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Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding'

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Landraces

Issue 1 October 2012

Conserving Europe's plant genetic resources

for use now and in the future

Landraces

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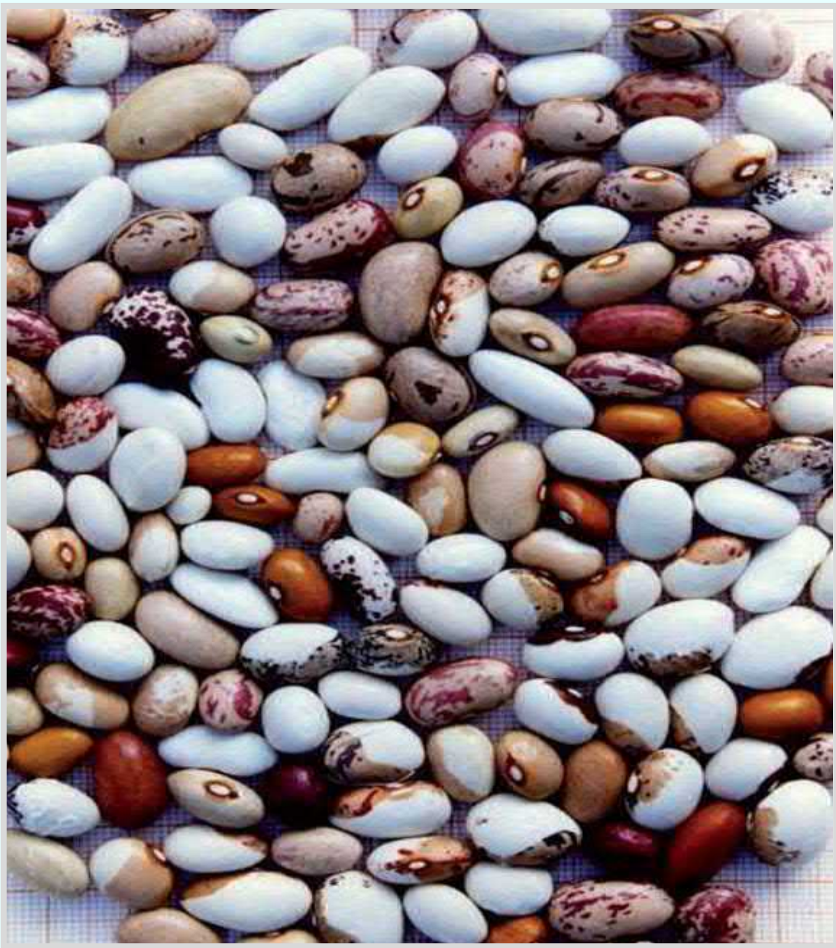
Editorial

Welcome to Issue 1 of *Landraces*. This inaugural newsletter is brought to you by the European Community funded project, “Novel characterization of crop wild relative and landrace resources as a basis for improved crop breeding” (PGR Secure, GA n. 266394) which commenced on 1st March 2011. *Landraces* provides a medium to publicise information about the conservation and use of crop landraces; including an introduction and updates on the activities of PGR Secure but also more general articles on landraces conservation and use. We anticipate that anyone with an interest in landraces, whether conservationist, breeder, farmer, policy-maker or educator will benefit from this publication, both by spreading news about their own activities and by learning about other initiatives.

This introductory issue provides information about the aims and objectives of PGR Secure, explaining the rationale for the initiation of the project. It serves to highlight the importance of landraces as vital ecosystem components, as a resource for food and agriculture and for their cultural values, as well as a critical resource for the improvement of crops. You can read an article regarding how to enhance the use of traits from crop wild relatives and landraces to help adapt crops to climate change. In the following articles more detailed information about the activities of the project are reported. They include: information on the aims and present achievements of the PGR Secure Work package 4 which is specifically dedicated to the conservation of landraces in Europe, a brief report about the issues considered during the joint PGR Secure/ECPGR workshop, the present achievements in compiling the Italian, UK and Finnish inventories of landraces. Finally, some contributions on landraces from several European countries (Turkey, Italy, Portugal, Spain, Austria and Azerbaijan) are reported. Note future editions will contain articles on landraces from other Regions of the world as well.



Above: Phenotipic variation in Italian landraces of *Phaseolus vulgaris* (Photo: Angela Rosa Piergiovanni)

PGR Secure: enhanced use of traits from crop wild relatives and landraces to help adapt crops to climate change

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Our food depends on the continued availability of novel sources of genes to breed new varieties of crops which will thrive in the rapidly evolving agri-environmental conditions we are now faced with as a result of climate change. Wild plant species closely related to crops (crop wild relatives) and traditional, locally adapted crop varieties (landraces) contain vital sources of such genes, yet these resources are themselves threatened by the effects of climate change, as well as by a range of other human-induced pressures and socio-economic changes. Further, while the value of crop wild relatives and landraces for food security is widely recognized, there is a lack of knowledge about the diversity that exists and precisely how that diversity may be used for crop improvement. PGR Secure aims to address these issues by: a) developing fast and economic methods to identify and make available genetic material that can be used by plant breeders to confer resistance to new strains of pests and diseases and tolerance to extreme environmental conditions such as drought, flooding and heat stress—the biotic and abiotic pressures which are rapidly evolving and having an increasingly detrimental effect on crop productivity; and b) developing a Europe-wide systematic strategy for the conservation of the highest priority crop wild relative and landrace resources to secure the genetic diversity needed for crop improvement.

Read on to learn more about the project.

PGR Secure context: a call for a step change in agrobiodiversity conservation and use

The EC Biodiversity Action Plan for Agriculture (www.epbrs.org/PDF/EPBRS-IR2004-BAP%20Agriculture.pdf) highlighted the need for a step change in crop cultivar production in Europe because of rapidly changing consumer demands and the need to ensure food security across the continent; particularly in the light of the impacts of climate change. If these requirements are to be met, plant breeders need a broader pool of diversità to supply the necessary range of mitigating traits, as well as greater efficiency in characterization and evaluation techniques to locate the desired traits. The Action Plan also argued that maintaining the *status quo* for agrobiodiversity conservation and use is no longer tenable and that a step change in systematic conservation and use is required. The two major components of agrobiodiversity that offer the broadest range of diversity for breeders are crop wild relatives (CWR) and landraces (LR), but

Above: Sugar beet, *Beta vulgaris* (Photo: Strube Research GmbH & Co KG)

Above: *Medicago falcata* (Photo: Pavol Eliás)

there is currently a gap between their conservation and use and they remain under-exploited by the user community. In order to meet the needs of future generations, there are five key areas that need to be addressed:

1. *Climate change mitigation* – The adverse impacts of climate change (such as extreme weather events) on patterns of crop diversity and local cultivar adaptation are predicted to have a negative impact on crop yields. Breeders will be increasingly required to take adaptive action—breeding for example novel drought, pest and disease resistant cultivars—which will require extensive screening of genetic resources and use of adaptive traits in breeding resistant cultivars.

2. *Limited success of traditional characterization to meet breeders' needs* - Traditional phenotypic characterization and evaluation using field trials is resource intensive—thus,

the vast majority of conserved CWR and LR accessions remain uncharacterized and as a direct result largely unutilized. Novel approaches to characterization and evaluation beyond those previously applied are required to extend the use of CWR and LR diversity.

3. *Lack of systematic CWR and LR conservation* – Within European *ex situ* germplasm collections, only a very small percentage of germplasm holdings are CWR species and these are not a representative sample of the genetic diversity found in European wild populations. Although the numbers of gene bank holdings of LR are undoubtedly greater, without an inventory or conservation strategy it is unknown if these holdings truly reflect the diversity still maintained by farmers today in Europe. There is also currently no active *in situ* conservation of CWR in Europe as these species tend to fall between the priorities of the plant genetic resources for food and agriculture (PGRFA) conservation and nature conservation communities. Better systematic CWR and LR conservation and promoting their availability means that greater adaptive diversity could be made available to breeders.

4. *Threats facing CWR and LR diversity* – Worldwide, biodiversity is under severe threat from a range of deleterious factors (e.g., habitat destruction, degradation and fragmentation, over-exploitation, invasive alien species and changes in land management), but in the medium to long term climate change is predicted to be a degree of magnitude more catastrophic in terms of loss of species and genetic diversity. Recent research shows that at least 16 %

Above: Peter Brinch, maintainer of landrace beetroot 'Cheltenham Green Top' (Photo: Pupak Haghighi-Brinch)

Above: *Avena sterilis* subsp. *ludoviciana* (Photo: Richard Lia)

of the highest priority CWR species in Europe are threatened (Critically Endangered, Endangered or Vulnerable) or Near Threatened (http://ec.europa.eu/environment/nature/conser vation/species/redlist/downloads/European_vascular_plants.pdf); however, the threat to genetic diversity is even greater, meaning that the pool of locally adapted diversity required by breeders is decreasing. Landraces are under threat from agricultural intensification, market failure and socio-economic change. It is more difficult to quantify the loss of LR diversity because we do not yet have a comprehensive inventory of the diversity that exists; however, it is likely that LR are an even more threatened resource than CWR.

5. *Lack of plant genetic resource informatics cohesion* – In recent years there has been significant informatics development within the European PGRFA community. The *European Cooperative Programme for Plant Genetic Resources* (*ECPGR* – www.ecpgr.cgiar.org) crop networks developed the *European Central Crop Databases* (ECCDB – www.ecpgr.cgiar.org/germplasm_databases.html) that contain accession passport, characterization and evaluation data for major crop collections; the ECPGR *Documentation and Information Network* through the FP5 consortium EPGRIS developed the EURISCO web catalogue of European gene bank holdings (http://eurisco.ecpgr.org/); and the ECPGR *In Situ and On-farm Conservation Network* (www.ecpgr.cgiar.org/networks/in_situ_and_on_farm.html) through the FP5 consortium PGR Forum (www.pgrforum.org) created the Crop Wild Relative Catalogue for Europe and the Mediterranean (accessible via the Crop Wild Relative Information System, CWRIS – www.pgrforum.org/cwris/cwris.asp) containing a nomenclatural checklist and occurrence data for European CWR species. However, each system currently stands alone and there is a need to link these systems into one comprehensive information portal for European PGRFA. Furthermore, vast quantities of data on gene sequences are continually expanding in world databases and transcriptomic information is close behind. Effective CWR and LR diversity conservation and use requires advanced informatic techniques to join up all these information systems and the data they contain.

Box 1 PGR Secure work packages

Work package 1 – Phenomics, genomics and transcriptomics
• Demonstrate how novel phenomics, genomics and transcriptomics tools can be used to speed up plant breeding
• Insect resistance in brassica crops as a case study

Work package 2 – Informatics
• Produce a web-based Trait Information Portal (TIP) to provide access to CWR and LR trait data
• Predictive characterization (using FIGS) to identify populations of CWR and LR with adaptive traits for pest and disease resistance and tolerance to environmental conditions (*Avena, Beta, Brassica* and *Medicago* as case studies)

Work package 3 – Crop wild relative conservation
• Produce national and Europe-wide CWR inventories
• National CWR conservation strategy case studies for the UK, Finland, Italy and Spain
• Develop a European CWR conservation strategy for priority crop gene pools
• Produce a generic European CWR conservation strategy combining the regional and national approaches

Work package 4 – Landrace conservation
• Gain an understanding of the diversity of European LR and their present conservation status
• Develop a systematic European LR conservation strategy to promote their use by breeders and by local communities and farmers

Work package 5 – Engaging the user community
• Promote the use of CWR and LR in Europe
• Consultation with stakeholders (gene bank managers, breeding companies, public research bodies, NGOs), SWOT analysis to identify constraints in CWR and LR use
• Promote the flow of pre-breeding material and information gained in the project to stakeholders

Work package 6 – Dissemination and training
• Website, web-enabled inventories, TIP, publications, workshops, dissemination conference

Work package 7 – Project management

PGR Secure: answering the call

PGR Secure is a collaborative project funded under the EU's Framework 7 Programme and aims to address the issues outlined above by advancing CWR and LR diversity conservation and use. The goals of PGR Secure are to a) research novel characterization techniques for CWR and LR, b) develop conservation strategies for European CWR and LR diversity, and c) to enhance crop improvement by breeders as a means of underpinning European food security in the face of climate change. To achieve these goals PGR Secure has four research themes: 1) novel characterization techniques, 2) CWR and LR conservation, 3) improved use of CWR and LR by breeders, and 4) informatics (Fig. 1). Themes 1 and 3 address how to improve breeders' use of conserved CWR and LR diversity by applying novel characterization techniques such as genomics, transcriptomics, metabolomics, high-throughput phenotyping and GIS-based predictive characterization, as well as clarifying through dialogue exactly what breeders need to bridge the conservation–use gap and facilitating the flow of selected material and knowledge from the project to the breeder community. Theme 2 enhances CWR and LR species and genetic diversity conservation through development of CWR and LR inventories and systematic conservation strategies, while Theme 4 addresses the management and provision of access to CWR and LR trait and conservation information.

The project is implemented through seven work packages (WPs) (Box 1).

