with a single ear at the same height, is aesthetically pleasing, and this appealed to many corn growers" (Crow 1998). The standardization and homogenization of agricultural production, the increasing use of chemical inputs and water, and the standardization of the market are the main pillars of what we define as agricultural modernization. Alongside these dominant conventional agricultural practices, a different agriculture strongly connected to 'terroir' (a French word that refers simultaneously to the soil, climate and cultural values of an area) has been preserved and is now re-emerging in Europe. This alternative agriculture is based on different varieties from those of conventional agriculture, ones with strong local adaptation. In effect, locally adapted varieties, old landraces and mixed populations play a more important role in organic than in conventional agriculture (Almekinders and Jongerden 2002). In addition, quality aspects linked to specific regional or artisan

products are generally important in alternative agricultural systems, and are often responsible for the preservation of local varieties.

The development of low-input or non-conventional agricultural practices is also related to the diversification of public demands, in particular for organic farming and local products. These agricultural systems are based on varieties covering a wide range of genetic states and categories, for which the criteria of stability and homogeneity are not intrinsic qualities and are not necessarily required. Landraces and local varieties are often involved in this form of agriculture. Moreover, the shortcomings or unsuitability of conventional varieties with respect to the needs of organic farming has stimulated several PPB initiatives for organic farming, e.g. in France and the Netherlands (Chable 2005; Lammerts van Bueren et al. 2005; Desclaux 2005). PPB varieties can be bred from diverse genetic resources using breeding methods that are in compliance with the IFOAM (International Federation of Organic Agriculture Movements) draft standards for organic plant breeding (IFOAM 2005). Their main characteristics are the ability to adapt and co-evolve within the environment and with farmers' practices and needs. They are not necessarily bound to a geographical area and the role of seed exchange in traditional agricultural practices has been widely acknowledged (e.g. Almekinders et al. 2000; Berthaud et al. 2001; Elias et al. 2001; Alvarez et al. 2005).

28.2.2 Case studies in Europe

FSO performed a survey of European initiatives that resulted in a list of 68 initiatives in 17 European countries. Several other farmer-driven initiatives were unfortunately not included in our inventory, as the information concerning these initiatives usually remained local and in the national language, which often resulted in difficulties in identifying these initiatives. Relatively few Eastern European countries were identified, and while this may be partly due to the reasons mentioned above, our discussions with key stakeholders from four Eastern European countries made clear that there are relatively few seed initiatives in this region (Osman and Chable 2009). This may be due to the past system of collective agriculture during the communist era and the transition to private ownership afterwards.

A primary objective of FSO is to get an overview of the diversity of organizations and individuals involved in seed multiplication and breeding of landraces in Europe. Our description was based on their main seed activities. Thus, we distinguished the following groups:

- 'Seed Savers', private initiatives with the aim of collecting and conserving old local varieties *in situ* and promoting their use

- 'Seed producers', generally small-scale seed companies, often specialized in organic seed multiplication and conservation of traditional varieties
- 'Farmer breeders', farmers who breed their own varieties, often in collaboration with researchers in the framework of a PPB programme (Lammerts van Bueren et al. 2005; Vaz Patto et al. 2007; Chable et al. 2008)
- 'Biodynamic breeders', private (often non-profit) initiatives run by persons, mostly with an academic background (degree in plant breeding) who aim at improving landraces and old varieties.

It is important to note that there are no strict boundaries among these groups. Many initiatives belong to more than one group. For example farmer breeders are sometimes also seed savers or commercial producers of local varieties.

28.3 Evolution of the varieties on-farm

One important aim of FSO is to describe the varieties bred on-farm and to analyse the mechanisms (farmers' practices, natural selection) that drive the evolution and adaptation of these varieties. FSO will adapt or develop the appropriate criteria to describe these varieties in the framework of the current regulations, but will also elaborate the concepts of 'peasant/farmers' variety' and 'on-farm breeding' which are not yet taken into account in seed laws. The experimental data produced by the FSO project will be used as a reference to recommend modification of the current regulations and/or to suggest a new place for these types of varieties alongside the current regulations.

The field trials of the FSO project are being conducted over three years (2007 to 2009) by growing successive generations of various varieties of wheat, maize, spinach and beans in a European network (Italy, France, the Netherlands) on farms. Knowing that heterogeneity within a variety is largely dependent on the mating system, we have chosen allogamous and autogamous species to evaluate several ways of managing the variability within varieties. Thirty farmers from the three countries are involved in the experiment. Most of them apply organic or biodynamic agricultural practices. The others are engaged in low-input agriculture. Landraces, conservation varieties or farmers' varieties have been chosen depending on the species. The experiment follows the breeding and seed production practices of the farmers, according to their own objectives and within the normal operation of their farms.

In the third year (2009), samples of the varieties grown in the network will be phenotypically evaluated both on-farm and in a common experiment. The evaluation data and the history of these

varieties will be analysed in relation to the associated farmers' practices in order to understand their temporal evolution and spatial differentiation. This will allow us to identify key factors for the maintenance of genetic diversity and the development of local adaptation (e.g. seed exchanges, environmental changes, plot sizes, number of varieties per farm...). The link between the level of heterogeneity of these landrace/conservation/farmers' varieties and their potential for adaptation will be explored. Because landraces have always been exchanged in the past and have an intrinsic heterogeneity, they are expected to show more adaptive flexibility when moved from their location of origin to a new environment. In fact, very few cultivated species have remained in their original area in our agricultural history.

Quality aspects of on-farm seed production are also considered. Requirements for the respective seed categories have to be evaluated with a view to maintaining the sustainability of this seed production activity in terms of qualitative and sanitary standards. However, there is insufficient factual knowledge available about on-farm seed production. During the three years of on-farm experiments, specific attention will be paid to different aspects of seed quality. Moreover, surveys and evaluation of seed quality will be extended to other PPB or farm seed production initiatives in the countries of the FSO consortium. The conditions will be studied at various locations, and recommendations will be developed for improving the situation and/or proceeding under such conditions. These recommendations will most likely include solutions currently known to organic farming practitioners but as yet unrecognized in conventional seed production.

28.4 Identification of regulation needs

During the last century, plant breeding activities in public research centres and private firms have led to the development of varieties answering to the needs of agricultural modernization. Seed laws established in this cultural framework aimed at increasing the use of modern varieties and at the same time protecting farmers as seed consumers. Today, current seed regulations conform to the dominant concept of cultivated varieties and include the criteria of Distinction, Uniformity, Stability (DUS) and Value for Cultivation and Use (VCU) for arable crops.

The first legal mention of cultivated varieties in France is dated 1 August 1905, and was made by the 'Répression des Fraudes'. In 1942, the Permanent Technical Committee on Seeds (Comité Technique Permanent des Semences), made up of seed industry representatives and government scientists, determined the DUS criteria for defining

varieties listed in the official French seed catalogue. In 1966, the European Community created the Common Catalogue. Any commercialization, whether for sale or free distribution, is illegal for varieties not listed in the national or European catalogues. Moreover, only certified seed producers are allowed to sell seeds.

In 1998, for the first time, the European Directive 98/95/CE mentions the essential need for ensuring the conservation of genetic resources and the necessity of introducing a new catalogue with different rules which would include varieties called 'conservation varieties' which are threatened with genetic erosion. After ten years of discussions, in 2008 the Commission released the first directive specifically on conservation varieties (in June 2008 with the Directive 2008/62/CE), but only for certain agricultural species. Vegetables and seed mixtures will be considered in two new separate directives still in discussion in the Permanent Seed Committee.

Even if EU Member States recognize the limitations of the exclusive use of DUS criteria, new regulations proposed for conservation varieties restrict allowable varieties to those that fit the DUS criteria as much as possible, and restrict their cultivation to a limited 'region of origin'. Landraces or any kind of local varieties become 'conservation varieties'. The term 'conservation' does not allow for the evolving character of these varieties in the field. Since the beginning of the negotiations, no one has considered that innovative varieties could emerge from outside conventional seed systems.

The FSO project has identified several types of varieties, which may need different rules for certification and protection. These categories are defined in relation to their ability to meet DUS criteria, the actors responsible for varietal development, the potential region of diffusion for varieties, and the targeted agricultural systems. It is possible to produce the following preliminary list:

- Modern varieties (DUS varieties), registered in the official catalogue, which are mainly the product of formal breeding programmes following the concept of wide adaptation
- Local or old varieties that could fit the recent European definition of 'conservation varieties' and that could be registered in the new catalogue specifically for these varieties. They will be maintained by small-scale seed companies or breeders or farmers and will have a local or regional diffusion
- Population varieties, heterogeneous PPB varieties, and local and old varieties that could be distinct, but for which the criteria of uniformity and stability can be verified for only a few characters and which do not fit within the concept of 'conservation varieties' due to their wide diffusion. They will be particularly useful for organic and low-input agriculture

- Other varieties from farmer, professional and amateur breeding activities that will be continuously evolving with a variable level of homogeneity; these will be exchanged according to the willingness of the communities involved (farmers' organizations, associations), the definition of Farmers' Rights (Art. 9 of the International Treaty on Plant Genetic Resources for Food and Agriculture) and collective use rights in Europe.

28.5 Conclusion

Besides providing scientific support to policy makers, the FSO project is contributing to the recognition that plant breeding and the renewal of crop biodiversity or plant genetic resources can again be connected to farm production activities at a local level. Part of our inherited cultivated diversity has been rediscovered through PPB experiences on organic agriculture in Europe. This inheritance, which in recent years has been mostly maintained in genetic resource banks, must also be allowed to evolve on-farm (or in gardens) in order to keep its relevance in the context of rapid climate change. In this context, the efficiency of dynamic management for the maintenance of genetic diversity and the development of local adaptation were also demonstrated under experimental conditions (Goldringer et al. 2006).

An important part of the project is devoted to the integration of scientific and traditional knowledge to develop on-farm breeding methodologies, thus providing a basis for enhancing communication among stakeholder groups as well as between these groups and society at large. An important part of our activities is to share experiences and strategies among scientists and farmers from developed and developing countries. Since seed legislation poses a challenge to farmers in developing countries where on-farm breeding is still a daily practice (Louwaars 2007), breeding strategies will be compared in order to broaden seed laws at the international level. Collaboration with non-governmental organizations, collective seed organizations and farmers' rights movements in Europe and developing countries will result in recommendations for regulations that better meet the needs of farmers throughout the world and improve food sovereignty.

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29. On-farm Conservation Portugal – Vaso Project – a Long-term Conservation Programme

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29.1 Introduction

The VASO (Sousa Valley) project began in 1984 with Dr Silas Pêgo (Pêgo and Antunes 1997; Pêgo 2007) as a pilot project where an 'Integrated Philosophy' approach was implemented on a mountainous polycrop system in northwest Portugal. In contrast to a 'Productivist Philosophy', the 'Integrated Philosophy' approach considers agriculture as an holistic system where the *rural farmer* (producer of high-quality products, genetic resources curator, environmental agent for soil and water management, forest fire-fighter and cultural traditions keeper), *local landraces* (where co-evolution with pests and diseases and also climatic changes is expressed by strong GxE interaction) and *breeding* (maintaining the quality while improving the quantity, so that local genetic resources can be competitive and maintained at farmer level) should all be considered and related. Here the farmer is considered as the most important genetic resource to conserve and also to be where the power for decision resides (Pêgo and Antunes 1997; Moreira 2006). The VASO project implementation, methodologies and lessons learnt for future insights are presented in this paper.

29.2 Implementation

An understanding of the importance of on-farm landrace conservation led Silas Pêgo, in 1984, to a detailed survey of farmers' maize fields in one of the most fertile areas of the northwest region of Portugal, the 'Vale do Sousa' region, as a starting step for the VASO project (Pêgo and Antunes 1997). Pêgo encountered a region characterized by small farms, with scarce land availability due to a high demographic density, where maize still played an important role. Maize hybrids were already covering a considerable area, in comparison with other areas of the country (in 1985, 25% versus 15% respectively), but he still found an extensive number of traditional maize landraces being cultivated in polycropping systems. To provide an incentive for

in situ conservation of these traditional maize landraces, Silas Pêgo engaged the local farmers and their seeds in a participatory maize breeding programme. By doing this, his goals were not only to conserve but also to improve the social well-being of this rural community by increasing farmers' income through rising yields from some of their own seeds. To start this programme, three main choices had to be made: 1) the location that best represented the region; 2) the farmers to work with; and 3) the germplasm source to start from (Pêgo and Antunes 1997).

