CONSERVATION OF CROP GENETIC RESOURCES IN ITALY WITH A FOCUS ON VEGETABLES AND A CASE STUDY OF A NEGLECTED RACE OF *BRASSICA OLERACEA*

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Abstract

The study attempts, above all, to provide a summary, with a strictly scientific basis, about the strategies of conservation of autochthonous agrobiodiversity followed in Italy. A special focus is dedicated on vegetables and, therefore, could represent a contribution to improve the national strategy for the safeguarding of its agrobiodiversity in general. The paper offers also an outlook on the most critical factors of the *ex situ* conservation and some actions which need to be taken. Some examples of 'novel' recovered neglected crops are also given. Finally a case study is proposed: 'Mugnolicchio', a neglected race of *Brassica oleracea* L., cultivated in Altamura (Ba) in southern Italy. 'Mugnolicchio' might be considered as an early step in the evolution of broccoli (*B. oleracea* L. var. italica Plenck) like 'Mugnoli' another neglected race described from Salento (Apulia).

Keywords

Agrobiodiversity, vegetables, plant genetic resources, Italy, safeguarding, landraces

The present study is a small review reported by the authors after a number of safeguarding projects and collecting missions have been carried out, since the1970s, in all Italian agricultural districts [1, 2], including small islands [3]and linguistic areas[4].

Conservation of crop genetic resources: the Italian situation

To understand the role and the importance of agrobiodiversity in the Italian agricultural system, it is interesting to know the statistics that describes it: one has the impression of being in front of a country still caught between tradition and modernity, where agricultural activities – today an insignificant percentage of GDP – still retain their value for a large part of the population. In fact, despite the decline in recent years, Italy is the third largest agricultural country in Europe after Poland and Romania, with more than a million employees in the sector. Also for the number of companies in agriculture, Italy holds the third place, again after Romania and Poland. In this framework, agrobiodiversity plays a dual role: on the one hand, it is still strongly linked with farmers who manage their farms

traditionally and not as real “enterprises” and, on the other hand, their highly qualitative production awarded by many geographical indications (e.g. PDO, PGI and TSG) represents worldwide excellence. Italy, for the latter, is the queen of Europe with more than 200 certified products, which represent more than 20% of the European total. “Geographical indication” trademarks are a demonstration of the link between territory, culture and agriculture; their strong presence in Italy attests the importance which this trio still has in shaping the economic development of Italian agriculture. It should be noted, however, that most of the agrobiodiversity and traditional knowledge associated with it, is kept in a class of farms generally conducted by elder farmers over 65 years in age [1, 2, 5].

It is necessary, therefore, to adopt policies to cope with this situation, and to avoid loss of knowledge and of landraces due to generational change, and to create economic, social and cultural conditions for these farms to continue working in agriculture. In fact, the market and international competition are horizons too far away to them that, without adequate forms of protection or development, would disappear, taking with them all the specific culture handed down from generation to generation. In this context, agricultural policies play a central role, in particular, those of rural development, which can, if properly set up, promote the link between tradition and modernity, avoiding interruptions and using agrobiodiversity as a factor in local development. For this reason, it is not a simple implementation of conservation policies for plant genetic resources, but also a change of perspective by moving towards a system of safeguarding to provide a reciprocal interaction and a necessary complementary action between *ex situ* and *in situ*/on-farm conservation.

The Regions and the Autonomous Provinces are public bodies which, by their deep knowledge of the territory and their legislative autonomy in the field of agriculture, are the privileged place to synthesize and coordinate the main actions of conservation and exploitation of agrobiodiversity. In fact, there are many regions that fund and promote in various ways such actions in their territories. In some cases, these activities have led to a specific regional legislation with the aim of protecting local breeds and varieties. Tuscany was the first region to enact a law on the protection of agrobiodiversity in 1997, followed in subsequent years by Lazio, Umbria, Friuli Venezia-Giulia, Marche, Emilia-Romagna, Basilicata and Apulia. At present also other regions are discussing to enact similar laws [5]. The experiences of Italian regional laws can be considered as one of the few operative examples in Europe for protection and exploitation of PGR. They have anticipated policies at national and European level, even operating in line with the objectives of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). In Italy, however, in addition to the regions, there are several entities that, variously integrated with each other, depending on the territorial dynamics, interact towards building a chain of plant genetic resources, from storage to exploitation. There are three categories of entities: scientific institutions, local authorities, and the non-governmental sector. The three categories should work in a completely synergistic way with each other. In general, these are:

- Scientific institutions dealing with collecting, preservation, characterization and documentation of material and *ex situ* conservation, as well as dissemination of the information collected;
- Regions, Autonomous Provinces and other local institutions (Provinces, Municipalities, Mountain Communities, GAL – Groups of Local Action, etc.) coordinate and promote these actions often supporting them with dedicated lines of credit (e.g. regional laws for the protection of agrobiodiversity) or through funds for agricultural regional research and the "Plans of Rural Development" or others;
- the non-governmental sector (all subjects not included in the previous two categories, such as individually or jointly working farmers, associations, foundations, various organizations, etc.) stimulates and/or carries out paths of preservation and exploitation of specific landraces or particular territories, starting from the needs of local communities and farmers and their history.