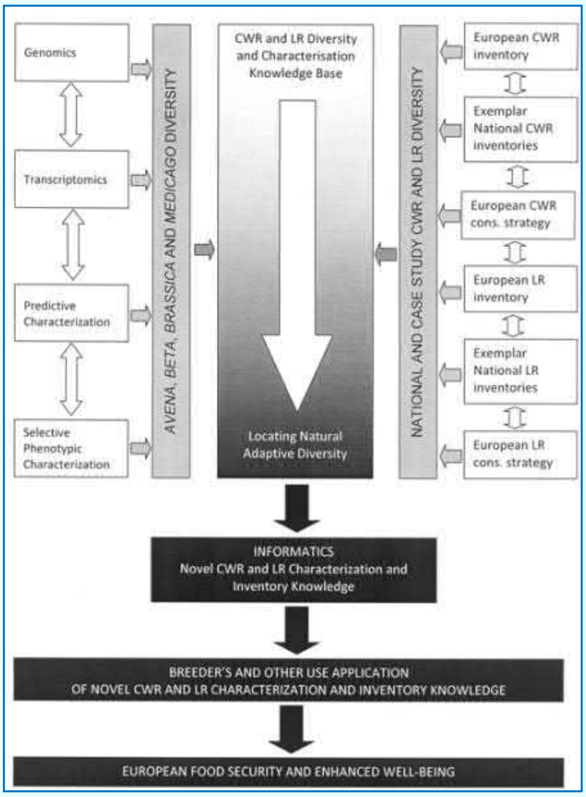

Figure 1 Schematic diagram of interrelated PGR Secure project themes

Above: Sugar beet, *Beta vulgaris* (Photo: Strube Research GmbH & Co KG)

Array machine and plate arrays (Photo: Sean May)

The expected impacts of these actions are:

- Enhanced techniques to identify useful adaptive traits and to accelerate plant breeding;
- Better access to and wider take-up of CWR and LR resources in plant breeding programmes;
- Increased capacity and options for crop improvement to support European farming;
- Improved conservation of European CWR and LR resources;
- Provision of a resource base and tools to back-stop food security in Europe;
- Enablement of coherent planning of plant breeding and agrobiodiversity conservation policy in Europe.

Who is involved?

The PGRFA user community in Europe is diverse; ranging from breeding companies, public research institutes, gene banks, non-governmental organizations (NGOs), universities and farmers; but it is use by plant breeders that has potentially the greatest economic and social benefit in Europe. FAO's Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture (www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/sow/sow2/en/) highlights that "*Considerable opportunities exist for strengthening cooperation among those involved in the conservation and sustainable use of PGRFA, at all stages of the seed and food chain. Stronger links are needed, especially between plant breeders and those involved in the seed system, as well as between the public and private sectors*". The PGR Secure project seeks to strengthen these links and involves collaboration between European policy, conservation and breeding sectors throughout Europe.

The project was initiated by and involves members of the *In Situ* and On-farm Conservation Network (www.ecpgr.cgiar.org/ networks/in_situ_and_on_farm.html) of the European Cooperative Programme for Plant Genetic Resources (ECPGR) from throughout Europe. The Consortium itself comprises 11 partner institutes and includes both plant breeding and conservation research institutes, as well as Europe's primary plant breeding research network, the European Association for Research in Plant Breeding (EUCARPIA) (Box 2). The Consortium is supported by an External Advisory Board which involves senior researchers in plant breeding and PGRFA conservation and policy, as well as a Breeders' Committee comprising plant breeders and pre-breeders of major European food crops.

Stakeholders in the project are Europe-wide and include: a) small and large plant breeding companies; b) scientists and policy-makers in public and private research institutes; c) farmers and others working in the agricultural sector; d) plant gene banks, protected areas and the broader conservation community; e) government agencies and non-governmental organizations involved in plant conservation, plant breeding and national or local nutrition and food supply issues; and f) the European Commission.

For further information, please visit the project website: www.pgrsecure.org or contact the Project Manager, s.kell@bham.ac.uk.

Box 2 The 11 partner institutes forming the PGR Secure Consortium

1. The University of Birmingham, UK (Coordinator)

2. Wageningen UR Plant Breeding and Centre for Genetic Resources, The Netherlands

3. Bioversity International

4. The University of Perugia, Italy

5. Julius Kühn-Institut, Federal Research Centre for Cultivated Plants, Germany

6. NordGen, Sweden

7. MTT Agrifood Research, Finland

8. The University of King Juan Carlos, Spain

9. ServiceXS BV, The Netherlands

10. The University of Nottingham, UK

11. European Association for Research on Plant Breeding, Hungary

PGR Secure Work package 4 'Landrace conservation': introduction and present achievements

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The overall objective of Work package 4 (WP4) is to promote the relevant interventions securing and improving the *in situ* and *ex situ* conservation of European landrace (LR) diversity as a means of improving LR use by breeders and local communities. It is noted that there is much less information available for European LR diversity than for crop wild relatives (CWR) diversity and that prior to developing the above - mentioned relevant interventions, it is important to better understand the diversity of European LRs and their current conservation status.

At present no European-wide LR inventory has been developed, although some information has already been published (Veteläinen *et al*., 2009, 2012; Negri *et al*., 2012; Maxted *et al*. 2012) and tools favouring LR data recording and sharing of information on existing always on-farm/in-garden conservation activities have already been made available on the web by the On-farm conservation WG of ECPGR (http://www.ecpgr.cgiar.org/Networks/Insitu_onfarm/Docs/OnfarmDescr_DRAFT271107.pdf) by UNIPG (see: http://www.sharinginformation.eu/) and recently by PGR Secure itself (see below).

This work package has four subordinate objectives:

1. to create a European inventory of LRs maintained *in situ* (i.e. on-farm and in garden) as the necessary informative basis for any conservation and use action. All crops should be included, but considering the resources available, the focus will be on *Avena*, *Beta*, *Brassica* and *Medicago* (for which CWR exist in Europe) taxa, at least. An other objective is to make available a web-enabled Europe-wide inventory that contains basic biodiversity data and is moderated by national Plant Genetic Resource programmes.
2. to generate exemplar national LR conservation strategies, based on detailed LR inventory case studies carried out in Finland, Italy and the UK, will be developed.
3. to develop an analysis of the European LR gene pools of *Avena*, *Beta*, *Brassica* and *Medicago* and a specific European conservation strategy.
4. drawing on PGR Secure priority gene pool case studies and the three country inventories, along with ECPGR On-farm Working Group activities and existing information sources, PGR Secure aims to develop a generic European LR conservation strategy that will review European LR wealth, conservation status, prioritized *in situ* and *ex situ* conservation actions and links to breeder-based exploitation of LR diversity.

The LR conservation WP involves the University of Perugia (I), the University of Birmingham (UK), MTT Agrifood Research (FI) and Bioversity International as main actors, but calls on all European countries to contribute (Fig.1).

Concerning the first aim, the project has already provided training to generate National LR Inventories (NIs) in European countries with the ''Conservation strategies for European crop wild relatives and landrace diversity'' workshop that was held in Palanga in September 2011 (see the following article).

A European LR inventory can only be based on NIs, considering that the responsibility to conserve and sustainably use LR diversity (as well as any other biodiversity component) lies with individual countries and that any concerted action will be implemented at the national level, even when driven by policy at the European level.

Delegates from almost all European countries who were officially nominated as LR Inventory National Focal Points (NFPs) by the National coordinators, NFPs associated with the ECPGR Documentation and Information Network, as well as the ECPGR Secretariat, attended the meeting to discuss a strategic approach to European and National LR inventorying and conservation.

During the workshop the delegates were provided with a comprehensive set of references and informed about possible tools and strategies that favour LR *in situ* (e.g. on-farm/in-garden) conservation activities. In addition, and most relevant, an implementation plan for the construction of NIs was agreed upon, although National delegates underlined the fact that lack of resources in the National Programs that will possibly make it difficult to put it into practice. The work plan agreed upon has the following basic steps:

To collect information on LRs that are still maintained *in situ* by using a minimum set of Descriptors to be developed on the basis of the suggestions received during the workshop.

To build up LR NIs,

To make data available to PGR Secure for compiling a European Inventory.

Soon after the workshop the PGR Secure WP4 team started to work out the *in situ* LR descriptors taking into account the suggestions received from the NFP, the ECPGR Documentation and Information Network during the Palanga workshop and ECPGR Secretariat and from Bioversity International that is involved in drawing up the FAO WIEWS Multi-Crop Passport Descriptors.

The Descriptors For Web-Enabled National *In Situ* Landrace Inventories have been recently published on the PGR Secure helpdesk web page (www.pgrsecure.org/helpdesk) (Fig. 2). They are a fundamental tool for recording LR *in situ* data in a standardized and agreed upon manner in order to allow the first European database for LRs to be constructed, in the first place, and to feed other European databases of genetic resources like EURISCO. The Descriptors include fields related to the Inventory, taxon, landrace, site and farmer identification, the landrace status, characteristics and use and finally fields concerning conservation actions and monitoring actions eventually taken in favour of LR diversity maintenance. The progress towards the national inventory of landrace diversity in Italy and the UK are described in the following pages.

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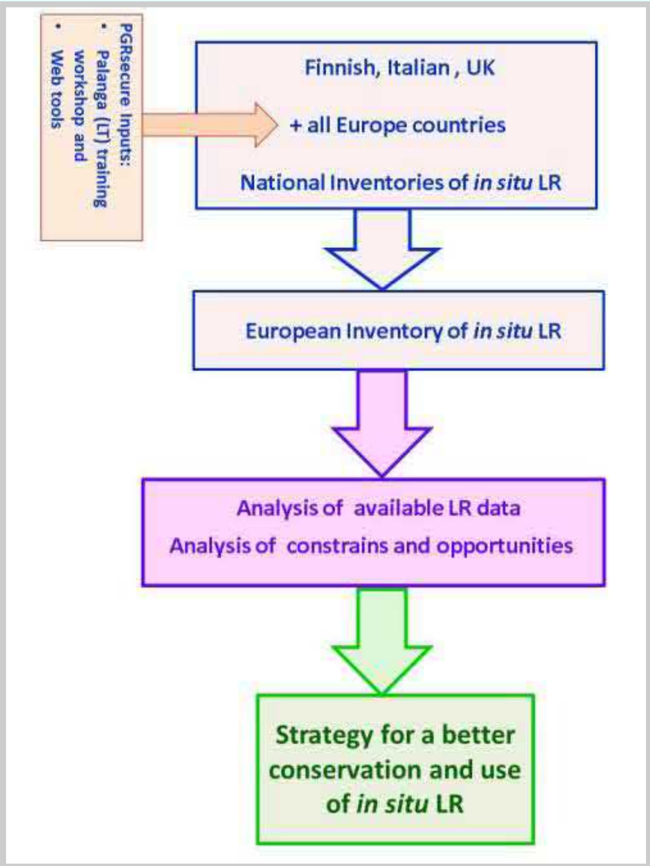

Figure 1: PGR Secure Workpackage 4 development in synthesis

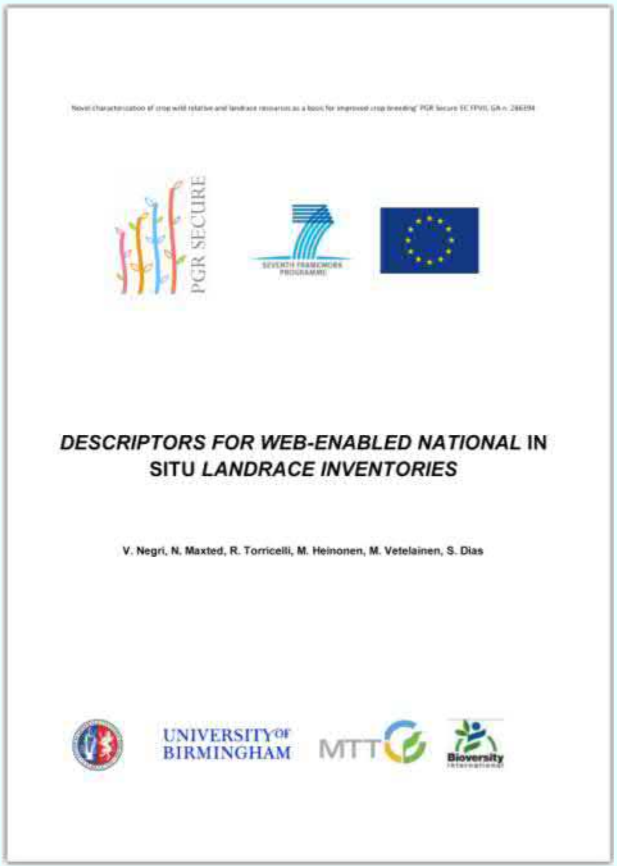

Figure 2: The cover of the LR Descriptors developed on the basis of the suggestions received during and post the workshop (dowloadable from: www.pgrsecure.org/helpdesk)

Above: on the left an example of “Roveja” (*Pisum sativum* ssp. *arvense*) cultivation on Plains of Castelluccio (Apennine Mountains), on the right a detail of the “Roveja” flower (Photos: F. Picottini)

Conservation strategies for European crop wild relative and landrace diversity: a joint PGR Secure/ECPGR workshop

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A joint PGR Secure/European Cooperative Programme for Plant Genetic Resources (ECPGR) workshop, ''Conservation strategies for European crop wild relative and landrace diversity'', was convened in Palanga, Lithuania from 7–9 September 2011 to discuss and agree a strategic approach to European and national crop wild relative (CWR) and landrace (LR) conservation.