29.3 Location

The chosen area, in spite of being largely used for high-quality food under a multi-crop system, was also the location of the national maize production champion (18 t/ha, with a single cross hybrid for feed, under mono-cropping). Both circumstances, together with the availability of a basic amount of agro/sociological/economics data previously collected by some members of the original multidisciplinary team, assured the breeder of a good crop adaptation and a thorough knowledge of the region. Finally, but of extreme importance for the long-term viability of this programme, a local elite farmers' association (CGAVS) agreed to be part of the project, by providing logistic support to it.

29.4 The farmers

Choosing the right people to work with is also a major decision in an on-farm project, since the system is supposed to be implemented along with the farmer who will have the power of decision. The farmers were selected based on their initial acceptance and enthusiasm to join the project, thus assuring a good chance for success. With careful respect for the local traditional agriculture, a tacit agreement was made between the breeder and the farmers involved. While the breeder would apply his breeding methodologies, the farmers would continue a parallel programme with their own mass selection criteria. With this agreement the breeder had to accept low-input and intercropping characteristics, as well as to accept and respect the local farmer as the decision maker. On the other hand, the farmer was able to compare the effectiveness of the two breeding systems (phenotypic recurrent and S2 lines recurrent selection). This allowed the farmer to base his/her decisions on solid grounds. Finally, due to the choice of locally adapted germplasm, diversity and quality were considered as the priority traits.

29.5 Germplasm

One of the first aims of the VASO project was the selection of a regional open-pollinated variety (OPV), a pre-requisite of the integrated philosophy option. This selection was done taking into account the second class soils and stress conditions (e.g. high aluminium content), medium nitrogen inputs, water availability, flint type, bread making characteristics most preferred by the farmers, and fitness to the traditional polycropping system (maize/beans/forage). Two OPVs were selected as the starting populations:

- 'Pigarro' was an FAO 300 maturity landrace with white, flint kernels and with high levels of root and stalk lodging. It was characterized by having 18 to 28 average kernel row numbers, i.e. strong fasciation expression, and its white colour was preferred for the traditional bread (broa).
- 'Amíudo' was a yellow flint maize landrace, FAO 200, adapted to stress conditions such as aluminium toxicity and water stress.

The VASO project was also the arena for on-farm conservation of additional germplasm landraces such as: 'Basto', 'Aljezur', 'Aljezudo', 'Castro Verde', 'Verdial de Aperrela' and 'Verdial de Cete'. In parallel with the landraces approach, a synthetic population 'Fandango' (open pollinated variety) was also included, which has been selected under mass selection since 1985 (Moreira 2006; Moreira et al. 2006).

29.6 Methodology

The VASO project is a long-term case study of on-farm maize landraces conservation by participatory breeding. In this project, local maize landraces with quality for bread production – 'Pigarro' and 'Amiúdo' – were submitted to a participatory population improvement programme that included yield, lodging performance, pest and disease tolerance, and indirectly, adaptation to climatic changes. The breeding approach was conducted based on the concepts of quantitative genetics and three simultaneous methodologies were applied in the farmers' fields: phenotypic recurrent selection (MS) and S2 lines recurrent (S2RS) selection for 'Pigarro' and S1 lines recurrent selection (S1RS) for 'Amiúdo' (Pêgo and Antunes 1997). The procedure of passing through several cycles of selection involved keeping samples of MS and S2RS or S1RS lines in cold storage described below. The evaluation trials of each method *per se* and their comparison during 20 years of selection are described in Moreira et al. (2008) and Vaz Patto et al. (2008) for 'Pigarro'. In the case of 'Amiúdo', evaluation will be done in the future. During the VASO project, some pre-breeding methodologies were also developed (e.g., HUNTERS, Overlapping

Index) (Moreira and Pêgo 2003; Moreira et al. 2006). These methodologies are very useful for maize landraces' selection for on-farm conservation programmes.

29.7 Phenotypic recurrent selection (mass selection)

The phenotypic recurrent selection or mass selection (MS) (from 1984 until the present), included two-parent control (stratified mass selection with parental control c = 1.0). This is an improved extension of the mass selection procedure commonly used by farmers (for one-parent control c = 0.5). In this case the farmer was advised to conduct selection under a three-step sequence (A – B – C). The first two steps (A and B) take place in the field and the third one (C) at the storage facilities:

A. Immediately before pollen shedding, selection is performed for the male parent by detasselling all the undesirable plants (weak or pest and disease-susceptible, and plants that do not fit the desirable ideotype)
B. Before harvest, besides selecting for the best ear size, the plants are foot-kicked at their base (first visible internodes) to evaluate their root and stalk quality. With this procedure, as an indirect measurement, the pest and disease tolerance can be also evaluated. In practical terms, if the plant breaks or lodges at an angle of over 45º, it is eliminated. Prolific plants are preferably selected
C. At the storage facilities, after harvest, selection is performed separately for both normal and prolific ears and always includes ear length, kernel row number, prolificacy, and the elimination of damaged/diseased ears. The selected ears are finally shelled and mixed together to form the next generation of seed. The farmer selection pressure ranged from 1 to 5%.

29.8 Recurrent selection by S2 lines

S2 recurrent selection was applied to the chosen landraces ('Pigarro' and 'Amiúdo') since it takes into consideration the additive component of the genetic variance (3/2) (Hallauer 1992). Nevertheless, while 'Pigarro' could be handled easily up to the S2 stage, 'Amiúdo' exhibited very strong inbreeding depression, making the yield tests on S2 lines impossible to assess. This circumstance forced the breeder to substitute S2 lines with S1 lines for the recurrent selection. Selection was performed by the breeder and was organized in a three ('Amiúdo') or four ('Pigarro') season scheme with three completed cycles:

Season 1 - 1000 S0 plants were selected and selfed, from which 500 to 600 S1s were selected at harvest

Season 2 - 500 to 600 S1s were planted and selfed to obtain the S2 seed and at harvest the best 200 ears were selected

Season 3 - the selected S2s were submitted to a yield trial in a randomized complete block design and tested for yield performance, pest and disease tolerance, and stalk quality

Season 4 - using remnant S2 seed, the best 30 to 35 S2 lines (15 to 20% selection pressure) were planted and recombined through controlled pollination to form the first cycle C1(S2) seed. The same sequence was conducted until the third cycle C3(S2) was completed.

29.9 Results and lessons learnt

From more than 20 years of these on-farm conservation/improvement approaches some conclusions can be noted.

From both selection methods used on 'Pigarro', the VASO project results suggest that mass selection is better than S2 Recurrent Selection due to the following reasons: (a) mass selection is a cheaper methodology, technically more accessible to farmers, which is a great advantage in the establishment of on-farm conservation programmes; (b) one cycle of selection can be completed each summer, and *in situ*/on-farm conservation of the genetic diversity is effective (Vaz Patto et al. 2008). This suggests its role as a back-up system (complementary with *ex situ*) and a monitoring process for effective on-farm conservation of diversity; (c) the lack of significant yield increase is a disadvantage.

S2 recurrent selection, when applied to 'Pigarro', seems to be more adapted for an on-station breeding programme where a massive selfing effort is needed. Unexpectedly, this germplasm showed very low inbreeding depression when going from S0 to S2 lines. A reduction in fasciation expression was also noticed, i.e. less variation in ear diameter and kernel row number and a greater reduction in root and stalk lodging were observed. Besides being a more complex and time-consuming approach (four seasons per cycle of selection) when compared with MS, Moreira et al. (2008) concluded that the S2RS yield decrease could be due to a decline in fasciation expression or even to the selection procedures for stalk and root lodging improvement. In order to clarify this situation, more cycles of recurrent selection would be needed.

Molecular data from Vaz Patto et al. (2008) using 16 SSR on three selection cycles (C0-84, C9-93, C20-04) of 'Pigarro' revealed that no effective loss of genetic diversity had occurred during the

selective adaptation to the farmer's needs and the regional growing conditions. Variation among selection cycles represented only 7% of the total molecular variation, indicating that a great proportion of the genetic diversity is maintained in each selection cycle. Genetic diversity has not been reduced from the 'Pigarro' bred before 1984 to those examples improved after 2004, but the genetic diversity maintained is not exactly the same. Mass selection seems to be an effective way to conserve diversity on farm.

The anthropological and sociological objective of participatory breeding suggests that more attention should be given to: (a) learning more about how plant breeding itself has been influencing farm changes and agricultural systems; for example, is on-farm plant breeding simply conventional plant breeding on farms, or is it a whole different kind of plant breeding approach for the future? (Powell 2000); (b) how on-farm conservation is managed to ensure genetic diversity and breeding success; (c) the definition of 'yield' needs to be reconsidered and broadened to include the total yield of the polycropping system and not just the yield of a single crop *per se* (Pêgo and Antunes 1997; Powell 2000); and (d) it is important for breeders to work with other people involved in the food production 'chain' such as traditional grain millers and bakers (Powell 2002).

The VASO project allowed the farmer and the breeder to compare breeding methodologies *in loco*, i.e. decisions were based on knowledge (Pêgo and Antunes 1997). The improvements achieved on ear size (selection for big ears) led to the winning of several trophies by the farmer at the 'Sousa Valley Best Ear Annual Contest'. This kind of initiative, supervised by the local Farmers' Cooperative Association (Cooperativa Agrícola de Paredes) has not only contributed to the recognition of the farmer by the community, but has also attracted new farmers and new germplasm to this programme, which could be identified and preserved on-farm by the same approach (Moreira et al. 2008). An important aspect which should not to be forgotten, on conserving diversity through landrace production and generation of farmers' varieties, is legal protection. Current intellectual property rights do not protect farmers developing their own varieties.

When compared with the literature on collaborative plant breeding, the VASO project can be considered an outstanding example as far as its duration is concerned (a continuous project since 1984). Nevertheless, due to the successive agricultural policies pursued by the European Community, this conservation project is in danger because of the disappearing of smallholder farming as a viable way of life in Portugal and the socio-economic 'pull' factors that remove younger generations from the farm (Powell 2000; Vaz

Patto et al. 2007). Stakeholders outside agriculture, e.g. the tourism industry, could also be involved in rewarding farmers for their conservation measures that offset the loss of biodiversity in the agricultural landscape, securing tourism income especially in rural tourism areas (e.g. through the quality of the gastronomic offerings).

Hybrid populations' development could also contribute to yield progress and to avoiding the collapse of some interesting germplasm. This approach can be applicable in a rural development strategy if farmers' associations for specialties (e.g. maize bread) are willing to pay the farmers an extra price due to the on-farm conservation and improvement of these populations or even for these populations' hybrids. This means that the apparently contradictory integrated and producer philosophies have their specific niches of application and some 'hybrid' philosophical adaptations will be preferred in certain situations. This scenario is supported by enthusiastic results from hybrid populations (Silas Pêgo, personal communication) that could be of great importance to define heterotic groups that could enhance the breeding efforts (Tracy and Chandler 2006).

The participatory plant breeding approach (PPB) can be associated with *in situ* conservation of landraces, contributing to their economically sustained presence in the farmers' fields. It can also contribute to define *in situ* / on-farm strategies that could help to design better synthetic hybrid populations for a new generation of low-input and organic farming adapted to environmental changes.

Our experience with the utilization of local landraces with special quality traits suggests that there is a potential for economic exploration under a rural development programme, where specialties and traditional foods are the major output and where the hybrid seed industry can also search for germplasm (according to the International Treaty on Plant Genetic Resources for Food and Agriculture) being maintained in a co-evolutionary process of low-input or sustainable organic farming.

Finally, lessons from the VASO project could help us to design new on-farm conservation projects not only for the Portuguese reality, but also for developing countries where adaptation to small farmers' needs (e.g. maize quality for food, traditions) are outside the scope of multinational seed companies.

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30. The Crab Apple *Malus sylvestris* – Basis for a Delicious Fruit Tea

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The wild apple species *Malus sylvestris* (L.) Mill. belongs to the Rosaceae family. It is insect-pollinated and quite a rare species. Wild apple trees have expanded crowns and often look like bushes. They can grow up to 10 m tall with trunk diameters of 24 - 45 cm and can live 80 -100 years but sometimes even much longer. Owing to their weak competitive ability, the wild apple exists mostly at the edge of the forests, in farmland hedges or on very extreme, marginal sites. *Malus sylvestris* is indifferent to soil type; wet edges of the forest are preferred. The species has extremely high light requirements and does not tolerate competitive pressure well, especially from beech (Stephan et al. 2003).

Malus sylvestris is native in most European countries, spread over Western and Central Europe and occurs in a scattered distribution pattern as single individuals or in small groups. It is generally a rare species in mixed hardwood forests. Hybridization with cultivars grown for fruit production is supposed to be common, making it very difficult to identify pure wild fruit trees. Individuals with intermediate phenotypes are known to occur throughout the European landscape.