In this context, the role of farmers is crucial. They are important both as farmers as such (growing landraces in their farms), as "guardian farmers", and as associate members in programmes to exploit and promote specific PGR.

Consumers are also particularly interested in landraces, so that a vibrant market for local and/or typical products is created. Typicity presumes that a local variety, its product and any process of transformation are closely linked to the territory in which the genetic resource has evolved. The term "territory" should be used in the broadest and complete sense, indicating both the physical space and anthropological space (typical elements of the mode of man settlement), as well as the set of values, history and culture that characterize it.

In recent years there have been many experiences of conservation and exploitation of landraces by private persons (farmers and non-farmers) who autonomously have provided funds for projects that were often linked to the promotion of a particular territory and products connected to it. These initiatives are dispersed throughout the country (through, e.g., fairs, markets, dissemination, promotion and exploitation actions, consortia of producers, development of product rules, small projects on typical products), which over time have shown a strong fragmentation, poor coordination and frequent overlap, but most have failed to transmit adequately the "know-how". It must be said, however, that the dissemination activities, including publications produced in recent years, have contributed in a concrete way to the knowledge of the heritage of Italian landraces, which often did not find adequate description in the official manuals. The collection of information derived from cookbooks and popular knowledge should not be underestimated, which allows proper cultivation and use of old landraces. The wealth of material and knowledge created in the past from ancient and disinterested experience of farmers is a precious inheritance that has to remain "World Heritage".

Plant Genetic Resources stored by Italian public institutions and universities

The depletion of PGR has important implications both ecologically and economically. The erosion and possible extinction of these resources can undermine the resilience of ecosystems and endanger the essential environmental services derived from them. For the economy, PGR are a source of direct and indirect benefits. They are indeed a source of raw materials as well as useful information, for example, in the processes of plant breeding of crops. The Mediterranean, and particularly its less developed rural areas, is traditionally rich in PGR which, however, are undergoing a process of genetic erosion due to causes both socio-economic, such as the marginalization of agriculture, and environmental, as in the case of the loss of natural habitats.

The Italian national activities of inventorying PGR for food and agriculture, promoting the collecting and safeguarding, to establish a network of updated information on PGR, are concentrated mainly in the "Council for Research and Experimentation in Agriculture and Agricultural Economic Analysis" (CREA) and the National Research Council (CNR).

Although it is known that many universities maintain large collections of agricultural genetic resources, a comprehensive list has never been compiled. Several universities store remarkable collections and work in areas rich in crop diversity. The Department of Applied Biology (University of Perugia), for example, has important collections of forage species (legumes and grasses), food, industrial, medicinal and aromatic crops while the Centre for Conservation and Exploitation of Plant Biodiversity (University of Sassari) has collections of seed germplasm and DNA of populations of native endemic species of high phyto-geographical interest, collections of cultivars of fruit and vegetables, and micro-organisms – both pathogens and symbionts. In Sicily, instead, a specific measure of a regional law (POR 2000–2006) allowed the Universities of Palermo and Catania, the CREA and the CNR, to create several centres for the *in vivo* and *in vitro* conservation of germplasm of fruit trees, olive and citrus that could be networked together, sharing information and contributing to the knowledge on all plant material in storage [6, 7].

PGR stored by the research institutes of the CREA

The MiPAAF (Italian Ministry of Agriculture), to deal with these and other international commitments, had financed in 1999 and 2001 two nationwide projects aimed at a census of PGR for agriculture preserved *ex situ* at the Institutes for Experimental Research in Agriculture (former IRSA, now institutes of CREA) and the fruit germplasm preserved *ex situ* in various Italian institutions of different backgrounds (IRSA, CNR, universities, regional experimental farms). Since 1995, the focal point of coordination actions on PGR is the CREA-FRU[1], which, over the years, has established itself as the reference point for the MiPAAF both nationally and internationally with regard to the PGR.

[1]Institution acronyms are explained in Table 1 below.

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In 2004, with the approval of the FAO International Treaty on Plant Genetic Resources for Food and Agriculture, the first global agreement entered into force. It involves concrete obligations for the Contracting Parties regarding the conservation and documentation of species of agricultural interest, in order to facilitate access to them and sharing benefits arising from their use. For Italy, MiPAAF has the responsibility for the implementation of the FAO Treaty; MiPAAF entrusted the CREA-FRU with the scientific coordination of the actions for the collection, conservation, characterization, evaluation and enhancement of PGR of agricultural interest, as defined in the specific project "Plant Genetic Resources / Implementation of the FAO Treaty", launched in 2004, that gives special priority to old and local varieties. The project involves 27 centres and Research Units belonging to the CREA, the former Institute of Plant Genetics of CNR in Bari (today IBBR), and, since 2008, 10 NGOs that have joined in the "Semi Rurali" Network (Table 1). Starting in 2014, the CNR was involved at a high level through the Department of Biology, Agriculture and Food Science, which hold many different plant and microbial collections through its network of institutions.