While the ultimate aim is to ensure the systematic conservation of European plant genetic resources for food and agriculture (PGRFA) which is important for food security and the European economy, the workshop addressed five primary topics: 1) production of National Inventories (NIs), 2) taxon prioritization, diversity and gap analysis, and threat assessment, 3) data collection, management and exchange, 4) linking conservation to use, 5) development and implementation of national CWR and LR conservation strategies by the ECPGR Network members. The workshop comprised a series of presentations and discussion sessions on the state of the art of CWR and LR conservation in Europe and reviewed the available approaches and methods.

Participants shared knowledge on current national activities, discussed the practicalities of developing national CWR and LR conservation strategies, and agreed on the way forward. The workshop was structured around three plenary sessions (introductory, interim and final reporting) and three working group sessions (CWR conservation, LR conservation, and information management). It was attended by 101 participants from 38 European countries and one from the United States of America. Participants included members of the ECPGR In Situ and On-farm Conservation Network (Wild Species Conservation in Genetic Reserves and On-farm Conservation Working Groups) and Documentation and Information Network, as well as Consortium and External Advisory Board Members of the EU Framework 7 project, PGR Secure.

The workshop was organized and facilitated by the University of Birmingham, (UK), University of Perugia, Italy, Nature Research Centre Lithuania (NRC) and ECPGR and was hosted by the NRC. Following is a brief summary of the discussed LR issues.

Above: V. Negri and M. Veteläinen give an introduction on possible ways to LR conservation during the workshop. Pictures taken during the excursion to the Curonia Spit (Photo: R. Torricelli).

WORKING GROUP 2: LR CONSERVATION

V. Negri (University of Perugia) introduced the general aim of the workshop (i.e. to provide background information and training in LR NI and LR *in situ* conservation strategy development) and presented the specific topics to be covered and discussed in the group 2 session. The following presentations were then given.

What are LR A training presentation was given by V. Negri which considered the nature of LR, (their definitions and genetic structure), their importance and possible ways to *in situ* (on-farm/in garden) conservation. She initially noted that there are many definition of what constitutes a LR. Italy is presently working to inventory its own heritage of LR under the definition that was given in the frame of the EU funded project AEGRO (http://aegro.jki.bund.de/aegro/): "*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 and is associated with the traditional uses, knowledge, habits, dialects, and celebrations of the people who developed and continue to grow it*" (see Lorenzetti and Negri, 2009). This definition emphasizes the aspects of a long standing, unbroken and active management of LR in a specific human context and underlines that a LR belongs to the people who developed it and feel to be its owner.

LR inventories R. Torricelli and V. Negri (University of Perugia, Italy) then presented the goals of inventorying LR, where LR can be found and LR gap analysis.
It was initially noted that LR are still present across Europe, however, complete inventories for single European country are still lacking. This lack of information severely hampers the possibility of conserving and using effectively these LR. To create NIs is the needed informative base for any conservation action which is presently strongly needed and required by many legally binding international agreements

M. Veteläinen (MTT Agrifood Research Finland), after recalling goals of the inventorying action, presented the available tools, information sources and the current situation of inventory actions in Europe. Available tools presently include *ex situ* information systems such as local/regional gene bank, EURISCO and CCDBs and *in situ* information available from earlier inventories, literature, Internet, NGOs and other grower organizations, farmer interviews and the on-farm/in garden (http://www.sharingingformation.eu/). She noted that to carry out inventories, attention should be paid to the collection of guidelines, forms and descriptor lists, to give LR grower information on subsidy systems, to consider *ex situ* back-up possibilities and conservation networks and to have a post-inventory follow-up plan. All this in order to build up a well designed, integrated *ex situ* / *in situ* conservation system.

M. Veteläinen and V. Negri suggested a list of basic data to be recorded when inventorying LR on the farms and stimulated a discussion on the topic. About data to be recorded it was first noted that there are two levels to be considered: the national needs and the PGR Secure needs. As for the latter, a minimum set of data are needed. The format to be used should be on that used by EURISCO in order to facilitate a EURISCO extension to include on-farm data in the future.

It would of course be useful to record also other data (see the minimum descriptor list already worked out by the ECPGR On-farm Working Group (WG) downloadable from: http://www.ecpgr.cgiar.org/networks/in_situ_and_on_farm/on_farm_wg.html), but the data listed above are the minimum which would allow the PGR Secure project to achieve its aims. All crops should be inventoried, but focus should be on those belonging to the *Avena*, *Beta*, *Brassica* and *Medicago* genera.

M. Heinonen (MTT Agrifood Research Finland) gave a training presentation on how to get information from farmers based on experience in Finland within a project started in 2006. She noted initially that knowledge on LR is typically scattered, non-organized, rarely written down and locally based. Since the generation is vanishing to whom LR have been part of the everyday life, it is badly needed to locate the LR and to gather the diverse (agricultural, biological, cultural, historical, local) knowledge. A national call for LR in Finland was announced by the PGR National Programme in the early 2006 asking for information about cereals, flax, pea, and hemp and made it clear that interest was focused on LR in cultivation and old commercial varieties bred in Finland that were not yet stored *ex situ* at the gene bank. The importance of making inventories to the purpose of safeguarding PGR was strongly stressed and assistance in reporting the existence of LR and old cultivars still on the farm to the Finnish National Programme for PGR elicited relying on the need to save a common heritage.

Following the previous speech, M. Heinonen, taking as an example an old apple tree LR (called 'Huvitus'), gave an outlook on how possibly historical data can be used to evaluate what LR groups can be still in cultivation, to locate the LR and to evaluate the LR origin. To be found this old cultivar, besides interviews of local informants, there are several information sources old scientific literature: pomological, plant breeders publications other old literature and achieve documents, old photos and maps and statistics.

Above: M. Heinonen during one of her presentations (Photo: R. Torricelli).

LR characterization and threat assessment

R. Torricelli gave a training speech on how to identify and characterize LR. In Italy there are still many LR of different crops present on-farm and in home gardens (over 1,300 LR were inventoried in Central Italy alone).

They are maintained because of their better quality than commercial varieties, better performance (yield/persistence) under difficult pedo-climatic conditions and traditional reasons such as particular traits appreciated by the farmer's family and ritual or religious use. In Italy some LR are protected by national and regional laws (and other supportive measures).

Within this (also legislative) context morpho-phenological characterization is needed to: plan actions to safeguard individual LR; assess the identity and distinctiveness of a certain LR; enhance the value of product obtained from LR; implement any actions to market the seed of conservation varieties (2008/62/EC, 2009/145/EC and 2010/60/EU Commission Directives).

R. Torricelli also explained how threat assessment is implemented in Italy to protect LR within the Italian legislative frame. He mentioned that Italy was the first country in Europe to protect genetic resources (GR) (and LR in particular) with several regional and national laws passed from 1997 onwards. These laws are now being harmonized with the recent European legislation which allows seed commercialization of 'conservation varieties' (e.g., LR, ecotypes and old varieties): 2008/62/EC, 2009/145/EC and 2010/60/EU Commission Directives.

The Italian Regional legislative frames promote the agrobiodiversity *in situ*/on-farm conservation with the goals to reduce the "genetic erosion threat" of local (i.e., autochthonous) GR, to develop an economic interest for food products from local GR and to enhance information on local GR. The text of the Lazio Regional Law n. 15 (March 1st 2000) 'Protection of autochthonous genetic resources of agricultural interest' (Costanza *et al*., 2012).

Linking LR conservation to use

M. Heinonen gave a speech on how to increase the conservation value of LR by using cultural information. In fact she considers absolute value (biodiversity value) is not enough to keep LR in cultivation. Biodiversity value needs to be transformed to more concrete value which has an exchangeable value on market.

There are several possibilities to add this sort of value to LR and LR conservation: to point out their diverse use values (good cultivation properties, the niche products that can be obtained from them, the authenticity they bring to the historic sites, manor gardens, museum gardens when cultivated there, the cultural and social values they have as personal, family, local and national heritage). When people are aware of the origin of a LR, they take care of the LR. So it is very much important to collect cultural information when collecting LR.

In this respect aged (retired) farmers are probably the most useful sources because they are able to recollect the rich indigenous knowledge on LR cultivation and use. However some young farmers have strong personal connection to and commitment (emotions) to LR cultivated in the family for several generations and then can also be a useful source of information.

M.P. Mendes Moreira (Escola Superior Agrária de Coimbra, Portugal), also on behalf of the co-author C. Vaz Patto Universidade Nova de Lisboa), gave a presentation on how conservation can be linked to local use taking as an example the use of maize LR in making a traditional bread (see article at page 12).

R. Torricelli illustrated how and where emmer wheat LR are maintained in Italy. He explained that the crop is well suited to the marginal conditions of hilly and mountainous areas of the country, generally cultivated under an environmental friendly (mostly organic) management systems and that LR are maintained because of these positive traits and of traditional use. Some LR of emmer have quality marks awarded by the European Union (PGI and PDO, respectively) and this increases the added value of emmer products and protects both consumers and producers. Presently farmers make good profits from the crop which is sold at a high price on the market (emmer business is about 2 millions of euro in Italy).

R. Vögel (Brandenburg State Office of Environment, Health and Consumer Protection, Germany) offered interesting information on a reintroduction project of cereals carried out in the German biosphere reserve Schorfheide-Chorin and through a farmer network. LR were extinct in the area, so gene banks were asked for LR and old cultivars.

About 400 were tested and a choice for reintroduction was made on the base of the traits farmers considered most valuable across years (1995–2010). Presently 30 LR and old cultivars are successfully managed by the farmers in and outside the biosphere reserve and are source of income, others are considered of potential interest and a small percentage of interest for demonstration gardens. In wheat, although grain yield of the reintroduced materials is relatively lower, straw yield is higher than that of modern cultivars under low input conditions. The experience shows that LR and old cultivars have a role to play in low input agriculture not only for the competitive yield under low input conditions and good quality of the products, but also because they bring a special value to the protection of nature and elicit the local agro-touristic business

M. Ambrose (John Innes Centre, Norwich, UK) examined the points of difference between conventional and participatory breeding, the role of gene banks as facilitators in making available materials and information to the potential users and stakeholders of genetic resources and some case study. He noted that while conventional breeding is mostly aimed at improving specific traits, obtaining cultivars with uniformity, stability and high production level and mostly uses already obtained cultivars as the base for further improvements, participatory plant breeding mostly asks for local or regional provenances as a basic material for the breeding work. These show local adaptation and often specific features which are valuable to the farmers.

Finally M. Ambrose presented the work carried out at the John Inns Institute on heritage wheats which, beside characterization and evaluation work, includes maintaining demonstration fields for farmers interested in reintroducing them. He concluded that to create LR NIs is just the first part in the pathway of conserving LR and old cultivars in agriculture. There is the need to use them widely to preserve diversity on-farm. Gene banks have an important role to play as facilitators of the process.

Development and implementation of national LR conservation strategies by the ECPGR network members

V. Negri made available to delegates a strategy to identify areas that are rich in biodiversity where to locate safeguard actions with priority through a holistic approach (Negri *et al.*, 2012). Once LR are inventoried and georeferenced, the country area is (artificially) subdivided in squares (as superimposing a grid to the country). In each subdivision, the LR density, diversity in terms of species and evenness, diversity of agricultural systems (taking advantage of the CORINE land use map) and presence of PA data can be worked out. Each square is then ranked on the basis of the maximum level of the above mentioned characters. The top ranked areas are the richest in terms of agrobiodiversity and deserve special attention when setting conservation strategies. An example is reported that concerns central Italy. The approach described can be easily applied to the whole of Europe because the CORINE land use map (which is available online for the entire European territory through the European Environment Agency website), as well as the main PA locations, are available for the entire area. However basic data on LR location are needed and must be recorded when inventorying LR.

The preparation of a conservation and use action plan was then reviewed by M. Veteläinen. She also addressed the responsibilities at national and/or European level. Each country is responsible for LR inventory, LR and farmer survey, *in situ* and *ex situ* conservation, sustainable use of plant genetic resources and integration of conservation plans into national and regional action policies.

However, an integration of different activities and policies is needed at European level and projects like AEGIS and PGR Secure operate to facilitate this integration. In developing of effective means for systematic *in situ* conservation of LR more efforts should be dedicated by each state member to raise awareness among conservationists on the importance of on-farm conservation.

However the ECPGR On-farm Working Group has a role to play. At the national level appropriate management strategies should be developed, an enhancement of the farmer management of LR should be pursued and on-farm conservation and management of LR should be integrated in a system that promotes LR use.

At European level it is necessary to agree on protocols for assessing LR threat status (according to the model of the IUCN Red List Criteria) may be taking advantage of already existing example such as that reported for the Lazio Region in Italy. It is also necessary to develop methods to assess impacts of climate change on LR which is a task for the research at European level.

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Above: Participants at the Joint PGR Secure/ECPGR workshop, held in Palanga, Lithuania in September 2011

Towards an Italian inventory of landrace diversity

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Many landraces (LR) are still maintained on-farm in Italy, including not only of all the main crop species but also neglected and underutilized species. A recent inventory listed over 1300 LRs in central Italy alone (Negri *et al*., 2012). These LRs are maintained for various reasons, including better quality than commercial varieties, better performance (yield or persistence) under harsh agro-environmental conditions, traditional uses such as particular traits appreciated by the farm family, and ritual or religious use (Negri, 2003).

They are not necessarily maintained under 'traditional farming systems', but are 'maintained because of tradition', especially related to food. It is estimated that less one third of them is already marketed as niche, typical product (Negri, 2003). However, most of them, especially garden and neglected crops, are highly threatened because they are cultivated primarily by aging farmers (Negri, 2003; Galluzzi *et al.*, 2010).