Morphological characters are initially used for identification purposes. The five main traits to characterize *M. sylvestris* are the lack of hairiness of the undersides of leaves and all parts of the flowers, the maximal fruit diameter of about 30 mm and the lack of red skin colour of the fruits as well as the astringent taste. Genetic analyses indicate that introgression of *M. sylvestris* into the *M. x domestica* genepool has rarely or never occurred in the past (Coart et al. 2003). The domesticated apple *Malus x domestica* is a hybrid complex with the main progenitor *M. sieversii* native to Central Asia. Any possible influence of *M. sylvestris* is thought to have been only on cider apples.

Genetic resources of the wild apple are seriously endangered in many countries: rare occurrence and a narrow genetic base cause genetic drift due to the small numbers of mother trees and long distances between adult trees (Wagner 1999). Natural regeneration is not guaranteed and if it occurs it is endangered by grazing, and hybridization with cultivated forms of apple is considered to be a major obstacle. On the other side the living area is being decreased

by the intensification of agriculture and by the increase of forest production, reducing hedges and limiting secondary trees. The importance of this rare tree is not often appreciated.

The natural situation of this rare fruit tree species and its occurrence as single individuals or in small groups restricts the possibilities for implementing *in situ* conservation strategies. The establishment of *ex situ* conservation seed orchards is the most suitable and efficient conservation measure to undertake. Natural regeneration should be supplemented by repatriation of seedlings originating from seed orchards or controlled crossings. This method extends the genetic base of regeneration, which is important for future adaptability (Stephan et al. 2003). The importance of *in situ* conservation measures is clearly indicated at a pan-European scale (EUFORGEN 2005).

In the framework of model and demonstration actions on genetic resources in Germany, supported by the Federal Agency for Agriculture and Food, the project *In situ* Conservation of *Malus sylvestris* in the East Ore Mountains was awarded. The aims are (1) the preservation and sustainable use of the crab apple (*Malus sylvestris*) in the East Ore Mountains and (2) the development of a management plan using the East Ore Mountains as a model to preserve the crab apple as a genetic resource in other areas of Germany. The main project leader is the registered association 'Grüne Liga Osterzgebirge' supported by scientific consultation with the Julius Kühn-Institute in Dresden-Pillnitz and the Saxon state-owned enterprise 'Sachsenforst'.

Why was the region of the East Ore Mountains located in the south-east of Germany close to the German/ Czech border chosen as a model? The domesticated apple was hardly ever cultivated in the East Ore Mountains (Saxony) until the 20th century. Because of the harsh climate at altitudes from 300 to 800 m, only well-adapted cultivars could be planted. In old literature the 'Borsdorfer' apple was mentioned. The ecology of this area is characterized by forest. Typical for this region are the so-called 'Steinrücken', stone cairns originating from the gleaning of rough stones to prepare agricultural fields. These conditions have resulted in occurrences of wild apple *Malus sylvestris* populations, and a low rate of hybridization is assumed between *M. sylvestris* and *M. x domestica.* In the Saxon dialect these mountains are called 'Holzäppelgebirge' ('Crab Apple Mountains').

The project mentioned above is subdivided into four parts: (1) field mapping with morphological and genetic evaluation, (2) the elaboration of a management plan for conservation, (3) the testing of possibilities for sustainable utilization and (4) public relations.

For conservation purposes, it is of the greatest importance to distinguish the true type of wild apple trees from cultivated and/or hybrid forms. The importance of the hybridization process was often underestimated by conservation biologists until recently. The evaluation of the genetic structure of the population constitutes a key element for the definition of a strategy for genetic conservation of a given species.

Wild apple timber is of low economic value, it is less compact and stable than comparable species (Wagner 1999). On a limited scale the timber was and could be used for turnery and carving to produce jewellery or accessories.

In prehistoric times the wild apples were used as dried fruits for the winter time (Schweingruber 1989). Dried fruits were found in the lake dwellings around Lake Constance. It is known from the literature that the fruit skin was used for the preparation of a fruit tea with antipyretic action (i.e. prevents or reduces high temperatures) (Lohmann 1997). Publishing the crab apple project in different newspapers of the East Ore Mountains and asking for knowledge and stories about the crab apple resulted in a range of information obtained, especially from older people. They knew from their childhood that fruits of the crab apple were collected and dried in the kitchen stove to prepare fruit tea to decrease fevers. The aim of the project is to develop an efficient method of tea production to establish a way of sustainable long-term utilization after the project is finished, and to refresh and reactivate knowledge about the crab apple and its uses.

In the beginning of the project many steps were carried out with the help of volunteers. From the project database the positions of the trees were located and described using GPS. The fruits were collected paying attention especially to the right ripening time; the seeds have to be brown. The date of harvesting fruits at the right ripening time varied, depending on the altitude of the tree position. Harvest is extended over the whole month of September. Most farmlands and forests are in private ownership and it was necessary to get the owners' permission in advance for collecting fruits. After harvest the fruits were sorted and only apples of the proper quality were used. To have a sufficient amount of apples available, they were stored for a short time in the refrigerator. After washing, the apples were cut into slices of 2-3 mm by machine or by hand in cases when private users would like to try this procedure.

The desiccation took place in a specialized company's facilities to ensure hygiene standards. After a pre-desiccation period at 65 °C for two hours using infrared light the apples were finally desiccated for a further four hours at 65 °C. During the desiccation process the

apple slices are placed on wire trays to guarantee air circulation. For private use the desiccation could be done in the kitchen stove. Within the project phase the tea is being offered in regional pharmacies or restaurants to test public acceptance. For this reason the tea is packed in 100 g bags and labelled with a project-designed logo.

Two recipes are recommended for making tea. For the fast method use 20 g tea, put the tea in a tea pot, add 1 litre of boiling water and steep for ten minutes. Remove the apple pieces from the pot (if you have a strainer or infuser) or pour the liquid into another vessel (a cup or a pot, with a strainer to catch any apple pieces). The second method can be used especially in cases when the user has a cold: let 15 g dried tea swell in 1 litre cold water over night. Use the brew the next day, boil it for a moment and steep for ten minutes. It smells heavenly during the brewing process. Again remove the apple pieces from the pot or pour the liquid into another vessel. A second infusion is possible for both procedures. Enjoy the delicious crab apple tea!

Fruits of *Malus sylvestris* are characterized by respectable amounts of vitamin C. A first investigation of different accessions showed twice as much vitamin C on average in comparison with the domesticated apple. Recently, detailed analyses were planned to discover the vitamin C content found in tea of wild crab apples.

Further possibilities for the sustainable uses of *Malus sylvestris* will be tested in the frame of the project, i.e. making a distillate, producing ice cream or cider vinegar.

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Section 5 - National Policies

31. The European Seed Legislation on Conservation Varieties

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31.1 Establishing the context

The recent legislative developments at European level (i.e. Commission Directive 2008/62/EC 20 June 2008) on seed production and marketing have opened a new way to safeguard biodiversity of interest for agriculture. The Directive considers several crops with the exclusion of vegetables.

Although generally aimed *"to ensure* in situ *conservation and the sustainable use of plant genetic resources"*, the Directive focuses on seed production and marketing instead of biodiversity conservation *per se*, as is evident from its title:

> "*providing for certain derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes*".

Previous European seed regulation made it impossible to commercialize landrace seed because of the requirements for distinctness, uniformity and stability (DUS) needed to register material to be commercialized and of the registration costs. The national implementation of Directive 2008/62/EC is currently a matter of active discussion across Europe. This paper aims at contributing to this discussion.

The following concepts are considered to be fundamental by us as well as by other authors (see Frese et al., Chapter 7 this volume) to define decision criteria required to implement the Directive within the Member States:

1. Agricultural landraces and varieties
2. Region of origin
3. Genetic erosion risk.

It should first be noted that:

- some definitions of the above-mentioned items are given in the Directive text while others are not
- definitions given are not unanimously accepted across PGR stakeholders (see Negri et al., Chapter 1 this volume)
- different terms are used in different national language translations of 2008/62/EC (the English, French and Italian versions were mainly considered here)
- in the English text different meaning is given to some terms than is usually accepted in scientific literature.

What is described above is likely to generate a considerable amount of different interpretations and consequently implementation actions and resource assignments across Europe. With the hope of, at least partially, overcoming these constraints a review of the above-mentioned concepts was carried out on the base of bibliographic records, documents produced in meetings and national regulations (when known).

31.2 Agricultural landraces and varieties

The Directive 2008/62/EC (Art.2), in its English version, defines the 'landrace' as "*a set of populations or clones of a plant species which are naturally adapted to the environmental conditions of their region*."

This definition corresponds to the definition of 'ecotype' as coded by Turesson (1922) and usually accepted in scientific literature (cf. Rieger et al. 1976) and not to the definition of landrace as recently reviewed by different authors. However, it must be noted that the Directive title clearly addresses 'agricultural landraces', so it seems obvious that the above-mentioned definition considers only cultivated populations. As a consequence, whether the national translation of the title is 'ecotype' (as in the Italian translation) the term should be understood as 'agro-ecotype'.

In any case it must be stated that in recent publications the term 'landrace' is used in the above restricted sense (i.e. agro-ecotype), in fact it has been defined as

> "*a dynamic population of a cultivated plant that has historical origin, distinct identity and lacks formal crop improvement, as well as often being genetically diverse, locally adapted and associated with traditional farming systems*" by Camacho Villa et al. (2006),

> "*a genetic variable population that has not been object of formal crop improvement, is present in the specific area where it originated through continued cultivation and is recognized by local farmers*

as belonging to their own" for the Working Group of the Italian Interregional Seed Project (PRIS2 2005-08) (Lorenzetti 2007), and

"*(of a seed-propagated crop) a variable population, which is identifiable and usually has a local name. It lacks 'formal' crop improvement, is characterized by a specific adaptation to the environmental conditions of the area of cultivation (tolerant to the biotic and abiotic stresses of that area) and is associated with the traditional uses, knowledge, habits, dialects, and celebrations of the people who developed and continue to grow it*".

This definition which combines other definitions (Brush 1992; Papa 1996; Asfaw 2000; Louette 2000; Negri 2005; Camacho Villa et al. 2006), was proposed and accepted at the Second Meeting of the On-farm Conservation and Management Task Force of ECPGR (19-20 June 2006, Stegelitz, Germany) (Del Greco et al. 2007; see also www.ecpgr.cgiar.org/Networks/Insitu_onfarm/OnfarmTF_intro.htm)

The two latter definitions emphasize the aspects of a long-standing, unbroken and active management of landraces in a specific human context (Frese et al., Chapter 7 this volume). In order to develop sound national implementation of the above-mentioned EC Directive, we would recommend using the two latter definitions because they offer a certain number of advantages from biological, cultural and practical points of view:

i) From a biological point of view, landraces, defined as above, are understood as populations that are adapted to the local environment. Continued use and maintenance over time would not have occurred if a landrace did not show adaptive traits. In other words adaptation to the specific local environment is proven by evidence.
ii) The two definitions give high consideration to cultural heritage, fulfilling the requests of many recent papers and international documents. Linking both biology and cultural diversity they also acknowledge that both are continuously evolving. Just as genetic diversity evolves in response to environmental pressures, human culture (new techniques, new uses and new products, as well as new traditions, habits or ways of speaking) also evolves based on the experience and knowledge of a certain landrace crop that farmers gained over centuries of cultivation (see for example Torricelli et al., Chapter 18 this volume).
iii) Lastly, from a practical point of view, the two latter definitions also:
    - open the way for a recognition of farmers' rights and favour their protection
    - support the development of local economies based on landraces favouring their conservation and commercialization

- being more restrictive, limit the number of landraces to be registered (which in turn facilitates the practical operability of the Directive provisions) and
- better satisfy the CD 2008/62/EC Art. 8 dictates, which require the indication of the region in which the variety has historically been grown and to which it is naturally adapted.

The problem of how to define the term 'landrace' for vegetatively propagated crops has also been addressed. They are often understood as genetically homogeneous populations (i.e. composed by the same genotype). However, clonal selection in crops such as *Vitis vinifera* and *Olea europaea* extensively carried out from the last century up until now, shows that they are not really genetically homogeneous (i.e. a single clone). For example in the 'Sagrantino di Montefalco' landrace, one of the five vine landraces of Umbria, morphological diversity exists so that four clones are registered. At the molecular level, Fornek et al. (2003) assessed genetic variation within *V. vinifera* cv. Pinot noir. They could then be considered as landraces as defined above.

About the term 'variety', it must be taken into account that the European legislation already defined it in Regulation 2100/94 (Art. 5 part II) on Community plant variety rights (27 July 1994) and in the same way the term is understood by the plant breeding and seed multiplication community, i.e. as a "*plant grouping within a single botanical taxon of the lowest known rank, which grouping,…, can be i) defined by the expression of the characteristics resulting from a given genotype or combination of genotypes, ii) distinguished from any other plant grouping by the expression of at least one of the said characteristics and iii) considered as a unit with regard to its suitability for being propagated unchanged*" [cf. also Glossary of Crops Science Terms (1992) and UPOV Convention (Art. 1 vi)].