Italy is presently working to inventory its own heritage of LR under the definition that was given in the frame of the EU funded project AEGRO (http://aegro.jki.bund.de/aegro/), i.e. "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 and is associated with the traditional uses, knowledge, habits, dialects, and celebrations of the people who developed and continue to grow it (see Lorenzetti and Negri, 2009). The definition was also adopted in recently produced manual aimed to help the Italian Regions to inventory landraces (Marino, 2010), the manual was commissioned by the Italian Ministry of Agriculture.

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

The UNIPG work in compiling an Italian inventory and defining an Italian strategy to landrace conservation must take into account the political and legal frame that is present in Italy. To be noted in the first instance that the responsibility of (Plant and Animal) Genetic Resource maintenance lies with Italian Regions, not with the State. The Italian Regions decides on the matter of agriculture (genetic resources included) while the Ministry of Agriculture (Mipaaf) has only an orientation and coordination role. All the matters that concern agriculture are discussed and agreed in a Permanent Conference State-Regions.

In particular, on the matter of genetic resources there are consultancy bodies that have to be asked: the Permanent Committee on Genetic Resources (CPGR, made of some Regions and other public administrations such as the Ministry of Environment and autonomous Provinces representative persons) that is coordinated by the Ministry of Agriculture and the Interregional Network for Agriculture, Fishery and Food (made of Regions and autonomous Provinces representative persons) which reports needs of the Regions and Provinces to the Ministry of Agriculture.

Italy was the first country in Europe to protect Genetic Resources and LR with specific Regional and national legislations. The Tuscany and Lazio Italian Regions preceded the State in adopting and implementing policies protecting local genetic resources with specific Regional Laws (Tuscany Laws no. 50/1997 and Lazio Law no. 15/2000. Other Regions followed (Friuli Venezia Giulia Law no. 11/2002; Marche Law no. 12/2003 and Emilia Romagna Law no. 1/2008), while many other Regions have not implemented a law or have Laws under discussion. All these laws are very similar to each other and an account of what they foresee and how they are implemented will be given in the next *Landrace* issue.

Soon after the first two Regional laws were issued, the National Law no. 212/2001 set a section for conservation varieties in the National Register of varieties, the Law no. 101/2004 adopted the International Treaty on Plant Genetic Resources for Food and Agriculture and Law no. 46/2007 defined 'conservation varieties' and terms of seed commercialization. The latter preceded the European legislation (Commission Directives 2008/62/EC, 2009/145/EC and 2010/60/EU) that allows seed commercialization of 'conservation varieties'.

Presently, a new Law is in preparation that is intended to harmonize all these disciplines and in particular foresees the creation of an Italian Register of all (i.e. plant, animal and microbes) genetic resources of interest for agriculture. This was foreseen in the National Plan for Biodiversity Conservation released in February, 2008 which already considers the need to prepare an inventory of genetic resources (Marino, 2010).

The compilation of an Italian landrace inventory, and the consequent definition of an Italian strategy for the *in situ* conservation of landraces, funded by the PGR Secure project fits very well in this scenario (Fig. 1). However, it is complicated by the complexity of the administrative context. In order to compile an 'official' inventory, UNIPG has contacted in order: The Ministry of Agriculture, the above mentioned consultative bodies, providing information on PGR Secure and aims, and, immediately afterwards, each single Region officer in charge of Genetic Resources with the request of providing official data on landrace maintained *in situ*. At present data were gathered from Emilia Romagna, Lazio, Marche and Tuscany Regions. In particular, Tuscany and Lazio Regions have online data on landrace maintained *in situ* which were used to the purpose.

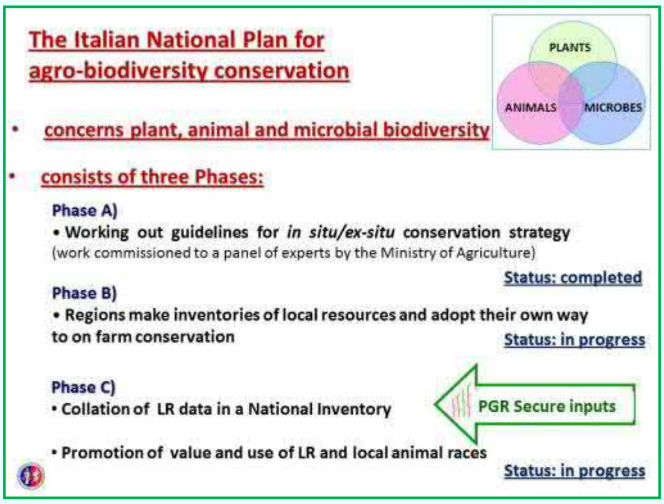

Figure 1 The Italian National Plan for Biodiversity Conservation and the PGR Secure inputs to it

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Above: Seeds of two typical Italian landraces: "Lenticchia di Castelluccio di Norcia" and "Farro di Monteleone di Spoleto". Photos: UNIPG archive

Home garden in Maremma, Tuscany (Photo: G. Galluzzi)

Youth taking care of "Francescano" tomato landrace in his home garden (Photo: T. Tesei)

The "A pisello" common bean landrace in Colle di Tora (Rieti): the environment, the seed and Manlio Pandolfi , one of the farmers cultivating it (Photo composition: V. Negri)

Above: Landraces and landrace environments in Central Italy.

Towards a UK inventory of landrace diversity

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During the last 100 years, European agriculture has undergone a sea change. In the early 1900s, agriculture was mainly based on traditional cultivation systems, where most of the inputs and products (including seed) came from the farm itself; now, the many genetically diverse traditional crop varieties (or landraces) that were once grown by European farmers have been largely replaced by fewer genetically uniform commercially bred cultivars and for vegetables FI hybrid varieties, which now dominate agricultural production. The extent of loss of crop genetic diversity associated with the loss of landraces is difficult to quantify accurately, but we do know that both worldwide and in Europe there has been a massive loss of named landrace varieties that is thought to equate to a significant loss of crop genetic diversity. This erosion of our agrobiodiversity resources is likely to be critical for future food security and has been recognized in a number of international legal instruments, including the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture. As a signatory to these treaties, the UK has an obligation to take steps to secure the full range of its plant genetic resources for food and agriculture, including the diversity of UK landraces.

An initial scoping exercise for UK crop landraces (funded by the UK Department for Environment, Food and Rural Affairs) indicated that there remains a significant wealth of landrace diversity in the UKfor all major crop commodity groups, but that it is often highly geographically localized and critically threatened with extinction.

For example, the average landrace maintainer was found to be 65 years old and there was little evidence of the next generation being willing or able to continue the family role as maintainers. Previous studies of landrace diversity in the UK have focused primarily on cereal and forage crops and current knowledge of *in situ* vegetable landrace maintenance throughout the UK is limited—hence the need for research in this area and the production of a corresponding inventory.

The second short term project, again funded by the UK Department for Environment, Food and Rural Affairs, focused more precisely on 'Vegetable landrace inventory of England and Wales' as a step towards securing this agrobiodiversity resource for the benefit of future generations.

In this study landrace data were collated from a wide range of sources, including existing data sets from four UK seedbanks that are central to the maintenance of landrace diversity *ex situ*, and traditional vegetable varieties included in the UK National Lists of Vegetable Varieties, 'B' List. Other data were collated following media releases and advertisements and by using a questionnaire, internet searches, email correspondence, telephone calls and face to face meetings, capturing a broad range of interest groups, companies and individuals.

Results of analysis of seedbank data did not reflect the full range of English and Welsh vegetable landrace diversity available in *ex situ* collections maintained in the UK, mainly because a proportion of landrace germplasm is not yet recognized in the seedbank information management systems. Nonetheless, the analysis was an important first step in the process of consolidating *ex situ* collections data for inclusion in the UK landrace inventory. 'B' List varieties collectively form another important component of the inventory; there may be challenges in the future in keeping this part of the inventory of *in situ* maintained material updated due to a dependency on data provision by a number of commercial companies who are the official maintainers of a large proportion of the varieties.

A number of key *in situ* maintainers of English and Welsh vegetable landrace diversity were identified and these include commercial seed companies, non-governmental organizations, individual farmers, allotment-holders and home gardeners. Critically, this research highlighted the fact that while the genetic diversity of our vegetable crops may have been impoverished through the loss of many traditional varieties in the past—diversity that is irreplaceable—new variation is currently being created through individual grower-based breeding. This may be as a result of deliberate or passive variety improvement through repeated cycles of selection and seed-saving or occasionally through accidental or deliberate cross-pollination leading to the production of a new variety. Therefore, while the loss of old varieties and the diversity that has gone with them is of concern, and recognizing that any new variation will not replace what has been lost, it is important to acknowledge that we may now be in a new period of expansion of locally-based vegetable crop diversity and therefore need to put in placestrategies to capture this diversity and nurture the culture that is responsible for creating and maintaining it.

The English and Welsh vegetable landrace diversity study concludes with a number of recommended actions that will be necessary to secure the diversity of UK vegetable landraces as an agrobiodiversity resource critical for future food security, as well as a vital component of our biodiversity and cultural heritage. Key among them was the establishment and maintenance of a comprehensive inventory of UK vegetable and fruit landraces. As a response to this call the UK Department for Environment, Food and Rural Affairs is sponsoring a new project entitled 'Enhancing Conservation and Use of Untapped UK Vegetable and Fruit Landrace Diversity'.

The aim is to systematically inventory, conserve and enhance the use of UK vegetable and fruit LR diversity. Specifically the new project will involve: (i) completion of the inventory of UK vegetable and fruit landrace (VFLR) diversity and the writing of a Strategy for UK LR Conservation and Use, (ii) enhanced use of UK VFLR diversity by breeders via the study and promotion of adaptive traits, (iii) active conservation to identify priority VLR diversity for inclusion in the most relevant ex situ collections to serve as a safety backup for the in situ VFLR diversity, (iv) the development of policy options for the implementation of the Strategy for UK VFLR Conservation and Use, and (v) raising public and professional awareness of the rich, unique value of UK VFLR diversity. The project will involve all major PGR institutes in the UK and will be led by the University of Birmingham.

Parallel to the vegetable inventory study the University of Birmingham has been actively engaged in vegetable and fruit survey of allotment sites of in Worcestershire and the West Midlands region. In both surveys a large number of allotment sites were sampled with questionnaire data collated from individual plot holders. The questions asked focused around five topics: participant, site, crops grown and cultivation details, seeds and sources of information. Analysis of results enabled the creation of an inventory of LR grown; 'new' accessions not recorded elsewhere were discovered and a significant link found between the growth of landraces and the maintainer ethnicity. The inventories of Worcestershire and the West Midlands allotments acted as baseline data for the creation of complementary conservation strategies employing both *in situ* and *ex situ* techniques.

Paul Watkins showing variation in his 'Throws' broad bean landrace (Photo: N. Maxted)

Paul and Tobias Watkins standing in a field of their 'Throws' broad bean landrace (Photo: N. Maxted)

Ongoing inventory on landrace potato onions in Finland

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Potato onion (*Allium cepa* Aggregatum -group) is close to shallot (Ascalonicum group), although producing larger bulbs and stronger aroma. Potato onion is a northern onion type, supposedly of eastern origin. Potato onions cultivated in Finland are all landraces, since there has been no breeding program. Potato onions have been commonly cultivated especially in Northern and Eastern Finland until mid 20th century, after that the cultivation has been very limited.

MTT Agrifood Research Finland and University of Helsinki collected Finnish potato onions during 1980's. Morphologically rich variation amongst potato onions were noticed in size (from one to several centimeters in diameter); in shape (from round to oval); in colour of the skin (from light yellow to light red); in resistance to virus and other deceases; in division of bulbs; and in storage resistance (Suojala-Ahlfors & Kallela, 2006).

27 accessions of potato onions have been accepted for long term storage in field collections at MTT Agrifood Research Finland. At the Nordic Genetic Resource Center (NordGen) there are a further 24 accessions of potato onions *in vitro* collection (Veteläinen, Hulden & Pehu, 2008).

In the PGR Secure project, our aim is to make an inventory on *in situ* conserved potato onions in Finland. In order to contact growers we have released a call for potato onions still in cultivation. Local and national media has been essential in spreading the call. National TV channel broadcasted a programme on potato onion, interviewing one grower as an example. We have written articles on trade magazines. Regional and local newspapers have published several articles on the basis of our press releases. We have been invited to broadcast short radio programmes on the topic. In addition, the call has also been announced at selected public events (e.g. garden fair).

So far we have received over 30 contacts of potato onion growers all over Finland. We have collected the preliminary information: contacts, location and estimated growing history. Only one respondent grows for the market, all others for home consumption. This data collection has been done by phone or via e-mail.

The potato onions in the national collection as well as the ones still in cultivation will be analyzed with microsatellite DNA markers. Growers of potato onion landraces have been asked to send a couple of bulbs as a sample. These samples will be analyzed with microsatellite DNA markers. The marker results of cultivated samples will be compared with the results of the accessions in Finnish national collection in order to estimate the genetic variation within the material, and to see if any clones have been distributed to several locations. The possible gaps in the *ex situ* collection will be eventually be filled.

The detailed plant specific data and grower data will be collected after DNA analysis results.

Above: A potato onion cultivated in the Central Finland. Photo: Maarit Heinonen, MTT.

Above: Potato onions *in vitro* at NordGen. Photo: Merja Hartikainen, MTT.