If previous legislation has to be considered as binding, in implementing the Directive 2008/62/EC at national level, we should refer to this concept and consider only the obsolete varieties which are not listed in the common catalogue and/or are not protected by the Community plant variety rights (2008/62/EC Art. 6) any more. The same conclusion was reached by the Farm Seed Opportunity project funded by PF6 (V. Chable, pers. comm.) which also has among its tasks to provide practical recommendations for the decision-making processes relating to the market release of seeds of landraces, conservation varieties and special 'amateur' varieties.

However, it is important that the Directive includes varieties among the materials that can be commercialized under a derogation regime because quite a number of them are likely to disappear from local markets in a few years due to the seed market competition, as the Italian experience shows (Bravi et al. 2002).

31.3 Region of origin

Regarding the definition of 'region of origin' the CD 2008/62/EC Art. 8 says that: "*When a Member State accepts a conservation variety, it shall identify the region or regions in which the variety* has historically been grown *and to which it* is *naturally adapted hereinafter 'region of origin'*"

It should be noted first that the pivotal verbs in this sentence are in the present tense or appear to give a sense of continuity from the past to the present. The same is true for the French, German, Spanish and Italian versions of the Directive. The Directive seems then to refer only to populations currently being cultivated. Strictly interpreting it, registration and commercialization of accessions stored in genebanks is not foreseen. The request of many stakeholders to register and commercialize accessions stored in genebanks (the great part of the diversity still present in many countries) remains unanswered, although at least some well-known landraces or obsolete varieties that are well documented for their past biological and/or economic value would be worth taking out from storage.

Second, the 'region of origin' appears to be understood as the region where a conservation variety was developed and/or grown over a sufficient period of time to leave a trace in documents or to be borne in the minds of people.

Contrary to extant landraces for which adaptation to the specific local environment is proven by their present cultivation, Member States may face problems in registering landraces and varieties maintained in genebanks because of i) the need to ascertain their adaptation to the environment, and ii) the need to ascertain their existence by historical records:

i) The adaptation of a discontinued conservation variety to a particular region (presumably its region of origin) has to be proved in orthogonal multi-location field trials (whereby one of the locations has to be situated within the probable region of origin), each including comparisons with different varieties.
ii) The link between a certain conservation variety and the history of the territory should be ascertained by documents present in archives, farm registers, grey literature (e.g. theses, local reports, and local technical bulletins), seed catalogues, etc. However, in some cases, the memory of old people of the community can be sufficient (especially when in their words a sense of property is evident).

The identification of the region of origin should be a task of the Local Authorities (see also the Italian case in Lorenzetti et al., Chapter 18 this volume). This could be carried out by a bio-geographical recognition, as is already done for Protected Geographical Indication

(PGI) or Protected Designation of Origin (PDO) products. For large areas the proposals could be made by single states or by more states in association when the region of origin is located in more than one Member State.

31.4 Genetic erosion risk

To be 'under threat of genetic erosion', defined by the CD 2008/62/EC as "*Loss of genetic diversity between and within populations or varieties of the same species over time, or reduction of the genetic basis of a species due to human intervention or environmental change*", is the condition for a conservation variety to be included in the national catalogues of conservation varieties.

The concept of genetic erosion can be seen from different standpoints, however it is generally understood in the sense of the Directive as "*diversity loss on the level of varieties or species*" (Hammer 2004; Gepts 2006) or as "*the loss of genetic diversity, including the loss of individual genes, and the loss of particular combinations of genes (or gene complexes) such as those manifested in locally adapted landraces of domesticated animals or plants adapted to the natural environment in which they originated. The term genetic erosion is sometimes used in a narrow sense, such as for the loss of alleles or genes, as well as more broadly, referring to the loss of varieties or even species*"(Wikipedia).

To implement national law, regulations and administrative provisions to comply with the CD 2008/62/EC, it is necessary to assess and attentively evaluate the threat of genetic erosion.

The level of threat should be quantified for each candidate conservation variety. Not many studies are available concerning the quantification of the level of threat (see Negri et al., Chapter 1 this volume), in addition, the estimate of diversity loss may require different criteria in relation to the species/population, the environment and the interaction between the species/population and the environment (where environment is to be intended *sensu latu*, including the 'human environment' because it is humans who decide whether to maintain a landrace or not).

We are limiting our discussion to landraces which are still cultivated, although accessions stored in genebanks (whether they should be considered in the implementation of the Directive) may also be subject to genetic erosion (especially during the multiplication/regeneration procedures).

For the landraces maintained on-farm the risk of loss of genetic variation should be evaluated both i) among and ii) within landrace levels (i.e. the risk of losing a landrace and the risk of losing variation within it, respectively):

- *Among landrace estimate of erosion risk* (risk of losing a landrace). The first logical step appears to be to compile national inventories of landraces as a baseline to be used in assessment of the level of threat. We know that landraces still exist in Europe and that most of them probably are under threat, but their total number per crop is generally unknown in each country. In absence of such inventories it is impossible to estimate the risk of genetic erosion over time. When on-farm landrace inventories are compiled, an example concerning how to evaluate the risk of a landrace loss could be the one proposed by Agenzia Regionale per lo Sviluppo e l'Innovazione dell'Agricoltura del Lazio (ARSIAL) Technical Committee for the Implementation of the Lazio (Italy) Regional Law for the Safeguard of Agro-biodiversity (1 March 2000, n. 15). This is going to serve as a prioritization tool to fund on-farm conservation of existing landraces under the scheme set out by the above-mentioned Regional law. Details concerning this model can be found in Porfiri et al. (Chapter 10 this volume).
- *Within landrace estimate of erosion risk.* Recent studies have shown that landraces are structured populations where farmers maintain different sub-populations more or less connected by gene flow, and where events of sub-population extinction and recolonization are present (Louette 2000; Gautier et al. 2002; Negri and Tosti, 2002; Lanteri et al. 2004; Tiranti and Negri 2007; Negri et al. in press). Therefore the evaluation of the risk of losing diversity within a landrace would require an initial assessment of genetic diversity and population structure and of socio-economic aspects that induce farmers to continue (or not) cultivation (i.e. farmers' age, motivations, income, etc.). In addition a periodical monitoring of the above-mentioned traits appears to be required.

31.5 Conclusions

All of what is described above should only be valued within the context of seed commercialization which the CD 2008/62/EC is concerned with. It is unlikely that all plant genetic resources still present in Europe can be preserved by the simple implementation of the Directive. As a consequence the need actively to promote and implement conservation activities remains a priority.

The CD 2008/62/EC does not specify the subject/s that can promote the inclusion of a conservation variety in the national register. In addition, its implementation at the national level appears to be difficult today due to the general lack of data on points discussed above.

In our opinion, a sort of bottom-up process should be activated, whereby regional authorities and agencies will play a pivotal role. In the first instance, they should make ready data on number of conservation varieties, their region of origin and level of threat. Second they should listen to the requests of people interested in their commercialization. Third they should prepare a list of conservation varieties that Member States will be called upon to register.

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32. National Policies and Support Systems for Landrace Cultivation in Finland

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32.1 Legal basis

According to the directives of the European Community, seed can be allowed to be marketed only if it has been inspected, analysed and officially certified. A variety can only be certified if it has been taken from a list of the varieties officially accepted for certification, commonly known as the National List of Varieties. A variety can be accepted if it is distinct, stable and sufficiently uniform (DUS). The variety must also be of satisfactory value for cultivation and use. The value of a variety for cultivation or use shall be regarded as satisfactory if, compared with other varieties accepted in the list, its qualities, taken as a whole, offer a clear improvement for either cultivation or use.

Since at least some landraces do not meet the standards for uniformity and in most cases they cannot be considered as an improvement compared with the varieties already accepted in the list, it has been difficult to include landraces in normal certification schemes. However, in 1998 a new Council Directive (98/95/EC) opened the possibility of establishing specific "*conditions under which seed may be marketed in relation to the conservation* in situ *and the sustainable use of plant genetic resources*". The Parliament of Finland included the idea in the Seed Trade Act of 2000 (728/2000) by allowing the seed of landraces to be marketed uncertified in order to conserve genetic diversity.

The Finnish Ministry of Agriculture and Forestry issued two statutes in 2000 and 2001 on the basis of the aforementioned act: the Statute on Registration of Conservation Varieties (437/2001) and the Statute on Seed Trade of Landraces of Cereal and Fodder Plants (117/00). Registration of conservation varieties is a task of the Finnish Food Safety Authority 'Evira', which decides on applications and keeps the register of approved conservation varieties. Evira is also the Designated Authority for seed certification in Finland and it approves the seed lots of landraces for marketing.

32.2 Requirements for registration of a variety

A variety is considered eligible for registration as a conservation variety if it is a landrace, an old commercial variety or an old

modified commercial variety. An old modified commercial variety is a commercial variety which has changed so much due to cross-pollination and/or environmental selection that it is distinct from the original variety. The variety must have been grown on the applicant's premises for a considerable time (at least several decades) or the applicant must have the consent of the original owner in order to get the variety registered. The transfer of ownership from old farmers to younger ones is encouraged, but the variety must not be taken too far from the original area where it was developed. A variety must also have a competent maintainer, which in most cases is the holder of registration but could also be somebody else.

The Finnish Food Safety Authority Evira makes a modified DUS-test (distinctness, uniformity and stability) for a conservation variety for which an application has been made. The test is done using the same methods as for the DUS-test required for national listing and/or plant variety protection, but the testing period is only one growing cycle. The requirements for distinctness, uniformity and stability are not as strict as for modern varieties, but the variety must be identifiable.

In order to be registered, a variety must not be on any National List of Varieties or EU Common Catalogue of Varieties. It must also not be protected with plant variety rights (PVR). If the listing or PVR are no longer in force, the variety can be registered as a conservation variety.

When a conservation variety is registered, it gets a name, which must be acceptable using the same principles used for modern varieties in the process of national listing and/or granting PVR. This name is the unique identifier of the conservation variety and it must be used whenever the variety is marketed for seed.

32.3 Requirements for marketing of seed

Of all the conservation varieties only landraces can be marketed as seed: old commercial varieties and old modified commercial varieties cannot. Seed production is also limited to species most commonly and/or traditionally grown in Finland: oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.), rye (*Secale cereale* L.), wheat (*Triticum aestivum* L. emend. Fiori et Paol.), red clover (*Trifolium pratense* L.), white clover (*T. repens* L.), alsike clover (*T. hybridum* L.), timothy (*Phleum pratense* L.), meadow fescue (*Festuca pratensis* Huds.), smooth-stalked meadow-grass (*Poa pratensis* L.), cock's foot (*Dactylis glomerata* L.), red fescue (*Festuca rubra* L.), turnip for slash-and-burn cultivation (*Brassica rapa* L. subsp. *rapa*), swede (*B. napus* L. var. *napobrassica* (L.) Rchb.), broad bean (*Vicia faba* L.) and pea (*Pisum sativum* L.).

The process of seed testing is the same as for normal seed lots which are certified. A field inspection is made on the farm by an inspector, who has been authorized by Evira. After harvesting, an authorized sampler takes a sample of the seed lot for laboratory analyses. Analyses are made by Evira Seed Laboratory, which is the only accredited seed laboratory in Finland. If the seed lot meets the standards set for landrace seed, it can be approved for marketing and Evira prints labels for the seed bags. The colour of the labels is brown.

There are only two differences between quality standards set for landrace seed lots and those for normal seed lots. First, the minimum germination required for landraces is for most species lower than for modern varieties. Second, some endangered or rare weed species are not considered as impurities if they are present in the seed lot. Otherwise a landrace seed lot has to meet all the standards of certified seed. Also the prices of inspections and analyses are the same as for normal seed lots.

Landrace seed lots can only be marketed in Finland, in contrast to normal seed lots which can be marketed in the area of the whole European Community without restrictions.

32.4 The state of affairs in 2008

By September 2008, 12 varieties had been registered as conservation varieties in Finland. One variety is considered an old modified commercial variety and the rest of the 11 varieties are landraces. The most popular species are winter rye and red clover, both with five registered landraces or varieties. In addition to these there is also one barley landrace and one turnip landrace adapted for slash-and-burn cultivation. Pending applications have been made for another five landraces. One red clover landrace has been taken on to the National List of Varieties, so it has been withdrawn from the register of conservation varieties.

Six landraces of rye, red clover, barley and turnip have been marketed for seed. Landrace seed is not of big importance in the scale of the whole country, but locally it can be considered meaningful, especially rye and red clover landraces which tend to be more winter-hardy than modern varieties.

32.5 Subsidies for conservation varieties

Since year 2000 it has been possible to apply for subsidies for the maintenance of a conservation variety. This subsidy is one type of the environmental subsidies paid by the Finnish Ministry of

Agriculture and Forestry. In order to get subsidies the maintainer must grow a registered conservation variety on an area of at least 1 ha each year and make sure that there is always enough seed in store for sowing an area of 2 ha. Farming methods used by the maintainer must ensure that the variety is not mixed with modern varieties and there will not be any undesirable cross-pollination. The maintainer must also keep a record book on cultivation and storing of the conservation variety. Maintenance is controlled by Evira by field inspection and post-control testing, which are both made once in five years.

In the autumn 2008 the yearly subsidy for the maintenance of a conservation variety is 450 €. The subsidiary is paid for only 1 ha per variety.

32.6 Future

In the spring of 2008 the European Commission issued a new directive 2008/62/EC providing for certain derogations for the acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties. This directive shall be implemented in Member States by June 2009. The Finnish Ministry of Agriculture and Forestry will start preparing a new statute during autumn 2008.

33. The Italian Laws on Conservation Varieties and the National Implementation of Commission Directive 2008/62 EC

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33.1 Introduction

The reference framework to discuss the Italian situation in the field of conservation of local agricultural landraces and varieties involves memoranda, international treaties, EU Directives, national and regional laws.

The first main step towards actions on biodiversity was taken at Rio de Janeiro in 1992 with the Convention on Biodiversity (CBD) whose principles have been developed in the FAO International Treaty on Plant Genetic Resources for Food and Agriculture (2001), ratified in Italy by the Law 104/2004.

In Europe, Directive 98/95 EC has given the possibility "*to establish specific conditions to take into account new developments to commercialize seeds for* in situ *conservation and sustainable utilization of phytogenetical resources*". This possibility has stimulated a lively and long discussion to define application rules that, after ten years and 12 drafts led to the promulgation of the Commission Directive 2008/62 EC of June 2008 providing "*derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties*". Member States shall bring into force, by 30 June 2009 at the latest, laws, regulations and administrative provisions necessary to comply with the Commission Directive.

Meanwhile Italy passed the Law 46/2007 giving application to articles 5 (*conservation, research, characterization and documentation of phytogenetic resources for food and agriculture*), 6 (*sustainable use of phytogenetic resources*) and 9 (*farmers' rights*) of the FAO Treaty. An application Decree of 18 April 2008 (O.J.122 of 26 May 2008) followed the law.

In Italy, Regional Governments have also been very active in safeguarding phytogenetic resources and promulgating laws, most of them prior to Law 46/2007. This *corpus iurium* respects the CBD and FAO treaty principles but it urgently needs to be reconsidered and harmonized so as to follow the hierarchical level of the Institutions.

First the Italian Law 46/2007 must be harmonized with the Commission Directive 2008/62 EC, which covers the same matter (i.e. 'conservation varieties') and great attention will be required in bringing

into force the Commission Directive itself. Later it will be necessary to reconsider the regional laws so as to have a clear operating scheme.

33.2 The Italian Law 46/2007 vs. Commission Directive 2008/62 EC

The National Law and the Commission Directive follow very different principles. A comparison between the major points of Italian Law 46/2007 and Commission Directive 2008/62 EC is proposed in Table 33.1.

Table 33.1. Conservation varieties: main points of the Italian Law 46/2007 versus Commission Directive 2008/62 EC.

Subject/matter	Italian Law 46/2007	Commission Directive 2008/62/EC
Aim/species	*In situ* conservation and sustainable use of PGR of all species	Marketing of seeds of conservation varieties in the context of the conservation of PGR (no vegetables)
Conservation varieties	Varieties, populations, ecotypes, clones, cultivars: 1) grown for at least 50 years in a local agrosystem and never included in a register of varieties 2) deleted from Register of varieties 3) not present in cultivation anymore but still present in botanical gardens, genebanks, research institutes for which there is an interest in reintroducing them into cultivation	Landraces and varieties threatened by genetic erosion
Region of origin	Area of traditional cultivation of the conservation variety. If it is not specified it is intended to be the Province of reference	Region or regions in which the conservation variety has historically been grown and to which it is naturally adapted
Catalogues	A section will be reserved for conservation varieties in the official catalogue	Accepted landraces and varieties shall be referred to in the common catalogue of agricultural plant species as conservation varieties
Promoters of the inscription	Regions	Not specified
Registration fees	No	Not considered
Requirements for acceptance	Official tests not required. Distinctiveness must be assured along with historical and cultural indications demonstrating the link between conservation varieties and local people	Official tests not required. Conservation varieties shall present an interest for the conservation of plant genetic resources. Member States may adopt their own provisions for DUS, which shall include at least the characters included in the Directive 2003/90 EC
Region of seed production	Area of origin	Region of origin. The Member State may approve additional regions, however seed may be used exclusively in the region of origin
Certification	Not considered	Member State may provide that seed of a conservation variety may be placed on the market if it descends from seed produced according to well-defined practices for maintenance of variety. Control of minimum varietal purity is not required, official examination or examination under official supervision is not required.

Table 33.1. Conservation varieties: main points of the Italian Law 46/2007 versus Commission Directive 2008/62 EC.

Subject/matter	Italian Law 46/2007	Commission Directive 2008/62/EC
Marketing area	Area of origin of the variety as indicated in the documents presented to obtain the inscription in the catalogue; otherwise the Province in which it is present	Region of origin. Member States may approve marketing in other regions provided that these regions are comparable to the region of origin as regards the natural and semi-natural habitat of the considered conservation variety
Marketing restrictions	Yes. In the area of origin of conservation varieties farmers can sell directly small quantities of seed of registered varieties to sow not more than 1000 square metres for vegetables and potatoes and not more than 10 000 square metres for other crops	Yes. The seed quantity of a certain conservation variety to be marketed cannot exceed 0.5% of each variety of the seed seasonally employed for each species in a Member State or the quantity required to sow 100 ha. The total marketed seed of conservation varieties of a certain species must not exceed 10% of the seed of species concerned used in the Member State, but in any case can reach the quantity necessary to sow 100 ha
Farmer rights	Considered, on the basis of art. 9 of the International Treaty on Phytogenetic Resources for Agriculture and Food	Not considered
Network of 'keeper farmers'	Considered	Not considered

The main aim of the National Law is to safeguard the local plant genetic resources (PGR) through the production and exchange of a very limited quantity of seed only in their area of origin. Local farmers can sell small quantities of seed of conservation varieties to the farmers of the area.

'Small quantity' means that the seed sold by a single farmer must not exceed that necessary to sow 1000 square metres for vegetables and 10 000 square metres for field species. 'Keeper farmers' should be in charge of the conservation of local types.

The Commission Directive 2008/62 EC is mainly concerned with seed trading aspects of conservation varieties. It is clearly the fruit of a compromise between those who consider them 'very specially improved varieties' useful to open the way for a 'renewed' agriculture and those who consider them a relic of the past used to break up the seed market as it has evolved in the past decades. It is not by chance that the Commission Directive 2008/62 EC required ten years of discussions and 12 drafts to be born.

33.3 Regional laws

In Italy six Regions' governments have already passed laws in the field of local PGR conservation (Table 33.2). Almost all of them are dated before both the National Law 46/2007 and the Commission Directive 2008/62 EC.

Table 33.2. Regional laws concerning agricultural genetic resources conservation in Italy.

Region	Number of law	Reference: Official Journal of the Region	Public body responsible for law application	Status
TUSCANY	Law n. 50, July 16, 1997 Law n. 64, November 16, 2004	n. 30, 26/7/1997 n. 46, 24/11/2004	ARSIA (Regional Agricultural Extension Service)	Operative
LAZIO	Law n. 15, March 1, 2000	n. 9, 30/3/2000	ARSIAL (Regional Agricultural Extension Service)	Operative
UMBRIA	Law n. 25, September 2, 2001	n. 45, 14/9/2001	Not yet designed	Not yet operative
FRIULI VENEZIA GIULIA	Law n. 11, April 22, 2002	n. 7, 26/4/2002	ERSA (Regional Agricultural Extension Service)	Partially operative
MARCHE	Law n. 12, June 3, 2003	n. 51, 12/6/2003	ASSAM (Regional Agricultural Extension Service)	Operative
EMILIA ROMAGNA	Law n. 1, January 29, 2008	n. 14, 29/01/2008	REGIONAL GOVERNMENT	Operative
CAMPANIA	Law draft, 2004			Draft still under political discussion
ABRUZZO	Law draft, 2006			Draft still under political discussion
SICILY				Issue under political discussion, law draft not proposed yet
SARDINIA				Issue under political discussion, law draft not proposed yet

They clearly show the great local interest in the matter and give indications for the implementation of the Commission Directive. They deserve serious consideration because it seems that the initiative to recognize conservation varieties and promote their inclusion in the catalogues should start at the local level.

Regional laws have most elements in common and their application can be the first step to organizing registration and trade of valuable material chosen with the help of farmers' communities. They are aimed at:

1. making inventories of genetic resources of the region through the institution of regional registers or repertoires (i.e. inventories);
2. identifying, for each species, farmers who possess and have particular interest in conservation varieties; they will be asked to give rise to a network of 'keeper farmers';
3. making a no-profit diffusion of a restricted quantity of seeds of conservation varieties possible;
4. promoting an equitable sharing of benefits from local genetic resources as stated in art. 8 of CBD (Rio, 1992) and art. 9 of FAO International Treaty (Rome, 2001);
5. promoting knowledge about traditional techniques and uses by local communities.

Today this work is supported by the National Law 46/2007 which stimulates the Regions to create continuously updated catalogues of conservation varieties that are of interest from a cultural point of view, for utilization, direct trade and/or future breeding work. Valuable landraces should be pinpointed, along with farmers who grow them, and to facilitate their diffusion the Italian law does not foresee any registration fee to be paid. Some of these farmers could be in charge of the maintenance of the conservation varieties and give rise to a network of 'agricoltori custodi' (keeper or maintainer farmers).

33.4 Conclusions

All the juridical instruments operative today in Italy in the field of PGR conservation focus on local agricultural landraces.

Regional laws promote the recognition of valuable materials and their inscription in registers along with a network of 'agricoltori custodi' of the conservation varieties. All the activities carried out by the Regions fulfil the requirements of the National Law 46/2007 which is only aimed at safeguarding PGR on-farm.

Restrictions for the quantity of seed to be produced and for the area of multiplication and use of conservation varieties are so stringent that the system does not interfere with large-scale seed trade. Regional registers consider all the plant species and all together could give rise to the National Register of Landraces of Italy.

However, only some of the conservation varieties included in the regional registers, those that are considered worthy of being traded, should be included as conservation varieties in the National and the Common Catalogues following the Commission Directive 2008/62 EC. In this case Regions and/or farmers' communities could ask for the recognition of farmers' rights that should be administered by Regions in favour of the communities involved. This proposal will allow us to avoid the risk of overloading the official catalogues of plant varieties, by including only materials that are of real commercial interest.

The Commission Directive has been prepared to regulate the commercialization of conservation varieties, but it is too simple to think that its implementation can solve all the problems related to the safeguard of local PGR. To safeguard Italian PGR under law 46/2007, a scheme based on a bottom-up criterion that coordinates all the initiatives starting at the regional level can be suggested. However, the commercialization of landraces and varieties under Commission Directive 2008/62 EC can help their conservation and also make it possible to put on the market typical products based on landraces which characterize many Italian Regions.

Section 6 – General Discussion

34 A European Strategic Approach to Conserving Crop Landraces

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34.1 Introduction

The aim of this text is to promote *in situ* on-farm conservation of landraces and their safe *ex situ* back-up, while promoting their sustainable exploitation both by European plant breeders but also by a growing range of additional users. As argued in earlier Chapters an inventory of existing diversity is a first step to conservation, and the national landrace inventories presented provide a foundation for the improvement of both landrace conservation and use. However, we should acknowledge that none of the existing inventories presented in earlier Chapters are fully comprehensive, both in terms of regional coverage within countries or in addressing the diversity within a specific crop group. The individual case studies presented, both on landrace conservation activities and on promotion of their use, underline the need for a systematic approach to on-farm conservation. While it is true that European landraces have survived till now in the face of extensive threats without a more systematic approach being applied, surely our goal should be more than survival if we wish to benefit from their diversity: also, anecdotally there is support for the view that their long-term survival remains uncertain. Landrace management within farmers' fields requires not only access to and conservation of the genetic material, but also appropriate farming systems that can maintain the inherent diversity and that are integrated into an effective user chain, as highlighted by Moreira et al. (Chapter 29 this volume).