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On-farm conservation of cereal and legume landraces in the north west transitional region of Turkey

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Introduction

On-farm conservation of genetic diversity involves farmers deciding to continue managing landraces in agro-ecosystems and communities where they have evolved historically. Turkey is an important center of origin and/or center of genetic diversity for cereals and legumes and many other main crops. Farmers in Turkey maintain landraces in association with their wild and weedy relatives (Tan, 2010). Genetic erosion is not as broad a phenomenon as had been expected, but is a testable hypothesis worthy of study in longitudinal micro and regional studies. Nonetheless, the total number of landraces as well as the area planted to landraces in Turkey, especially in the marginal and remote areas, appears to be declining over time. So *in situ* on-farm conservation is necessary for maintain the existing land races.

On-farm conservation

The conservation of plant genetic resources is important for the sustainable protection of genetic diversity. Legume landraces have significant diversity in Turkey. On-farm conservation is one of the ways of the landrace protection. So, on-farm conservation of food legume (lentil-*Lens culinaris*, chickpea-*Cicer arietum* and beans-*Phaseolus vulgaris* and *Ph. coccineus*) and hulled wheat (einkorn-*Triticum monococcum* and emmer *Triticum dicoccum*) local cultivars (landraces were studied with active participation of farmers in North Western Transitional Region where those traditional varieties are still grown. Socioeconomic and ecogeographical surveys were conducted in five provinces of the study area to determine the distribution of land races and socio-economic status of land races cultivation and the landraces were recorded, collected and maintained as ex situ at National Gene Bank. Therefore seed of this landrace is currently available for research. The collected landraces of legumes were characterized and candidate genetic reserves were determined as possible *in situ* (on-farm) conservation areas for legume landraces. Geographical Information System (GIS) was used to analyze, interpret and map the data compiled from socio-economic and ecogeographical surveys and agro-morphological characterization, for better understanding the eco-geographic variation of legume landraces throughout region for assessing the possibility of *in situ* conservation on-farm. All landraces exhibited high variation of observed characters. But during the selection the data analysis and the willingness of farmers and also whole village were taking into account (Tan, 2009, Tan, 2010, Tan *et al*., 2010).

Forty seven villages and one hundred and seventy one farmers from 5 provinces were visited in the North West transitional region of Turkey. One thousand eight hundred forty six land races of different crop species from study area were recorded.

The landraces in the transitional Region have evolved in response to wide variations in local conditions, combined with the careful seed selection and management practices of farmers.

Farmers choose to maintain the landraces they value by planting the seed, selecting the seed from the harvest or exchanging it with other farmers, and replanting. Their choices also determine whether or not genetic resources of social value for crop improvement continue to be grown in situ. Farmers may stop growing landraces if changes in the production or marketing environment cause them to lose their relative value. Designing on-farm conservation efforts presents a number of policy challenges, including the identification of the social and economic forces driving the loss of landraces in a particular locality.

In-depth group interviews with historical data confirm that in the villages in the plain of the study region, modern varieties are indeed displacing landraces. Some of the villages have high degree of genetic erosion; the others at the mountain part of the region have an incipient level. Genetic erosion in crops occurs because privately optimal choices for farmers result in levels of crop biodiversity that are below a socially optimal threshold. However, it has not been sufficient for the maintenance of the families, leading the farmer to look for new economic alternatives, like the grain differential yield. Moreover, governmental incentives and scientific support concerning the qualities of the landraces that they are producing exist.

Legumes and hulled wheat were targeted and studied are easy to grow and provide excellent nutritional value. This is why a large number of old traditional varieties remain in different regions of marginal areas. Traditional cultivars and/or landraces 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 traditions (Tan, 2009, Tan, 2010).

Morphologically diverse landrace has been characterized by a combination of continuous and categorical morphological descriptors, morphometric measurements of plants, flowers, pods, seed and leaf characters of legumes. Particularly in the villages of study site currently in use are landraces of *Phaseolus vulgaris* that display a wide range of seed and color patterns, maintained for generations by farmers, contributing to the genetic resources. The morphological trait data set provided the opportunity to analyze the diversity patterns of hulled wheat, both *T. monococcum* and T. *dicoccum,* morphology. Variation among the spike, spikelet and floret, awn traits were observed in hulled wheat landraces. Taking into account those diversity, at the end of the evaluation various factors three villages were selected for the on-farm conservation of each species (Tan, 2009, Tan, 2010, Tan *et al*., 2010).

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Collection, regeneration, morphological characterization and conservation of cowpea [*Vigna unguiculata* (L.) Walp.] landraces in Turkey

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Turkey is the one of the most significant countries for plant genetic resources and plant diversity in the world. Many agricultural crop species are part of the native Anatolian flora and domesticated 3000-7000 years ago, or they have gradually been introduced through cultural exchanges held with other civilizations in ancient times.

Although the native country of cowpea (*Vigna unguiculata* (L.) Walp.) is uncertain and cowpea originated in Africa, where it is grown throughout the tropics and subtropics. After it was introduced into Anatolia, its cultivation spread throughout most of the country. With its widespread distribution, natural and artificial selection by farmers has resulted in a great diversity of landraces. In many regions of Turkey, diverse cowpea landraces have gradually been developed over time.

A five-year project funded by the Food, Agricultural and Livestock Ministry of Turkey, General Directorate of Agricultural Research and Policies activities is currently in its third year. Given the diversity of cowpea landraces in Turkey, populations of cowpea were collected, regenerated, conserved in cold storage conditions according to in-situ conservation methods at the National Gene Bank (NGB) of the Aegean Agricultural Research Institute (AARI) and were also evaluated agro-morphologically. A total of 235 landrace accessions mainly from the Aegean and Mediterranean regions of Turkey were used to evaluate 51 qualitative and quantitative agro-morphological characteristics in the landrace samples. In the first 3 years of the project, 155 cowpea (*V. unguiculata* L.) landrace accessions were surveyed and collected, regenerated, morphologically characterized and conserved.

The goal of this project is to identify drought-tolerant and drought-sensitive of cowpea landraces by screening the material under field conditions and use the raw materials for breeding activities and sustainable use in organic and sustainable cultivation in Turkey. For this purpose, cowpea landraces collected from possible distribution areas of Turkey and accessions of cowpea at the NGB-AARI have been regenerated and enriched by the addition of new accession materials. While, raw materials, including local germplasm and landrace accessions of the cowpea have been cultivated in organic and sustainable farming systems in Turkey, new and more qualified varieties can undoubtedly be bred for different areas of use and the plant genetic resources of cowpea can also be bred and produced to meet the needs of organic farmers' needs.

Above : Cowpea diversity in Turkey (Photo: A. Kir) and Agricultural landscape diversity nearby Aphrodisias (Photo: T. Tesei).

Left: Cickpeas in a shop of Avanos (Photo: T. Tesei).

Phenotypic and qualitative evaluation of faba bean landraces in Central Italy

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Introduction

Vicia faba (2n=2x=12) originated in the Mediterranean-West Asia region during the Neolithic period and is presently cultivated in many temperate regions. It is one of the oldest legume crops mainly grown for human and animal dietary needs. Like other grain legumes it contributes to sustainable agriculture by fixing atmospheric nitrogen and in the past played an important role in the Mediterranean Basin crop systems.

The broad bean (*V. faba* var. *faba*) is mostly grown as a grain vegetable because of its large seed size, while the horse bean (*V. faba* var. *equina* Pers.) and tick bean (*V. faba* var. *minor* Peterm.) are grown primarily for animal feed or as a green manure crop; in Europe, the two latter varieties are referred to as field beans (Bond et al. 1985).

In the Mediterranean area these species are very important; unfortunately, cultivation of these crops has dipped in the last decades, although in recent years their importance has increased due to difficulties in sourcing GM -free soya beans and is also being used as feed in organic animal production systems as a protein source. Faba bean breeding has proceeded very slowly and with only a few interesting results. This is due to difficulties in pollination control and to the limited gene pool due to incompatibility with all other species of the genus (Bond 1987). More than 90 cultivars of *V. faba* are registered in the European Community Catalogue, half of which are Dutch, 18 British and 15 Italian. Most of the Italian varieties were registered before 1990.

Improvement in seed yield and yield stability are the primary objectives of most faba bean breeding programmes. However, other objectives such as resistance to the main biotic and abiotic stresses and obtaining genotypes that are free of certain anti-nutritional substances, are also important.

Above: Field bean legumes of landrace (Photo: R. Torricelli)

In the present work, data on the main morpho-agronomic traits and chemical and nutritive characteristics are recorded and determined on landrace accessions of field beans belonging to a collection established in the Umbria Region (Central Italy). In this area field bean is also used as a typical product in human nutrition. In the Amerino district (TR, Italy) some farmers grow a field bean landrace called “fava cottora” because it has a short cooking time and recently became a part of the Slow Food Presidium.

Materials and methods

A total of 10 field bean populations were compared: 5 local accessions (landraces) were collected in Umbria from local farmers, 1 accession from the Seed Bank of the Department of Applied Biology and 4 commercial varieties (Table 1). These were grown in the Amelia (Central Italy) area in on-farm trials during the 2006-2007 in a randomized block design with four replicates. Each plot consisted of two rows. The distance from plant to plant was 5 cm and from row to row 50 cm. The field trial began on November 11, 2006. Morpho-agronomic traits were evaluated according to UPOV methods, while the carbohydrate and protein fractions were determined according to the Goering and Van Soest methods and CNCPS model, respectively (Tables 2 and 3). Analysis of variance (ANOVA) was carried out for morphological traits and the structure of genetic variation among field bean populations based on chemical and morphological traits was analysed using Principal Component Analysis (PCA). All data were computed using the SAS statistical package.

Above: Field bean seeds of landrace (Photo: R. Torricelli)

Above: On-farm trial (Photo: R. Torricelli)

Table 1. Faba bean accessions used in the present study with their origin.

N.	Type of material	Origin
1	Landrace	S. Venanzo (TR - Italy)
2	Landrace "Fato"	Umbria region (Department Applied Biology)
3	Landrace	Amelia (TR - Italy)
4	Landrace	Amelia (TR - Italy)
5	Landrace	Amelia (TR - Italy)
6	Merkur (cultivar)	Czech Republic
7	Prothabat 69 (cultivar)	Spain
8	Castel (cultivar)	France
9	Landrace	Amelia (TR - Italy)
10	Vesuvio (cultivar)	Italy

Results and discussion

Except for stem diameter, pod angle at maturity, pod shape, pod number at the fourth node and seed shape, ANOVA showed significant (P £ 0.01) variability among populations for the evaluated traits (Table 2). The principal component analysis (PCA) indicated that the first two components accounted for 49.04% of the total variation (table not shown). The first component, which accounts for 30.37% of the total variance, is positively correlated with seed weight and protein related to the NDF and negatively correlated with flowering time. The second component which accounts for 18.70% of total variance, is positively correlated with seed shape and negatively correlated with pod width, Soluble Protein fraction and B1 protein fraction. A scatter plot of the 10 populations against the first two components is shown (Fig. 1).

Conclusions

The results show that some morphological and physiological traits can be used to discriminate field bean populations as well as some ruminal protein degradability parameters according to the CNPS model. Landrace "FATO", cv Vesuvio and Merkur which are commonly used in animal nutrition were well separated from the accession landraces collected in the Amerino district (TR Italy) commonly used as a typical product for human nutrition. Prothabat 69 and Castel cv showed intermediate behaviour. Amino acid and anti-nutritional factors are currently being determined to better characterise and enhance the value of these important genetic plant resources.

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Table 2. Mean and significance level from morphological characterisation of 10 field bean accessions

N	Morphological traits	Significance	Mean
1	Plant development	***	3.13
2	Time of flowering (days from 1st April)	***	6.90
3	Plant height (cm)	***	67.93
4	Stem number	***	2.57
5	Diameter of stem	ns	0.85
6	Stem colour at maturity	**	1.79
7	Leaflet number on the fourth node	***	4.66
8	Leaf dimensions	***	2.27
9	Flower number on the fourth node	***	5.65
10	Pod angle at maturity	ns	1.64
11	Pod length	***	6.87
12	Pod width	***	0.79
13	Pod shape	ns	1.13
14	Seeds per pod	***	2.51
15	Pod number on the fourth node	ns	1.38
16	Seed dimension	***	1.88
17	Seed shape	ns	2.90
18	Seed colour	***	2.80
19	Hilum colour	**	1.63
20	Thousand seed weight (g)	***	557,55
21	Seed production (kg ha^{-1})	***	2497.00

Table 3. Chemical characteristics determined in 10 field bean accessions

N.	Chemical parameter
1	Hemicellulose
2	Cellulose
3	Lignin (ADL)
4	Crude Protein (PG)
5	Neutral Detergent Insoluble Protein (NDIP)
6	Acid Detergent Insoluble Protein (ADIP)
7	Non Protein Nitrogen (Fraction A)
8	Rapid degradable protein in the rumen (Fraction B1)
9	Intermediate degradable protein (Fraction B2)
10	Slowly degradable protein (Fraction B3)
11	Not available Protein (fraction C) bound to ADF
12	Soluble Protein (SOLP)
13	NPN/SOLP

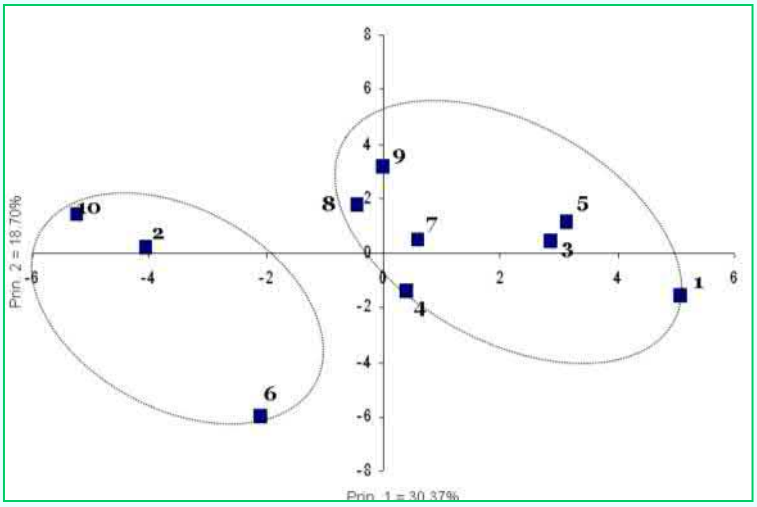

Figure 1. Scatter plot showing morpho-agronomic and chemical and nutritive characteristics variation in the 10 field beans populations obtained from the first two components of principle components analysis.

Maize traditional landraces in Portugal: past, present or future?

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Germplasm from its early beginning

Genetic resources are one of the most important legacies of our ancestors and they make us different as a people. It is therefore necessary to study and better understand genetic resources in its broadest sense because to store them in gene banks is not enough.

Maize was introduced into Portugal after Columbus and first appeared in the fields of the Coimbra region (Ferrão, 1992). Maize has been cultivated primarily in the north central regions of the country and the Algarve, and was responsible for the agricultural revolution of the XVII and XVIII centuries, shaping landscape and culture. The orographic and climatic differences, as well as the human component, were responsible for over five centuries of biodiversity development that transformed maize from an adapting crop to one of the most important crops in terms of production.

National seed facts

In 2008 the production value of the national seed sector was 197 million Euros, corresponding to 2.8% of the Portuguese agricultural GDP. In the same year, 4.6 million Euros worth of cereal and vegetable seeds were exported , while 53.2 million Euros worth of seed were imported (INE, 2009). In 2007, the weight of seeds and plants used in intermediate consumption for the production of cereals ranged from 6.4% in rice to 13.5% in arable crops, while for vegetables the variation was 16.5% in extensive to 21.6% in intensive horticulture (RICA, 2007). In 2011, 137,413 ha were in maize production in Portugal (87737 ha grain, IFAP/DRACA). These facts can serve as a guide in future planning for research and teaching.

The VASO project: genesis and network motivation

The "Green Revolution" was only achieved on the basis of the scientific discoveries of Darwin and Mendel. According to Duvick (2005), the genetic and agronomic components were each responsible for 50% of the maize production increase reached in the U.S. corn belt. These yield increases were due, in part, to the inbred line- hybrid concept and dwarfism. In addition, the discoveries of Liebig (principles of nutrition), Haber-Bosch (ammonia production) and pest control were crucial factors that resulted in the tripling of the world's agricultural production in less than a century. However, the replacement of local varieties by these higher yielding varieties has led to a huge loss of diversity. In addition, in many cases these high yielding varieties do not produce well in marginal environments (Ceccarelli and Grando, 2007).

Hence, participatory breeding projects have been developed as a way to respond to specific local problems, when the management of quality/quantity is of particular relevance.

The VASO project (Sousa Valley, Portugal) began in 1985 and is a milestone in participatory maize breeding. Silas Pego started the project to improve regional genetic resources of maize (for bread production), respecting local traditions and involving farmers in the breeding programs. The interest that the VASO project created led to immediate funding by CYMMIT, until Portugal joined the EU in 1986. While visiting Portugal in 1985, Wayne Haag (CYMMIT director of the maize breeding program in the Mediterranean area), said "where in America do we have open pollinated populations with these yields?" This project, unlike the national breeding programs already discontinued (e.g. NUMI for maize breeding) despite decades of successes (e.g., maize HP21 and HB3), remains active and is continuing in the farmer fields with the support of ESAC, the Lousada Municipality and CGAVS. Thus, it is still providing a product geared to the farmers' needs (e.g. production of maize for bread, polycropping systems) that can compete with the commercial seed. Interestingly, the VASO project began in a breeding station (NUMI) where awareness of the importance of genetic resources and its long term improvement already existed.

The available resources led Silas Pego to choose germplasm and farmers in marginal environments (Moreira, 2006). The breeding experiments were carried out simultaneously by farmers and breeders in the farmers' fields which meant that information flowed from breeder to farmer and vice versa. This was also a faster way to disseminate innovation among neighboring farmers. However, agricultural policies have frozen the innovation flows over the past decades and the majority of farmers have migrated or emigrated. Hence a remnant of a few participating farmers has survived. For this reason the number of farmers is not the issue, but rather the solid practice of this long term experience. The VASO experience is currently being used to engage new farmers in participatory plant breeding. This project is an experience that allows new farmers to listen to the older ones and for this reason, the VASO farmers' remnant is a source of inspiration for new projects and paradigms.

Towards new approaches

In parallel with the VASO Project, many other farmers throughout the country have maintained their genetic resources using on-farm conservation. This on-farm conservation is generally not exclusively market-oriented since self-supply is an important dimension of farming decisions. This is why traits such as organoleptic, cooking and processing qualities are highly valued (VazPatto et al., 2007; Dinis, 2011; Mendes-Moreira and Pego 2011)

For traditional maize landraces, one of the most important traits is technological capacity for baking. The traditional Portuguese maize bread, "broa", has great potential to address current food and environmental concerns. With the possibility of being a gluten-free product, if 100% maize is used, it is suitable for celiacs (Brites et al., 2010). It still plays an important role in the rural economy of the central and northern regions of Portugal and has an increased market value due to its health benefits. In additional it may be a way to preserve the biodiversity of farm ecosystems that are currently threatened by producing its raw materials, the traditional maize varieties.

Given these characteristics, repeated missions were taken to Portuguese farmers' fields to collect much of the national maize germplasm that possesses the technological capacity needed for the production of maize bread (Vaz Patto et al., 2007). The collected germplasm is now being studied to better understand and use a dynamic perspective. To achieve this goal, several research teams were involved in a maize cluster to study he ethnobotanical, agronomic, quantitative genetics, molecular genetics, quality parameters and socio-economic aspects. The research done by this maize cluster was made possible by a successful application for research funding at the national level (e.g., 2010-2013-PTDC/AGR-ALI/099285/2008; 2007-2010-PTDC/AGR-AAM/70845/2006; 2005-2008-POCI/AGR/57994/2004) and internationally (e.g. FP7-SOLIBAM).

The aim of the SOLIBAM project is to develop innovative approaches that integrate plant breeding and cultivation techniques. These approaches foster an increased crop performance, quality; sustainability and stability in organic (that in 2009, represented 3% of national UAA and 0.4% of total farms the Sub-Saharan Africa. In addition, particular attention has been given to the development of strategies for participatory plant breeding and farm management on small farms and marginal environments (SOLIBAM, 2012).

It should be noted that a permanent team with a projected time line of more than 20 years is crucial for long term conservation and breeding. Unfortunately, project funds are usually only granted for three-year periods.

Above: Collecting missions in Portugal

Above: Selection of the best maize ears

The maize cluster work can be summarized as:

-Germplasm exploration through collecting missions to farmers' fields and in complement with ethnobotanical issues (Vaz Patto et al., 2007).

-Germplasm characterization using pre-breeding tools such as HUNTERS (height, uniformity, angle of insertion of the leaf, flag, ears, stalk and root lodging plants) and overlap index (Mendes-Moreira, 2008).

-Mathematical approaches to data-characterization and its relationship to the best ear or yield (Mendes-Moreira et al., 2009).

-Characterization of the technological quality of traditional maize varieties for maize bread. The sensory analysis carried out showed a preference for bread obtained from the traditional Portuguese flint varieties due to its better taste in comparison with the American dent hybrids (Briteset al., 2010).

-Characterization of the germplasm organoleptic quality (aroma and flavors), in addition to its nutritional value (antioxidant composition) (Belo et al., 2011).

-Characterization of the germplasm organoleptic quality (aroma and flavors), in addition to its nutritional value (antioxidant composition) (Belo *et al.*, 2011).

-Participatory plant breeding is currently expanding the VASO Project with serious commitment by new farmers. Thus, some concepts regarding theoretical and practical selection are being shared with farmers.

-Germplasm testing through several trials established throughout Portugal, in six environments of organic farming, low input and conventional farming.

-Simultaneous assessment of the effect of mass (by the farmer) and recurrent selection by S2 lines (breeder), thus allowing the farmers to compare their selection with that of the breeder.

Above: Diversity among selected ears.

Above: Farmers meeting and selection of farmers ears type.

This assessment was possible because samples of the selected material were kept in cold storage. In the case of the 'Pigarro' and 'Fandango' samples, they were systematically harvested and kept in cold storage since 1985 (Mendes-Moreira *et al*., 2008; Mendes-Moreira *et al*., 2009).

-At the same time, in order to support and improve the above-mentioned germplasm, molecular tools have been developed, such as molecular markers associated with genes that control agronomic and quality characteristics (Vaz Patto *et al*., 2009). These may be used to increase efficiency and reduce the time needed to develope improved varieties such as raw materials to obtain healthier bread. To this end the genetic basis of these characteristics and the effect of environment on its expression have been studied, combining molecular data with the field and quality characterization (Leitão *et al*., 2011; Mendes Moreira *et al*., 2011; VazPatto *et al*., 2009).

-An exhaustive characterization of molecular diversity confirmed the richness of the national maize germplasm (Alves *et al*., 2009; VazPatto *et al*., 2004). Moreover, a study to compare the effect of the farmer's selection in participatory breeding versus the breeder selection is on going and partial data have been published (VazPatto *et al*., 2008).

-Use of a winter nursery is an also crucial in order to accelerate the improvement work because it allows two generations per year. This work is done in collaboration with Lavras University, Brazil.

Plant breeding requires decades of continuous, persistent work, i.e., it requires strategic and long-term vision. It creates not only seeds, but also knowledge and jobs, especially at the local and regional levels (Wolf *et al*., 2008). It is precisely at these levels that the germplasm maintenance, associated with food, preservation of landscape and cultural systems can most easily create wealth.

The lack of improvement programs leads to traditional varieties growing apart from improved varieties, which can lead to the abandonment of traditional germplasm. A lack of breeding programs is detrimental because Gene Banks are not useful for direct application to agriculture. For this reason, our maize cluster is trying to reverse this situation.

Renewed interest in organic and low-input agriculture, the awareness of the food-energy-environment trilemma (Tilmanet al., 2009) and the fact that plant breeding should contribute to the harmony between agriculture and the environment (Brummer, 2011) imply the need for change in the current plant breeding paradigm. This consciousness extends the need for conservation of traditional varieties at the farmers' field, i.e., in situ / on farm, fostering the process of coevolution between traditional varieties and the environment. This process may include: pests and disease resistance, quality, weed competition or ability to intercrop and interaction with beneficial soil microorganisms. All of these are important in the adaptation to organic and low-input farming. This type of variety maintenance of varieties has been discussed particularly in the ECPGR-On-farm Conservation and Management Working Group and through the PGR Secure project (Maxted et al., 2011).

Our commitment has been to maintain and enhance the multi-generation legacy and for this reason, the *Zea* + (*Zea mais*, in Portuguese) Association was created. The heritage can be squandered, maintained or multiplied. Our purpose is to multiply it.

Above: Maize bread.

Above: Mr. Meireles winner of Best Ear of Sousa Valley.

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In situ maintenance of the Muchamiel tomato landrace in the town of Muchamiel (Alicante, Spain)

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Muchamiel is a tomato landrace that is very popular in southeastern Spain due to its organoleptic fruit quality. Fruit of the Muchamiel cultivars have a melting texture and mild flavor, are large in size, flattened and strongly ribbed. However, this landrace is severely endangered and at risk of extinction due to its high susceptibility to several viruses, such as those caused by the Tomato mosaic virus (ToMV), Tomato spotted wilt virus (TSWV) and Tomato yellow curl virus (TYLCV) (García-Martínez et al., 2011).

In 2008, we started a project in collaboration with the main farmer organization in the area (ASAJA) and the Council of Muchamiel, the town after which the tomato variety is named, trying to involve local farmers, consumer associations and local restaurants. The goal was to preserve the genetic diversity in this small area, through the recovery, conservation, improvement and use of the local tomato varieties.

Plant breeding to promote on-farm conservation: introgression of resistant genes

The incidence of several viruses makes the cultivation of tomato landraces difficult. We have conducted a breeding program fto introduce three dominant genes (Tm-2a, 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' landraces. The genes Tm-2a 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. Breeding lines were obtained by crossing a Muchamiel line with a commercial cultivar followed by several generations of backcrossing to the Muchamiel cultivar. Marker-assisted selection was used in each generation in order to select the plants that carried the three resistance genes. In addition, a high selection pressure for Muchamiel characteristics was applied during each backcross generation. After additional generations of selfing and selection, pure-breeding lines, homozygous for the three introgressed virus resistance genes, were selected from a single family whose seed was multiplied by self-pollination.

Resistance to ToMV and TSWV was also verified by mechanical inoculation assays, and tolerance to TYLCV was demonstrated in several assays performed in naturally infested fields. As a result of the breeding program, promising breeding lines have been obtained, with organoleptic characteristics similar to the original landrace (Alonso et al., 2010). These have to be further adapted to the specific agroclimatic conditions in different localities.