There is no detailed review of information on on-farm conservation activities in Europe and this text intends, at least in part, to fill this existing information gap. Our aim in this final chapter as editors is to make explicit the recurrent messages from earlier chapters concerning

why landrace conservation remains critical, what is the conservation status of landraces, what threats they face and what opportunities there are for further exploitation in an attempt to ensure that lessons can be learnt, and then finally to make suggestions for a more strategic approach to European landrace conservation and use.

34.2 Why we still need landraces

The significance of landraces to plant breeding and food security was recognized as early as the Agricultural and Forestry Congress in Vienna (1890). Modern cultivars are deliberately bred for phenotypic and genotypic uniformity to maximize income generation, but landraces have tended to retain their inherent variability, which is perhaps ironically one of the reasons they have often been replaced by modern cultivars. The variability or genetic diversity inherent in landraces ensures that they have significant potential for future use in breeding programmes. As such, on-farm conservation of landrace diversity should be valued because it has direct and indirect utilization value to humankind (Negri 2005). Among direct utilities it is worth noting that not only are landraces the most important source of variability for plant breeders, but that, in some cases, they are also the basis of profitable markets for local people. They also have potential future use in breeding and in developing new farming systems and economies (as in some of the case studies reported in this text). To negate for future generations the opportunity to use this biological and cultural heritage would mean to deprive them of an important public good. While acknowledging our responsibility towards future generations which is a core ethical issue, it is our natural duty towards our children to help sustain their lives (Jonas 1993).

In spite of the fact that in many cases modern cultivars out-produce landraces, there is ample evidence in the preceding Chapters that landrace cultivation persists, even thrives, throughout Europe. Farmers continue to make a deliberate choice to grow landraces because for them they have value over and above the benefits associated with modern cultivars. In this respect the 'human factor' is crucial and understanding the farmer's motivation, as well as socio-economic constraints and opportunities, are key components of conservation and exploitation planning. The obvious question is what value do European landrace maintainers see that encourages them to continue cultivation of landraces? The reasons for Europe are likely to be similar to those found in other parts of the world (Brush 1995), i.e. higher quality and/or resistance to biotic and abiotic stress, sticking to family traditions, high market value, existence of niche markets and religious use, in addition the

prospect of obtaining high-quality and highly prized products also plays an important role (Negri 2003; Negri et al. 2007; Sanchez et al. 2008; Mazzucato *et al.* 2008; Torricelli et al., Chapter 18 this volume; Negri, Chapter 17 this volume).

34.3 Conservation status of European landraces

Gap analysis is a well-established conservation evaluation technique that assists the prioritization of biodiversity elements for conservation action by comparing selected elements of biodiversity with that proportion of diversity being conserved. The differences between the pattern of natural (or in the case of landraces, the range of farmer maintained) intrinsic diversity and the elements of that diversity already effectively represented by existing *in situ* and *ex situ* conservation actions become the conservation priorities for future action (Maxted et al. 2008). If this methodology is applied to European landraces it is necessary to start with an inventory of European landraces cultivated by farmers, and to understand the diversity of European landraces that is conserved *in situ* on-farm or *ex situ* primarily in genebanks. Each of these necessary pieces of information are in fact currently only partially known, therefore it is not possible to assess accurately whether European landraces are adequately conserved.

We can however review the information that is available to help formulate initial conservation priorities. We do know from the reviews of landrace inventories in Chapters 4 – 15 that several countries have initiated inventory activities, but it is fair to conclude that the breadth and depth of these inventories is variable and as yet no European country has a comprehensive inventory of its landrace diversity. Similarly the approach to *in situ* on-farm landrace conservation has largely been associated in Europe with the efforts of particular researchers or individual projects rather than providing systematic on-farm conservation of landrace diversity. Notable previous examples of on-farm landrace conservation in Europe include for example: Zeven (1996), Laliberté et al. (2000), Negri et al. (2000), Negri (2003, 2005) and Scholten et al. (2008). Clearly however a more systematic approach to on-farm conservation is desirable and required if we are to maintain farmer-based *in situ* diversity.

However, since the establishment of the EURISCO Internet search catalogue of European *ex situ* seed holdings (http://eurisco.ecpgr.org/[12]) we can estimate at least the number of landrace accessions held in genebanks – there are 234 447 (36% of the total 653 449)

[12] Search undertaken on 09.03.09.

accessions representing 5 515 crop taxa. If the biological status of all holdings included in EURISCO is queried, landraces are the most common inclusion, which bearing in mind that there are 2 204 crop species cultivated in Europe and the Mediterranean (Kell et al. 2008), tentatively indicates that the coverage of conserved landrace per crop is reasonably systematic. The word tentative is important here as to confirm the systematic conservation of landrace per crop would require a direct comparison of landrace numbers conserved with each crop. However, even assuming that this were the case and there were on average 42.5 landraces conserved per crop taxon, we still do not know if this figure adequately reflects the farmer-based *in situ* landrace diversity found in that crop. To answer this question accurately would require genetic analysis of all landraces for a crop and then to compare this with the diversity in the *ex situ* conserved landraces, or, where this were not possible, to assume genetic diversity is correlated with ecogeographic diversity and to establish if landraces have been conserved from throughout the crop's range. Even the latter would be a significant question to address, but these are important questions to answer if we are to assess the conservation status of landrace diversity.

Knowledge of the levels of landrace diversity, which is so important for landrace use in breeding, is also fundamental for planning on-farm conservation activities and for defining technical actions to manage and monitor populations on-farm. If genetically similar landraces exist in a certain area, a single farm could carry out the conservation activity; however, if the landraces are different, several farms would need to be involved in their preservation. The level of variation within a population is also important because it affects the persistence of the population over time (Nunney and Campbell 1993; Soulé 1987). The existence of a population structure, as assessed in landraces of both autogamous and allogamous species (Tosti and Negri 2005; Tiranti and Negri 2007; Negri et al. 2007), increases their effective size and consequently their chances of survival. Local extinction of a single subpopulation would reduce the overall amount of variation and should therefore be prevented. Consequently, the best strategy for preserving the diversity of a certain landrace would be to maintain the entire population on-farm. This means that every farmer should receive appropriate advice and support to maintain his/her own population.

34.4 Threats to on-farm management of landraces

At present it seems likely that Italy is the European country where the maintenance of landrace diversity on-farm is most

comprehensive; there are hundreds of landraces still routinely cultivated on-farm throughout the country. However, even here most of these landraces are under a severe risk of extinction due to socio-economic motivations, loss of off-farm income generation or simple lack of forethought in regional, national or European agricultural, conservation and development policy planning, but also particularly by the increasing average age of farmers and the reduced number of people having agriculture as their principal occupation. Too often the simple need to maximize short-term income generation is adopted rather than a more holistic longer-term approach that places higher value on landrace diversity itself. Although the available information for other parts of Europe is scarce and fragmented, it seems from information gathered within the European Cooperative Programme for Plant Genetic Resources (ECPGR) that a similar picture is found wherever landrace cultivation survives.

Contributing authors have identified several factors that threaten European landraces and their continued management on farm (notably Hammer and Diederichsen, Chapter 2 this volume). These can roughly be classified as factors threatening the genetic material, the farmer/grower, the production environment and the uses of the crops. In the following sections the threats along with the opportunities identified by the authors of this publication are recapitulated in order to establish the European strategic approach to conserving crop landraces on farm.

The genetic material, landrace diversity, has been threatened and the genetic base eroded for a century by widespread replacement by modern cultivars and hybrid varieties due to changing agricultural production systems that demand uniform performance of the crops. However, the remaining extant landraces grown in farmers' fields and their inherent genetic diversity is further being narrowed by wider socio-economic factors. For example, fewer farmers are cultivating landraces, which lessens seed availability and seed security at the local level (Nikolaou and Maxted, Chapter 23 this volume). Consequently, risks with seed availability can lead to dramatic changes in local diversity of a landrace, a genetic bottleneck or even extinction. An example of a legal factor narrowing the genetic variability of landraces is pointed out by Marum and Daugstad (Chapter 19 this volume): DUS requirements for approval of a variety for acceptance into official variety lists require the stable behaviour of a variety over time. This is against the nature of landraces which are supposed to evolve in dynamic interaction with the environment.

Since the farmer is the key person maintaining the landrace, it is important to understand his/her socio-economic situation that

affects the possibilities and willingness to continue the maintenance of landraces. In Italy statistics show that open field crops (forage, cereal and lentil landraces) are generally grown under modern agricultural techniques by farmers of an average age of 56 years, mostly inland, in mountainous areas and on farms of comparatively large scale for Italy. Garden crops in Italy are prevalently found at lower altitudes. They are mostly grown by elderly farmers with an average age of over 60 years running small farms or home gardens and under traditional farming systems, which nonetheless include the use of mechanical tools for soil preparation and, occasionally, the use of chemical fertilizers (Negri 2003). In Finland (Heinonen, unpublished data) and Shetland, Scotland (Lever 2006) the relative farmer age is also increasing for landrace-cultivating farmers. Furthermore in Scotland, where the average age is 38, the average age of farmers cultivating Shetland kale was 65 years and no maintainers were under 40 years old (Lever 2006). Not only ageing of farmers, but also their reduced overall numbers and the reduction in those having agriculture as their principal occupation threaten the on-farm management of landraces. In Eastern Europe Strajeru et al. (Chapter 12 this volume) report that the migration of poor farmers to urban areas and abroad is an important factor diminishing the number of landrace growers. On the other hand the farmer may not always be aware of the genetic uniqueness and value of his/her landrace or its potential value to the farm as an enterprise income (Negri, Chapter 17 this volume).

Consequently, there is a critical requirement to increase awareness about the importance of on-farm conservation for the wealth of future generations at every level: farmers, farmer communities, researchers and research communities, policy makers, common people and local, national and international authorities. Only when this goal is achieved and there is broad awareness will it be possible to preserve landraces effectively. In turn, awareness must be substantiated by engendering the sustainable and 'local' values associated with on-farm conservation. In a related context, Groom et al. (2006) discuss the rehabilitation of the Guanacaste National Park in Costa Rica and refer to the project being based on a philosophical approach called 'biocultural restoration', which incorporates local people in all aspects of the reserve's development and protection. The Guanacaste National Park project not only resulted in the restoration of degraded habitats and *in situ* conservation of biodiversity, but has also restored to local people a biological and intellectual understanding of the environment in which they live. Hawkes et al. (2000) discussed and provided examples of how this concept might be extended to landrace conservation, where

the improved farmer awareness of the value of landrace diversity not only helped maintain or restore landrace diversity but also restored to the local people a biological and intellectual pride in their environment. Reinforcement of local cultural identity through 'agro-biocultural restoration' is certainly an equally important outcome to the actual conservation of the biological diversity itself, particularly since with landraces it is the farmer who actually does the conservation.

The changes in the production environment affect the extent and prospects for landrace cultivation. For example in Hungary, over 3 million hectares that are valuable for on-farm conservation areas have been identified as ecologically sensitive. However, it is anticipated that the continued spread of high-input and intensive agricultural practices may lead to the degradation of such areas (Holly et al., Chapter 9 this volume). Another example of land use change that squeezes the area for landrace cultivation is the fact that traditional farms are increasingly being converted into holiday homes, as reported by Nikolaou and Maxted (Chapter 23 this volume). In many areas of Europe this gentrification of traditional farms is likely to expand because the next rural generation is unable to continue farming, due to: a) traditional farms generating relatively low income, b) traditional farm work being physically demanding, involving long hours and being relatively insecure (i.e. subject to threats beyond the farmers' control, e.g. animal disease outbreaks, agro-economic down-turns, fickle consumer demands), c) the output of traditional farms being marginalized by the supermarket culture of high-throughput, uniformity and semi-perfect quality, d) the farmland itself is of substantially more economic value than the income that can be generated annually from farming the land (in some cases simply investing the income will provide a substantially more secure economic return), and e) traditional farms are relatively small scale and are often located in areas of outstanding natural beauty that are relatively easy to sell to middle-income, professional families looking to escape urban life for a rural idyll; but importantly, after the sale the farm is seen as a hobby not a means of income generation. Also the low availability of labour and rising labour costs in the rural areas is reported to diminish the extent of cultivation of landraces (Cardoso and Maxted, Chapter 22 this volume).

Cultivation of landraces on-farm aims for their use in the household, in the local community or for selling in order to generate income for the grower. In other words, the motivation for continuing to grow the crop is essential. Marketing opportunities for local actors versus main commercial markets that require uniformity and large production amounts have an effect on the motivation to

cultivate *per se* and to cultivate diverse landraces as described by Cardoso and Maxted (Chapter 22 this volume). Set-up of product development schemes to create an added value for a landrace can be a demanding task even for research institutes (Martin et al., Chapter 26 this volume) not to mention for elderly farmers or small local cooperatives. While traditional uses of landraces are disappearing, the motivation to grow them by the younger generation will be lacking if new markets that generate additional income are not developed (Heinonen and Veteläinen, Chapter 6 this volume).