On-farm management

Resistances to ToMV and TSWV were additionally verified by mechanical inoculation assays, and tolerance to TYLCV was demonstrated in several assays performed in naturally infested fields. As a result of the breeding program, we have obtained promising breeding lines, with organoleptic characteristics similar to the original landrace (Alonso *et al.*, 2010) which have to be further adapted to the specific agroclimatic conditions of different

In 1988 a collaboration agreement was signed between the University (UMH), the main farmer organization (ASAJA) and the Council of Muchamiel. Several meetings with interested local farmers were planned, in order to explain the aims of the programme and surprisingly many farmers attended the meetings. Over the last 5 years, lots of seeds and seedlings corresponding to breeding lines from both the improved landrace, with genetic resistance to several viruses, and from the original landrace, have been distributed to local farmers (Table 1). Taking into account their own experience, farmers select the best plants in their own fields looking for specific adaptation. Rather than selecting a single cultivar, the aim of the program is to develop a range of cultivars, adapted to different environments, including open field and protected cultivation, with different genotypes, in order to maintain their ability to evolve under different selection pressures

Above: Muchamiel landrace: diversity of fruit shapes.

Above: The breeding program was thoroughly explained to the farmers attending the meetings.

Table 1. Number of seeds and seedlings distributed to local farmers during the last 5 years.

Year	Collaborator	Type	Condition	Number of plants	Date
2008	Council	Breeding lines	Seeds	50	May
	Farmers	Breeding lines	Seedlings	150	April
2009	Council	Breeding lines	Seeds	6 packs x 50 seeds/pack	February
		Breeding lines	Seedlings	300	March
2010	Council	Breeding lines	Seeds	45 packs x 100	February
		Breeding lines	Seedlings	600	April
		Landraces	Seeds	10 packs x 100	February
	Farmers	Breeding lines	Seedlings	300	April
2011	Council	Breeding lines	Seeds	25 packs x 50	February
		Breeding lines	Seedlings	900	April
		Landraces	Seeds	10 packs x 50	February
2012	Council	Breeding lines	Seeds	30 packs x 50	February
		Landraces	Seeds	15 packs x 50	February
	Farmers	Breeding lines	Seeds	5 packs x 500	February

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Biodiversity of vegetable landraces for the public

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Vegetables are the most diverse foods we have. They differ not only in botany and ingredients but also in texture, colour, shape and taste more than any other aliments. If you go to supermarket you might be impressed by the diversity of offered goods. But at second glance you will notice that there are just 15-20 different species of vegetables to choose. We know from old garden books and seed catalogues that in the 19th century there were at least 50 (!) additional species in use. They disappeared because they were not suited for large scale agrotechnical production or whole sale marketing. For these reasons we lost many fascinating and tasty vegetables in our every day menus.

At the Horticultural College and Research Institute Schoenbrunn in Vienna, Austria, the Schoenbrunn Seminars have been initiated by Wolfgang Palme – head of department of vegetable growing – and Johann Reisinger - a chef with a focus on gastronomic specialties and taste education.

The Schoenbrunn Seminars try to bring together propagators throughout the food chain – people involved in growing, commercializing, processing and consumption. Expert lectures expound the „history“ of certain vegetables, so that specialists get a holistic approach to the produce. Additionally, extensive exhibitions show the diversity of species and varieties and serve as a documentation of the wide range of use of vegetables. Degustations of the raw produce help to define the diversity of flavors, which is also held in high esteem in chef Reisinger's kitchen.

This diversity receives great attention and is converted into culinary delicacies, the focus being put on the character of the produce, i.e. its optical, haptic and sensoric identity.

Viewing both horticultural origin and culinary outcome turns out to give a complete picture, allowing an entirely new, holistic approach towards vegetables that has long been forgotten in our specialized world.

This way vegetables such as tomatoes, peppers&chilis, vegetable roots, lettuces, cucumbers, peas&beans, spinaches, kales, eggplants, onions and radish have been presented so far.

In 2009 an extraordinary exhibition in Viennese museum of applied art and contemporary art was held. It was titled “Varieties” and tried to attract attention to the biodiversity of vegetables for all senses. Unknown vegetables of *Solanaceae* grown by the Horticultural Research Institute were presented by an Ikebana artist. A composer wrote a special piece of modern music for choir. Additionally, culinary delicacies provided a holistic pleasure for more than 400 visitors of the event.

In 2011 the Vegetable Orchestra of Vienna (www.vegetableorchestra.org) played a concert on the location of Horticultural Research Institute in the center of famous Schoenbrunn area. Therefor special music instruments like radish trumpets or turnip drums were created. They completed the strange sound of leek violins, carrot flutes, cucumberophones and eggplant cymbals.

All of these activities aim at gaining more public awareness to the biodiversity of vegetables. That may lead to a paradigm change in our societies where vegetables are seen just as ordinary articles of daily use instead of valuables of pleasure.

Above: An extraordinary exhibition in Viennese museum of applied art and contemporary art showed the fascinating diversity of *Solanaceae*

Above: The Vegetable Orchestra of Vienna in the famous surroundings of Schoenbrunn

Above: A trumpet made from radish and carrots is able to create a melodious sound

Above: Johann Reisinger (left), the chef, and Wolfgang Palme, the researcher, initiated the Schoenbrunn Seminars of vegetable biodiversity

Genetic resources and prospects for the use of fruit crops in the Azerbaijan

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Introduction

Extreme diversity of the soil and climatic conditions in Azerbaijan support a very rich diversity of plant genetic resources. More than 4700 higher plants have been registered , 237 of which are endemic. During archaeological excavations near Nakhchivan, scientists found 500,000-year-old grapevine leaves that were charred. Historically wild fruits were used by people for food, medicinal crops and for other purposes. Azerbaijan is considered one of evolution centers of cultivated plants. Archaeological findings prove that the history of horticulture and viticulture in Azerbaijan dates back at least 6,000-7,000 years. Almost all of the present-day major cultivated plants appeared for the first time in Azerbaijan several millennia B.C. Signs of farming and ancient horticulture discovered in a settlement west of the town of Goy-Gol date back to the early second millennium B.C. Fruit crops (apple, pear, apricot, pomegranate, quince, fig, almond, walnut, hazelnut etc) and grape have been cultivated to meet the demand of the population for foodstuff and other products. Most of these crops are still considered major agricultural crops in the country. Historical facts and excavations carried out in Gazakh, Agstafa, Agdam, Mingechevir and other areas have testified that cultivation of the main fruit crops in Azerbaijan was highly developed in the Bronze Age (middle of 2nd millennium B.C.).

Materials and methods

Materials for research included the local varieties and wild relatives of fruit crops grown in field collections of the Institute of Genetic Resources of the National Academy of Sciences of Azerbaijan and other institutions and by farmers in different regions of the country.

Phenological phases, growth, biomorphological description and productivity, fruit quality traits, resistance to disease and pests were studied by using the common description methods of fruit plants (Michurinsk, 1973, Michurinsk, 1980).

Results and discussion

In the territory of Azerbaijan there are 149 species of fruit crops belonging to 39 genera and 15 families. The high number of genera and species of wild fruit and fruit-berry plants sprouting up in forests and rural regions of Azerbaijan provides the greatest diversity of fruit crops: *Amygdalus communis* L., *Amygdalus fenzliana* (Fritsch) Lipsky., *Armeniaca vulgaris* Lam., *Berberis vulgaris* L., *Castanea sativa* Mill., *Cerasus avium* (L.) *Moench, C. vulgaris* Mill., *Cornus mas* L., *Corylus avellana* L., *Crataegus orientalis* Pall. ex M. Bieb., *Cydonia oblonga* Mill., *Diospyros lotus* L., *Ficus carica* L., *Fragaria vesca* L., *Hippophae rhamnoides* L., *Juglans regia* L., *Malus domestica* Borkh., *Mespilus germanica* L., *Morus* L., *Persica vulgaris* Mill., *Pistacia mutica* Fisch. & C. A. Mey., *Pistacia vera* L., *Prunus cerasifera* Ehrh., *P.domestica* L., *P.spinosa* L., *Punica granatum* L., *Elaeagnus angustifolia* L., *Pyrus communis* L., *Rubus* L., *Vitis vinifera* L. subsp. *sativa* D.C., *V. vinifera* L. subsp. *sylvestris* (C. C. Gmel.) Hegi. and etc. (Akparov, Imamaliev and Musayev, 2003., Asadov and Asadov, 2001., Safarov, 1979).

Each region has its own specific and qualitative fruit varieties. For instance, Shirvan is famous for pomegranate and quince, Nakhchivan for apricot and peach, Shaki-Zagatala for walnut and hazelnut, Ganja-Gazakh for grapevine, cornelian cherry and cherry, Absheron for almond, pistachio, fig and grapevine, Guba-Khachmaz for apple and pear. Walnut, hazelnut, chestnut persimmon, dogwood and tens of other species available on the southern slopes of the Caucasus mountains that are used by people for food. Landraces of these species are available on farmers' land located in this region. Large diversity of apple, pear, mulberry, medlar, dogwood and other crops is widespread in this territory. At one time, wild and cultivated medlar, pomegranate, sweet cherry, cherry, grape covered large areas in he riverbank woodlands together with other forest plants.

The Lankaran-Astara region has valuable varieties of blackberry, fig, pomegranate, bush cherry plum, dog-rose and citrus plants, while Absheron has varieties of grape, fig, pistachio, almond, oleaster, mulberry, quince and pomegranate where these crops grow naturally or are cultivated by farmers on their land and orchards. Areas of wild grape, strawberry, raspberry, and other berries are distributed throughout the republic. At one time, a number of fruit crops including cornel, sweet cherry, cherry, pomegranate, quince, fig (*Ficus carica* L., *F. hyrcana* Grossh.), pear, grape (*Vitis vinifera* L.) and other fruits were widespread in the territory occupied by Armenia, and were used by the local people. In the Guba-Khachmaz region more than one hundred varieties of apple– Sari tursh, Jirhaji, Sikhijani, Ayyubi, Shirvan gozeli, Jibir, Gand alma; pear – Nar armud, Abbasbayi, Jirnadiri, Ispigi, Kurduku, Nargila, Bildirchin budu, etc. are found, often in fruit gardens, especially in amateur gardeners' courtyards. More valuable varieties of grapevine and stone-fruits are cultivated in extensive areas of Nakhchevan AR. Particularly famous are some varieties of apricot (*Armeniaca vulgaris* Lam.); peach (*Persica vulgaris* Mill.) – Salami, Zafarani, Juyur, Agh kustu, Agh nazli; plum – Gara albukhara, Sari albukhara, Khatini; alycha (*Prunus cerasifera* Ehrh. var. divaricata (Ledeb.) L.H.Bailey) – Goychasultani, Shabrani, Payiz malasi, Agh alycha; walnut – Sugra, Seyfi, Araz, Disar, etc. A number of local varieties of pomegranate (*Punica granatum* L.) – Guloysha, Malas, Shahnar, Balmursal, Girmizigabig, Nazikgabig and etc.; quince (*Cydonia oblonga* Mill.) – Jardam, Gara heyva, Sari heyva, Armudu heyva, Qaraman, as well as alycha, plum, sloe, grapevine, etc. are cultivated in the Shirvan region. Aboriginal varieties of olive (*Olea europaea* L.) – Shirin zeytun, Azerbaijan zeytunu, Armudu zeytun, Baki zeytunu; fig (*Ficus carica* L.) – Absheron sari injiri, Buzovburnu, Goy injir, Gara injir, Boz injir, Sumakh injiri, Payiz injiri; almond (*Amygdalus communis* L.) – Nazikgabig, Sarayi, Mardakan; pistachio (*Pistacia vera* L.) – Amirjan, Bulbula, Narinji, Zumrud, etc. are cultivated in the Absheron region. In Shaki-Zagatala region ancient landraces of hazelnut (*Corylus avellana* L.) – Ata-Baba, Yaghli findig, Sachagli findig, Ganja findigi; walnut (*Juglans regia* L.) – Jar, Dundi, Gum, Tala, Zagatala; chestnut (*Castanea sativa* Mill.) – Khanlig, Ashig, Farash, Barguvara, etc. are grown. A number of landraces of apple, pear, quince pomegranate, grapevine plants are cultivated in the courtyards of Garabagh.

There are many aboriginal varieties of stone-fruits, berries and subtropical fruits, as well as grapevine, for example, cornelian cherry (*Cornus mas* L.) – Armudu zogal, Challak zogal, Girda zogal, Dilimli zogal, Gara zogal, Sari Kahraba zogal, Irimeyvali zogal in the Ganja-Gazakh region. Besides the above-mentioned fruit varieties, tea and citrus plants, as well as various varieties of feijoa, are grown in courtyards and on farms in the Lankaran-Astara region (Imamaliyev, 1988., Hasanov and Aliev, 2007).

Vitis vinifera L.

Azerbaijan is also one of the centers of origin and domestication of grapevine (*Vitis vinifera* L.). Here there are many wild grapevine forms (*V. vinifera* subsp. *sylvestris* (C. C. Gmel.) Hegi.) and aboriginal grapevine varieties (*V. vinifera* ssp. *sativa* D.C.). It may be concluded that wild grape spread throughout the whole territory of Azerbaijan in ancient times. Wild grape of Azerbaijan can be distinguished by some very specific characteristics. It is distributed throughout the territory of Azerbaijan from 12 m below sea-level (Kyur riverside, Salyan region) to 2000 m above sea-level (Gusar region). Wild grape grows on n the slopes of mountains, in forests, along the riverbanks and other places.