A more uncontrollable and as yet unquantified threat to landrace diversity is ongoing climate warming, which perhaps most obviously is causing fires and droughts which in turn threaten global on-farm-managed landraces and their cultivation, but particularly in southern Europe. Despite being in a period of known ecosystem instability resulting from climate change (IPCC 2007), when there is likely to be an increasing need for the genetic diversity contained within landraces to maintain crop production, there has – perhaps surprisingly – been no systematic attempt to assess the impact of climate change on landrace diversity or on how we will need to use landrace diversity to ensure continued food security. It seems likely that in many instances the locations where farmers have traditionally lived and cultivated their food will no longer be suitable for either purpose, therefore resulting in a completely novel level of threat to European landrace diversity. Obviously some landraces may be able to adapt in the changing environmental conditions, possibly even assisted by participatory breeding activities, but others will be lost.

Climate change is predicted to increase average temperatures by 2–4 °C over the next 50 years and will cause considerable changes in regional and seasonal patterns of precipitation (IPCC 2007). Furthermore, IPCC asserts that roughly 20 to 30%, varying from 1 to 80% among regional biotas, of species assessed so far are likely to be at increasingly high risk of extinction as global mean temperatures exceed by 2 to 3 °C pre-industrial levels. They continue that the loss of biodiversity will affect food and agriculture, and may well lead to significant losses of genetic diversity within the species most important for food and agriculture.

As stated above, there has been no systematic attempt to assess the impact of climate change on landrace diversity, but possibly we can gain some insight into the degree of potential threat by noting the impact on wild plant species growing in similar habitats. Thuiller et al. (2005) predicted a drastic reduction (27-42%) in wild plant species by 2080 as a result of climate change, but further they concluded that the greatest impact is expected

in the transition between the Mediterranean and Euro-Siberian floristic regions, a region of Europe also known to be of significant agronomic importance and rich in landrace diversity. Climate change will undoubtedly alter the environmental conditions under which our crops grow, dramatically impacting agriculture and horticulture and leading to a critical demand for adaptive genes to counter novel abiotic stresses. It is likely that many current crop varieties will need replacement to enable them better to suit the new and changing environments under which they will be forced to grow, but what response is required to secure and enhance our landrace diversity?

Although this is recognized as an important question there appears to be relatively little concerted effort to provide an answer! FAO (2008) recognizes the possible devastating impact on agro-biodiversity and the importance of the genetic diversity within agro-biodiversity to sustain production systems. It cites as a particular problem the mismatch in response times to climate change between interacting species, i.e. crops, pests and diseases, and the fact that some genotypes are likely to be favoured over others. FAO (2008) recommends as a response to climate change resulting in new abiotic stresses, the adaptation of crop varieties, that will allow new timing of sowing or harvesting, the breeding of crops to increase water use efficiency, heat tolerance and use of nutrients, the favoured use of underutilized varieties from harsh environments and the community-based management of a wide portfolio of genetic diversity to facilitate adaptive capacity, and for dealing with new biotic stresses – the use of disease-resistant cultivars or multilines to strengthen crop resilience and employing use diversification strategies to increase species and genetic diversity farmed. They also recommend a) developing the knowledge basis to monitor biodiversity trends and associated risks, b) mainstreaming of inter-sectoral cooperation and integrated planning, c) building adaptive capacity through biodiversity management in farming systems, and d) developing climate change-informed plans and policies for genetic resources for food and agriculture. All of which are positive actions to help adaptation and mitigation and to promote resilience to climate change, but we are still left with the question of what response is required to secure and enhance our landrace diversity? Clearly this is a critical issue and requires urgent action, perhaps a way forward would be in the first instance to establish an e-mail discussion group to debate the possible impact and scale of the coming changes and to develop a specific strategy to mitigate the impact of climate change on European landrace diversity, as well as promoting research of the critical issues.

34.5 Opportunities for future landrace cultivation

Despite the wide range of factors threatening the on-farm management of landraces in Europe, the authors of this publication suggest that there are also many new opportunities for landrace cultivation and use in Europe. There have been initiatives that have improved the status of single landraces and awareness of special values of our plant heritage. Also the increasingly commonly stated desire to diversify agricultural and horticultural production, the development of local niche products and ethical production methods can open new opportunities for European landraces and the products derived from them. In addition, realizing the usefulness of local landraces in agro-tourism development is a further opportunity that should not be neglected.

Landraces even today still provide food security at the family level in many parts of Europe due to their adaptation to local agro-climatic conditions (e.g. Krasteva et al., Chapter 4 this volume, Scholten et al., Chapter 15 this volume). Many authors also report the excellent taste qualities of landraces as a reason for their maintenance, as well as providing a justification for a higher price compared with standard commercial cultivars in local markets. Alternatively, selling the crop directly to supermarkets can maximize price returns at the farm level. Even in those part of Europe where the use of landraces for food is rare, their reintroduction to cultivation and consumption can be successful; recently in Finland the project 'Tastes that do not exist' involving the country's top chefs showed that demand for landraces can be created when introduced as a 'rare product' (see www.kiehuu.fi).

Such initiatives as the establishment of quality labels and establishing European regional uniqueness have proven to be useful since they give added value to the product (e.g. Negri, Chapter 17 this volume; Torricelli et al., Chapter 18 this volume). In fact it could be argued that the European wine industry is predicated on quality and establishing European regional uniqueness for its products (Fischer Boel 2008). The EU has established three schemes to encourage diverse agricultural production, to protect product names from misuse and imitation and to help consumers by giving them information concerning the specific character of the products. The schemes are:

- PDO (Protected Designation of Origin) – covers agricultural products and foodstuffs that are produced, processed and prepared in a given geographical area using recognized know-how.
- PGI (Protected Geographical Indication) – covers agricultural products and foodstuffs closely linked to the geographical area. At least one of the stages of production, processing or preparation takes place in the area.

- TSG (Traditional Speciality Guaranteed) – highlights the traditional character, either in the composition or means of production.

Each can act as a marketing tool and helps to underpin a niche market, enhancing income generation, and so can encourage production in a rural development context and consequently favour on-farm conservation of the landrace from which production comes. From the consumer point of view PDO / PGI / TSG help to identify crop varieties as being associated with cultural or biological heritage within a limited geographical area.

Landrace cultivation can also have environmental benefits, as shown with bere barley (Martin et al., Chapter 26 this volume). They can be grown with fewer inputs, and consequently nutrient load to the natural environment can be diminished, which is in line with European environmental policy. Moreira et al. (Chapter 29 this volume) also suggest that through participatory plant breeding, landraces can be used to develop varieties suitable for organic agriculture. In addition, participatory plant breeding can be a means to maintain dynamic on-farm breeding populations, i.e. landraces, and to increase on-farm diversity of the target crop along with the breeding process. Finally, access to the germplasm by the grower can be sustained at the local level, as evidenced by the introduction of the Scottish Landrace Protection Scheme; see Green et al. (Chapter 24 this volume).

34.6 From threats and opportunities to a strategic conservation approach

A strategic approach for conserving and using crop landraces to meet the changing needs of future generations demands an integrated multi-level approach due to the complexity of the issue involved. The strategy should not only focus on conservation *per se*, but also political, economic and sociological (perhaps even anthropological) factors that enable maintainers to sustain landraces and allow them to continue to evolve as a critical genetic resource. It is these factors that underpin the public good of landrace maintenance, ensuring the continued evolution of our European biological heritage while ensuring that the diversity can continue to be used by breeders and other stakeholders. In the formulation of a European on-farm conservation and management strategy the following issues should be considered.

Conservation issues

Based on the fact that the genetic diversity within landraces is threatened by extinction and erosion, the following priority measures should be taken:

- Inventory methodology development → how to use the wide range of data collected, including historical cultivation and use practices and other relevant data which can be collated to help identify conservation priorities.
- Complete inventory → landraces should be systematically inventoried by crop groups and regions.
- Extinction and genetic erosion assessment → as landrace diversity has not been inventoried or systematically conserved in the past, there is limited understanding of the magnitude of risks to landraces themselves and genetic diversity loss or erosion; therefore, it would be beneficial to undertake a detailed loss and genetic erosion assessment for the major crop gene pools using genetic time-series assessment techniques. This would involve the assessment of genetic variation within and between landrace populations that have been sampled and stored in *ex situ* collections and a comparison with fresh samples taken from the same localities to learn how patterns of genetic diversity have changed over time.
- Threat assessment techniques → there is a need to develop a standardized, objective means of assessing relative threat in cultivated landraces to help identify future conservation priorities.
- Gap analysis → this is now a well established evidence-based means of systematically assessing conservation requirements and targeting conservation activities, both *in situ* and *ex situ*, to ensure that limited resources are used efficiently and effectively (Maxted et al. 2008).
- *In situ* on-farm conservation of landrace diversity → it is unlikely that it will ever be possible systematically to conserve all landrace diversity *in situ* on-farm due to the sheer numbers of landraces that still exist and the limited conservation resources available, but a means of prioritizing crop groups and regions should be established systematically to conserve the highest-priority landrace diversity in active, on-farm systems that will form a coherent Global Network of On-farm Conservation. For lower-priority landraces education and public awareness should be used to underpin the value of current maintainers' activities.
- Collection and *ex situ* conservation of landrace diversity → Using the inventory as basis for prioritizing landraces, launch rescue efforts when they are in danger of extinction. Given, as argued in the previous point, that the *in situ* on-farm conservation of all landrace diversity is unlikely, systematic national and regional *ex situ* back-up duplication is critical. It should also be noted that landraces conserved in genebanks will often provide easier access to those wishing to exploit their potential.

- Establishment of local seed depositories/community seed banks → systems like the Scottish Landrace Protection Scheme (see Green et al., Chapter 24 this volume) should be established to ensure on-farm seed security and to underpin landrace dynamic studies.
- Farmer/grower studies on their prerequisites for continued management of landraces on-farm → there is a significant literature on maintainer motivation and the dynamic nature of on-farm conservation, but as this literature is almost entirely focused on on-farm conservation in developing countries and subsistence agriculture, it seems unlikely that this literature can be directly mapped on to the situation in Europe, so what motivates landrace maintainers in Europe, how do farmers choose which landraces to maintain and which seed to save, how dynamic in terms of genetic diversity are European on-farm systems, and what role do the wide range of local (NGOs, farmer cooperatives), national (governmental agencies, breeders, farmer bodies) and European (EC legislation and policy) actors play in landrace maintenance and use?
- Incorporation of landrace conservation within agro-environmental schemes → the European Commission makes significant funding available each year for various forms of agro-environmental schemes but the national application of these schemes varies significantly between individual EU countries, some countries prioritize landrace inclusion and conservation; while in others such as the UK landraces are excluded even though older animal breeds are included. In the UK at a recent meeting of biodiversity and agro-biodiversity communities it became clear that those applying the Directives within the UK wished to integrate landrace conservation but had no baseline to work from; they did not know how to define a landrace or know where they were cultivated in the UK (Maxted pers. comm.). As such and bearing in mind that this UK situation may be reflected elsewhere in Europe it is critical that the biodiversity and agro-biodiversity communities work more effectively together; the link would surely prove mutually beneficial.
- Allied to the maintenance of agricultural landraces on-farm is the maintenance of garden landraces in home gardens and the two activities should not be seen as mutually exclusive → recent experience in the UK while undertaking an inventory of vegetable landraces (Maxted pers. comm.) has highlighted the fact that while agricultural landraces may have been lost from commercial cultivation they may still be maintained within home garden systems and so it is advisable to make a fluid distinction between on-farm and home garden systems.

- Landrace and on-farm information dissemination → there is an urgent need to ensure that information concerning landrace diversity, its conservation and actual or potential utilization is made readily available to the widest stakeholder community. As is argued throughout this text, sustained landrace conservation is closely linked to utilization. Providing access to such information is critical, both for supporting effective and sustainable complementary landrace conservation, and to encourage and facilitate the use of landrace genetic diversity for crop improvement.