N. Vavilov (1931) said: "All existing data indicate that South Caucasus is the main hearth of origin of wild and cultivated grapevine". This opinion is confirmed by the high number of autochthonous varieties with ample diversity of berry colour and technological aptitudes; historical information; linguistic and folk data; and certainly, rich palaeobotanical artefacts and archaeological findings discovered since the "Shomutapa culture", dates back to VI-IV millennium BC (Akparov et al. 2010).

Hundreds (more than 600) of landraces of grapevine are grown in the Republic. White, red, black, pink colored table, technical and seedless grapevine varieties including:

For example: Agh shani, Absheron,s gyzyl uzumu, Alvan, Amiri, Gara shani, Sharigila, Kharci, Askari, Misgali, Hachabash, Gazandayi, Khalili, Agh Sahibi, Agh Aldara, At uzum, Aghri, Rishbaba, Chilal, Kishmishi, Tulkuguyrugu, Huseyni, Madrasa, Marmari, Bandi, Qara Aldara, Qoc uzumu, Tabrizi, Molla Ahmadi, Malayi, Novrast, Karimgandi, Durna gozu, Davagozu,Kechiamcayi, Khazri, Gizil uzum, Chil uzum, Beylagani, Khan uzum, Pishras, Mahmudabi, Khindogny, Hafizeli, Hachabash, Haji Abbas, Hamashara, Shiray, Shirvanshahi, Shireyi, Shirshira, Shafeyi, Shakarbura, Shahangir, Shakari, Sisag, etc. are cultivated here.

Most of them are only grown in definite areas and in private courtyards by amateur gardeners (Salimov and Musayev, 2007).

Above: Grape variety Sarıgile

Above: Grape variety Nakchivan

High quality products-jams, “doshab”, vinegar, “abgora”, “sucuq”, “kishmish”, “movuc”, “lavashana”, juice, syrup, vines and alcohol, which are made from grapevine in different regions of Azerbaijan show that grapevine-growing develops expediently.

Owing to the soil-climatic conditions of Azerbaijan vine-growing and wine-making has been developed here in various ecological directions. The vine plantations are mainly grown in the private and farm sectors. Table grapevine varieties are mostly grown in private vineyards (the subsidiary sector). The gathered harvest is used for food.

In spite of the fact that newly formed sectors will be growing both table and wine grape varieties there is a preference for wine grape varieties because the processing industries in Azerbaijan and in the neighboring countries (Russia, Ukraine, etc.) are interested in the supply of white and dark wine varieties of grape needed to produce high-quality wine products.

The large industries that grow table grape varieties show a preference for early-ripening varieties such as Ag Khalily, Novrast and Gara kishmish due to commercial purposes.

Grapes of the indigenous seedless or semi-seedless varieties such as Askery, Ag oval kishmish, Nakhchyvan chehraiyee kishmish, Gara kishmish, Girda kishmish, etc. are grown on private farms and are mostly used for food and to prepare jam. Raisins are only prepared in the Nakhchyvan region in the home using traditional methods for these varieties.

The chemical traits of wine grape varieties grown in Azerbaijan make it possible to prepare a wide assortment of high-quality wines. At present, the grape processing industries of Azerbaijan mainly produce natural and special (dessert, etc) wines.

Pyrus communis L.

Since ancient times, our paternal-grandfathers have collected many pear species from the forests that have valuable characteristics and have cultivated them in courtyards. As a result hundreds of aboriginal varieties were selected. According to Ahmad Rajabli (Rajabli, 1966), there were more than 400 ancient selected varieties of pear in Azerbaijan and half of them are in danger of extinction. Some of the pear varieties (*Pyrus communis* L.) are: Abbasbeyi, Adil armud, Agh armud, Agh gulabi, Aghagormez, Aghsach armud, Akhund armudu, Alcha armud, Bal armud, Bekmez armud, Bey armudu, Bildirchin budu, Chaltik armud, Chil armud, Jirnadiri, Dara giragi armud, Gabakh armud, Gakh armud, Gala armud, Garpiz armud, Gelinbarmaghi, Gorkhmazi, Govun gara armud, Goy armud, Gum armud, Gurula armud, Gush armud, Hajiarmud, Hazar armud, Jardahan armud, Jir Fisinjan, Jir Nabi armud, Khar armud, Letenzi, Molla Subhi, Mukhtar armud, Nar armud, Nelbeki armud, Nurun-burun, Ordubadi armud, Ozeksis armud, Peyghambari armud, Reihan armud, Saranduz armud, Sari armud, Sari-bal armud, Shaftali armud, Shekeri, Shikh armud, Sultani, Nargile, Sulu armud, Tursh sini armud, Turshmalasi armud, Usun armud, Usun sap armud, Yag armud, Yemish armudu etc.

These varieties differ with respect to ripening time (summer, autumn and winter), size, taste quality, productivity and other factors, for instance, Aghagormez and Bildirchin budu are early ripening, while Goy armud is very productive (1 ton per tree). Given all of these varieties, one can still find new species both in the forests and on farms.

Above: Apricot variety Schalaq Limonlu

Armeniaca vulgaris Lam.

The soil and climate conditions in Azerbaijan is very favorable for apricot (*Armeniaca vulgaris* Lam.) cultivation and it has been growing here since ancient times.

Apricot was developed 3000 years ago in the Zuvad area including the Nahkchevan and Lankaran-Astara regions. Apricot plays an important role in fruit-growing of Southern Azerbaijan. Dried apricots are highly prized on world markets. Ordubad is world famous for its valuable apricot varieties. The apricot varieties in Ordubad are distributed widely in Armenia and Georgia. Besides Nakhchevan AR, apricot has been developed in the Goychay, Aghdam, Aghdash, Tar-Tar, Yevlakh, Kurdamir, Khachmaz, Ganja, Gazakh, etc. regions of Azerbaijan since ancient times. Thus, several old landraces, varieties that differ with respect to some pomological and agricultural traits, are cultivated in the republic. (Talibov and Babayeva, 1997). Some examples of these traits include::

Skin colour – Hagverdi (white-red), Agh Teberze, Agh tokhum shamsi, Agh Novrasta, Gorkhmazi, Aghjabanat, Khurmayi, Badam erik (yellowish), Goy badam, Ordubadi (golden-yellow), Qaysi, Girmizi Novrasta (yellow-red), Sari Teberze (yellow), Khosrovshahi (yellow, reddish), Girmizi tokhum shamsi (dark-yellow), Abutalibi (green-yellow, reddish-orange), Shalakh (pink-yellow,red), Goyjanabat (green-orange-pink), Girmizi Teberze (dark-pink);

Pulp colour – Agh Novrasta (white), Gorkhmazi (white-green), Girmizi Novrasta (orange), Abutalibi, Hagverdi, Teberze, Agh Teberze (Balyarim), Sari Teberze, Agh tokhum shamsi, Gorkhmazi, Aghjanabat, Khurmayi, Qaysi, Khosrovshahi, Girmizi tokhum shamsi (yellowish), Goy badam, Ordubadi (golden);

Late flowering varieties – Abutalibi, Khosrovshahi, Teberze, Sari Teberze, Girmizi Teberze, Badam erik, Agh tokhum shamsi;

Early ripening varieties – Qaysi, Agh tokhum shamsi, Girmizi Novrasta, Shalakh, Agh tokhum shamsi, Girmizi tokhum shamsi, Badam erik; middle ripening varieties – Teberze, Sari Teberze, Girmizi Teberze, Agh Teberze (Balyarim), Hagverdi, Gorkhmazi; late ripening varieties – Abutalibi, Khosrovshahi, Goy badam, Ordubadi;

Aromatic varieties – Goyjanabat, Hagverdi, Goy badam, Ordubadi;

Productive varieties – Shalakh, Khosrovshahi, Badam erik, Abutalibi, Sari Teberze;

Varieties suitable for drying – Abutalibi, Khosrovshahi, Teberze, Sari Teberze, Girmizi Teberze, Agh Teberze (Balyarim), Agh tokhum shamsi, Badam erik, Aghjanabat, Khurmayi, Goy badam, Ordubadi, Goyjanabat;

Frost- resistant varieties – Abutalibi, Goyjanabat, Aghjanabat;

Disease- resistant varieties – Abutalibi, Teberze, Badam erik, Khurmayi.

Conclusions

In recent years the negative impact of diseases that spread among agricultural plants has increased the awareness of the importance of ancient native selected varieties. It is known that these varieties are not only a living history of the nation but considering their positive bio-agricultural traits – productivity, qualitative fruits, disease and pest resistance, they may be used to improve existing varieties, as well as aid in the selection of new potential forms and varieties for the future.

Above: Farmer Haci Salman, Quba d. Alpan village

Above: Farmer Haci Salmans, Apple orchard

Above: Farmer Haci Salmans, New walnut garden

Above: Farmer Haci Salmans, Old walnut garden

Above: Rural farmers market Gabala d, Vendam village

Above: Salami

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LR Resources

On this page you will find a number of resources to aid and inform the national LR conservation strategy planning process. For one-to-one guidance on any aspect of national LR conservation strategy planning, please contact Valeria Negri: vnegri@unipg.it.

LR conservation planning aids

A list of data sources that can be consulted to aid the development of a LR in situ conservation strategy
A Training Guide for *In Situ* Conservation On-Farm (2000) Technical skills and tools to build institutional capacity and partnerships to implement an on-farm conservation programme
Law and Policy of Relevance to the Management of Plant Genetic Resources (2005) Introduction to international legal and policy instruments relevant to professionals who manage, conserve and use plant genetic resources for food and agriculture and/or have policy-making responsibilities.
The International Treaty on Plant Genetic Resources for Food and Agriculture: Implementing the Multilateral System - Learning Module **(2010)** A module for professionals who work in plant genetic resources to understand the impact and working of the multilateral system of access and benefit-sharing of the International Treaty and to use its standard material transfer agreement (SMTA) to enhance transfer of plant genetic resources.
Draft PGRFA Conservation Toolkit: 'Conservation and Sustainable Use of PGRFA: a Toolkit for National Strategy Development' aims to help nations to systematically formulate national strategies for the conservation of LR and LR by leading the user through the various steps of the process and providing supporting reference material. Please note that this publication is currently undergoing review and major modification and will be formally published by FAO later in 2012.

LR data

Resources with a specific focus on in situ LR data.
http://www.arsial.it/portalearsial/RegistroVolontarioRegionale/Default.htm
http://germoplasma.arsia.toscana.it/Germo/
For a guide to searching for LR *ex situ* conservation data that can be used for searching landraces in situ as well as for carrying out a gap analysis, please consult the
http://eurisco.ecpgr.org/
The EURISCO web catalogue receives data from the National inventories, and provides access to all ex situ PGR information in Europe

LR information management

in situ LR descriptors: http://www.pgrsecure.bham.ac.uk/sites/default/files/documents/helpdesk/LRDESCRIPTORS_PGRSECURE.pdf

LR publications

Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces (2012)

LR networks

http://www.ecpgr.cgiar.org/networks/in_situ_and_on_farm/on_farm_wg.html
http://www.bioversityinternational.org/announcements/on_farm_conservation_neglected_and_underutilized_species_and_climate_change_a_new_international_effort.html

LR project websites

From the links below, you will find a number of project websites which are related to a different extent to LR and LR use.
An Integrated European *In Situ* Management Workplan: Implementing Genetic Reserves and On-Farm Concepts (AEGRO)
http://portal.geographie.uni-freiburg.de/forschungsprojekte/indigenoveg/
http://www.diverseeds.eu/
http://www.ensam.inra.fr/gap/resgen88/
www.solibam.eu/
www.urbesproject.org

LR conferences/workshops

From the links below, you will find a number of resources associated with future and past conferences/workshops, such as Powerpoint presentations, posters, reports and other related publications.
Towards the establishment of genetic reserves for crop wild relatives and landraces in Europe, Funchal, Madeira, 13–16 September 2010
Conservation strategies for European crop wild relative and landrace diversity, Palanga, Lithuania, 9–11 September 2011

Other useful links

http://www.bioversityinternational.org/
http://www.cgiar.org/
http://www.fao.org/
www.slowfood.com/
www.biodiversa.org

Call for contributions

We want to ensure that *Landraces* provides the information you, the readers, want. We therefore want to hear from you with your ideas for the content of future issues. For instance, there could be pages dedicated to short news items and event announcements, news about recent publications, and feature articles about the conservation and use of crop landraces.

To reach as wide a readership as possible, *Landraces* will be posted on the PGR Secure web site, circulated by email and a limited number printed for circulation by post. We would be grateful if you could spread the news about the availability of this new serial, and put us in touch with interested parties that would like to receive it.

Whatever profession or interest group you belong to, please send us your contributions for inclusion in future issues. We hope that this newsletter will be read by a wide audience; therefore, while we want to ensure a high standard in terms of scientific content, we would also like the serial to be available to those readers who are not directly involved in the genetic resources professions.

Articles should be a maximum 2000 words, and may contain good quality graphics and pictures. Please ensure that the appropriate caption and credit is included, and inform the editors if an article has previously been published elsewhere so that permission can be obtained for reproduction. Contributions should preferably be submitted in electronic format either by email attachment or on disc. *Landraces* will be published twice yearly; the next issue will appear in early 2013. Please direct all correspondence to Valeria Negri, email vnegri@unipg.it

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