Utilization issues

Conservation is not an end in itself, if conservation is to be sustained the conserved biodiversity must have some form of value to society; value implies some form of utilization. Support and development of different forms of landrace use enhance their maintenance within dynamic on-farm management systems:

- New approaches in plant breeding should enhance landrace use → the range of novel genomic and GIS techniques currently being developed (e.g. tilling, predictive characterization, high-throughput, targeted resequencing) have each facilitated a new approach to accession characterization and evaluation, enabling better targeting of those genes that the breeder wishes to use and the simpler transfer of just these target genes to host lines. These applications are bound to lead to greater use of landrace diversity, which in turn should promote conservation, so should be encouraged.
- Landrace improvement, possibly through participatory plant breeding (PPB), should be actively explored → in other continents PPB has been promoted as a means of sustaining landrace cultivation and so should be investigated as regards both landraces' economic feasibility and ecological impact and also their impact on inherent genetic diversity. PPB might be considered an essential activity that may help to mitigate the impact of predicted climate change on landraces, especially if simply maintaining the *status quo* becomes unviable as a means of maintenance.
- Support to a wide range of product development including support to small-scale production of landraces (access for material for further development) → old and new uses.
- Exploration of the links between landraces and on-farm conservation in organic production systems → including the cultivation of landraces by a novel maintainer perhaps through participatory varietal selection (PVS). It may be wise to encourage those wishing to take up landrace maintenance *de*

novo by growing out the range of local landraces of 'traditional' crops, then allowing the growers to select those most suited to their agro-environment or production conditions.
- Further utilization of PDO, PGI, TSGs and other product labelling systems → although the application of these systems is increasing, as a means of helping sustain landraces their use could be expanded significantly, for example in the UK the only PDO is the Jersey Royal potato variety.

Research issues

To support the actions proposed above, there are a number of particular areas of research that are needed to improve our knowledge of where to target landrace and on-farm conservation efforts, how to conserve landraces that are found outside formal on-farm conservation schemes, the causes of loss of landrace diversity, how climate change is likely to impact on landrace populations and how to involve local communities in the local conservation and use of landraces. Recommendations for priority research studies are outlined below. A wider use of landraces and their enhanced maintenance within dynamic management systems can help communities facing the current climatic and socio-economic changes caused by continuous innovations and developments in agriculture, human population dynamics and economic changes. With this aim we need to have a better understanding of:

- Present landrace diversity
- Population dynamics in relation to factors such as migration, drift and human and environmental selection pressures
- Impact of climate change on landrace diversity and how landraces might be managed to allow them to adapt, mitigate or be resilient in the face of its potential impact
- Usefulness of landraces in environmentally friendly agronomic systems
- Socio-economic factors driving on-farm maintenance of landraces
- Reinforcement of local cultural identity and linking local crops with local culture, 'agro-biocultural restoration' and transmission to the future generations of pride in their agronomic heritage will achieve both the conservation of landraces as well as the on-farm system itself.

Political and legal issues

Landrace management on-farm is an integral part of European food security. Therefore, variety and seed production legislation that conflicts with on-farm diversification should be questioned seriously on the national and European levels:

- Variety protection laws or European production standards are anecdotally thought to have negatively impacted European agrobiodiversity. Therefore it would be wise to monitor the changes in agriculture in the countries recently joining the EU.
- The present European legislative frame (i.e. Commission Directive 2008/62/EC 20 June 2008, currently being implemented in Member States), although instigated to maintain remnant landrace diversity, may or may not have this effect (see Lorenzetti and Negri, Chapter 31 this volume) because its prime focus is seed marketing and also because it allows such a wide range of interpretation and subsequent legislative implementation in each Member State.
- Legislative models based on the need to preserve plant genetic resources (instead of on commercializing them) exist (see Lorenzetti et al., Chapter 33 this volume) and their wider implementation would be more appropriate to guarantee future food security at local and regional levels.
- Given as argued above that there is a need to establish a coherent Global Network of On-farm Conservation, there is also a need to provide legislative protection of the on-farm sites to ensure their long-term financing and survival.

Land use is impacting landrace maintenance in their original environment:

- Strict restrictions in land management and use of fertilizers and pesticides should be introduced to prevent the degradation of natural, semi-natural and agro-ecosystems in environmentally sensitive areas.
- Land use planning in areas of active on-farm management should favour the conservation of ecologically diverse growing conditions that favour local landraces, not try to 'improve' the agro-environment so that improved varieties are favoured.

Public awareness and education

There is an immediate need to increase awareness about the importance of landrace diversity and on-farm conservation at all levels of society: farmers, farmer communities, researchers and research communities, policy makers, ordinary people and local, national and international authorities. Only when a wider understanding exists will the long-term preservation of landraces be achieved. In this context:

- Education of the youngest generations of farmers from the primary to the university level is crucial
- Publications, websites, leaflets about landrace maintenance activities to be widely distributed

- Maintenance of local genebanks and living collections of landraces should involve local people, through school visits to open trial days dedicated to farmers and/or gardeners showing local landrace diversity and offering seed opportunities to farmers
- Wide landrace seed duplication and distribution will ensure landrace retention – *don't put all your landrace 'eggs' into one basket* (in terms of either landrace maintainers or genebank holdings)!

The latter two points proved to be effective in some cases (see Negri, Chapter 17 this volume) and can help in achieving the goal.

Socio-economic issues

Perhaps as professional conservationists and scientists, we shy away from addressing the socio-economic aspects of landrace and on-farm conservation, but here if for no other reason than the fact that farmers are the conservationists we should not underplay the value of socio-economic study:

- Regional development, agro-business and environmental schemes should include management of genetic resources in their entirety (e.g. on-farm conservation, product development, participatory plant breeding and legal issues as they relate to landraces). Interestingly in the UK government funds are obtainable to promote the use of traditional animal breeds in environmentally sensitive areas but no such equivalent support is available for the cultivation of traditional landraces.
- Routinely, now when developing global financial support for on-farm projects a critical element of the project is examining the increased commercial value of landraces, niche market and market chain enhancement and the development of entirely novel markets, so there seems to be much scope for further application of these techniques to European landraces.
- Fears over global warming are promoting the localization of production and consumption of food and these initiatives should be supported whenever economically possible, as this is the socio-economic sphere in which landraces can thrive.
- Support for local seed production.

Cooperation issues

To facilitate the exchange of information on on-farm conservation activities and problem solving the widest cooperation and exchange of information among national and European institutions, agencies, farmers' organizations, NGOs and individual people is desirable and should be promoted at the national and European levels. The On-Farm Working Group of ECPGR is currently playing a leading role at the regional level, while it seems that cooperation at the national level needs

to be built up or strengthened in most European countries, perhaps particularly making the link between national NGOs working in this area. In addition, inter-regional cooperation would be most useful.

34.7 Conclusion

Finally, the central proposition of this text should be re-stressed: landraces are a critical resource for the future of humankind, they are being rapidly eroded or extinguished and yet it is their diversity that will be required by breeders addressing the challenge of climate change. It cannot be over-stressed that climate change presents a new degree of threat to global food security not previously seen, landraces contain the genetic diversity that can at least partially mitigate this threat, but we need to act now adequately to conserve and use landrace diversity for the benefit of humankind. The actions required are outlined above and are summarized in Box 34.1 as a Strategic Approach to European Landrace Conservation and Use with suggested time-bound targets. In every case we have the required techniques and even the necessary experience in applying them, but now we need European and national plant genetic resource, biodiversity conservation and plant utilization structures to coordinate and focus actions – all that is required now is the will to act!

Box 34.1. Summary Strategic Approach to European Landrace Conservation and Use.

Goal: *Effective and sustainable conservation and use of European landrace diversity.*

Target 1: Prepare national conservation and use strategic action plan – each European country to prepare a national action plan for the inventory, survey, conservation (*in situ* and *ex situ*) and sustainable use of landrace diversity, by 2012 and integrate plan into and complement existing national and regional plant genetic resource, biodiversity strategies and action plans.

Target 2: Establish a European mechanism/clearing house – establish a European mechanism for landrace diversity information using existing structures, such as AEGIS, ECPGR On-Farm Working Group and FAO, by 2012.

Target 3: Create national priority landrace lists and identify priority sites for on-farm conservation – each European country to prepare a national priority list of landraces in need of urgent conservation action using existing priority determining criteria by 2015. Identify within each country, at least five priority sites for the establishment of active on-farm conservation projects. These sites should form an interrelated network of internationally, regionally and nationally important on-farm conservation projects for *in situ* conservation.

Target 4: Create European priority landrace lists and identify priority sites for on-farm conservation – AEGIS, ECPGR On-Farm Working Group, FAO and other relevant bodies to put in place a system for prioritizing national landrace lists and identifying priority (20-30) sites for on-farm conservation of European regional significance, by 2018.

Target 5: Establish protocols for landrace information management and dissemination – existing information management systems for landraces to be harmonized and applied to national and the European EURISCO systems for *in situ* and *ex situ* management, by 2015.

Target 6: Develop effective means of systematically conserving landrace diversity *in situ* – each European country to assess whether existing on-farm activities adequately represent the full range of national landrace diversity, and suggest additional locations where required, by 2012. Raise awareness among biodiversity conservationists of landrace diversity and request they take into account the maintenance and conservation needs of landraces when drawing up or revising management strategies. Ensure landrace maintainers and local communities are central to the planning of community-based landrace conservation. Countries and agencies to encourage landrace conservation outside conventional plant genetic resource programmes, e.g. agro-ecosystems easements, set-aside and other appropriate protection schemes. Promote farming systems based on landraces as a generic means of aiding on-farm conservation. Publish protocols and examples of the integration of on-farm conservation and use as a means of promoting landrace use.

Target 7: Develop effective means of systematically conserving landrace diversity *ex situ* – each European country to undertake gap analysis of landrace diversity in national genebanks and field genebanks (clonal collections), as result identify gaps in collections and ensure they are filled by 2014. Promote the establishment of community seed banks for local landrace diversity.

Target 8: Assess landrace threat and climate change status – each European country to review the threat status and assess the predicted impact of climate change of all priority landraces, by 2015. Establish protocols for assessing landrace threat status similar in operation to the IUCN Red List Criteria.

Target 9: Ensure public awareness, effective security and legislative protection for European landrace diversity – each European country to integrate awareness of the importance of landraces into existing education and public awareness programmes for the private sector, national associations of producers, farmers, industry and other potential stakeholders. Also each European country to review current national and regional policy and legislative instruments that impinge on landrace diversity and where necessary instigate necessary policy and legislative changes.

Target 10: Promote sustainable utilization of European landraces – each European country to promote sustainable use of landraces, research novel approach to characterization and evaluation and encourage use of landrace diversity in breeding programmes.

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Photo collection

Photo 1 (Chapter 3). Collecting samples and indigenous knowledge from a landrace grower, Chios, Greece (Photo: Nigel Maxted).

Photo 2 (Chapter 6). The landrace winter rye from eastern Finland has been in cultivation for several generations in the family (Photo: Timo Mustonen).

Photo 3 (Chapter 14). French bean or brown haricot (*Phaseolus vulgaris* L.) 'Signe', a landrace collected in south-east Sweden and grown for generations there (Photo: Lena Nygårds).

Photo 4 (Chapter 7). 'Johannislauch' an *Allium lusticanum* landrace from Rüthen village north of Brilon, Land Nordrhein-Westfalen. This strain is used for the first onion dish in the spring season served with a cream sauce (Photo: Heidi Lorey).

Photo 5 (Chapter 16). Farmer collecting tomato landrace in Orihuela, south-east Spain (Photo: Juan José Ruiz).

Photo 6 (Chapter 19). The grower and owner of local timothy strain Grindstad from Norway (Photo: Oddrun Karlstad).

Photo 7 (Chapter 20). Seed plants of "Küttiger Rüeble" grown in a garden in Küttingen (Photo: Christoph Köhler).

Photo 8 (Chapter 15). Shetland cabbage plantation on the island of Whalsay, Shetland island, Scotland (Photo: Maria Scholten).

Photo 9 (Chapter 18). Mr Cicchetti saved 'Monteleone di Spoleto' emmer wheat from extinction and developed new products and techniques for this crop (Photo: Renzo Torricelli).

Photo 10 (Chapter 21). Manor Farm, Suffolk newly rethatched with long-strawed wheat (Photo: Mike Ambrose).

Photo 11 (Chapter 22). A vine landrace harvested and awaiting processing in Terceira Island, Azores, Portugal (Photo: Nigel Maxted).

Photo 12 (Chapter 23). Traditional lentil landrace threshing, Lefkada Island, Greece (Photo: Leonidas Nikolaou).

Photo 13 (Chapter 26). Jim McEwan, Production Director at Bruichladdich whisky distillery in Islay, Scotland, tasting spirit made from bere, a Scottish barley landrace (Photo: Bruichladdich distillery).

Photo 14 (Chapter 27). Local potato strain Puikula from Finnish Lapland (Photo: Antti Hannukkla).

Photo 15 (Chapter 30). The crab apple *Malus sylvestris* –basis for a delicious fruit tea (Photo: Monika Höfer).

Photo 16 (Chapter 30). Wild apple tree (Photo: Monika Höfer).

Index

Note: page numbers in *italics* refer to figures and tables

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