Table 1. Plant genetic resources of agricultural interest and research units of the project "Plant Genetic Resources / Implementation of the FAO Treaty" (modified from[8])

Plant genetic resources	**CREA institutes**	**CNR institutes**	**Other research units**
cereals	ACM, CER, GPG, MAC, QCE, RIS, SCV	IBBR	"Semi Rurali" Network
vegetables	ORA, ORL, ORT	IBBR, ISAFOM	"Semi Rurali" Network
fruits and nuts	ACM, FRC, FRF, FRU, SCA	IVALSA	"Semi Rurali" Network
fodder species	FLC	IBBR	
Industrial crops	API, CAT, CIN		
olive	OLI	IVALSA, ISAFOM, IBBR	
grape	VIT	IBBR	
ornamental species	FSO, SFM, VIV		
medicinal and aromatic plants	MPF		
forest species	SEL, PLF	IBBR	

Legend: ACM (Centro di ricerca per l'agrumicoltura e le colture mediterranee, Acireale), API (Unità di ricerca di apicoltura e bachicoltura, Bologna), CAT (Unità di ricerca per le colture alternative al tabacco, Scafati), CER (Centro di ricerca per la cerealicoltura, Foggia), CIN (Centro di ricerca per le colture industriali, Bologna e Rovigo), FLC (Centro di Ricerca per le Produzioni foraggere e lattiero-casearie, Lodi), FRC (Unità di ricerca per la frutticoltura, Caserta), FRF (Unità di ricerca per la frutticoltura, Forlì), FRU (Centro di ricerca per la frutticoltura, Roma), FSO (Unità di ricerca per la floricoltura e le specie ornamentali, Sanremo (IM), GPG (Unità di ricerca per la genomica e la postgenomica, Fiorenzuola d'Arda – PC), IBBR – Institute of Biosciences and Bioresources, Bari, MAC (Unità di ricerca per la maiscoltura, Bergamo), MPF (Unità di ricerca per il monitoraggio e la pianificazione forestale, Trento), OLI (Centro di ricerca per l'olivicoltura e l'industria olearia, Rende CS, Città S. Angelo – PE – e Spoleto – PG), ORA (Unità di ricerca per l'orticoltura, Monsampolo del Tronto), ORL (Unità di ricerca per l'orticoltura, Montanaso Lombardo), ORT (Centro di ricerca per l'orticoltura, Pontecagnano), PLF (Unità di ricerca per le produzioni legnose fuori foresta, Casale Monferrato e Roma), QCE (Unità di ricerca per la valorizzazione qualitativa dei cereali, Roma), RIS (Unità di ricerca per la risicoltura, Vercelli), SCA (Unità di ricerca per i sistemi colturali degli ambienti

caldo-aridi, Bari), SCV (Unità di ricerca per la selezione dei cereali e la valorizzazione delle varietà vegetali, S. Angelo Lodigiano), SEL (Centro di ricerca per la selvicoltura, Arezzo), SFM (Unità di ricerca per il recupero e la valorizzazione delle specie floricole mediterranee, Palermo), VIT (Centro di ricerca per la viticoltura, Conegliano), VIV (Unità di ricerca per il vivaismo e la gestione del verde ambientale ed ornamentale, Pescia – PT).

Sixty-five species are included in the project, of which 22 are listed in the Annex I of the FAO Treaty; the other 43 species are distinguished by their economic and strategic significance for Italy.

The Research Units of CREA store a large number of accessions (native and foreign material, old and new cultivars, populations, landraces, breeding lines, etc.), most of which are stored as seeds or *in vivo*; a small proportion of germplasm is also preserved through cryoconservation [9]and *in vitro* conservation.

The documentation of PGR is indispensable to make the results of the work available and to encourage the use of PGR in sustainable farming systems. The online catalogue "National Inventory of PGR stored *ex situ* in Italy", established in 2006 under the project managed by CRA-FRU is therefore proposed as a national platform to provide basic monitoring information (passport) as well as morphological and physiological data according to international standards. Currently, the database contains data on more than 30,000 accessions belonging to about 500 different species and stored in 44 Italian public institutions. The catalogue, thanks to its interactive nature, is constantly updated, a task accomplished independently by individual institutions, and therefore a constant increase in the number of accessions monitored and related information is expected.

The main critical factor is the lack of a single national institution responsible for the conservation of all PGR of agricultural interest or of a coordinated germplasm system. This national institution should also have the task of coordinating activities by other organisations at national and regional level for the purposes of a correct policy of duplication of collected accessions. The accessions of many species of agricultural interest are disappearing quickly; traditional crops are almost completely replaced by a few commercial varieties. The consequence is the decrease of genetic variability. The survival of many genotypes is exclusively linked to their presence in collections. A lack of cooperation among the various institutions (public and/or private) involved in the conservation of PGR should be noted. It is also important to mention the lack of adequate and continuous funding for the care and maintenance of the collections, including characterization activities. Equally important are: (a) the difficulties in finding adequate space for new accessions (often indigenous material threatened by genetic erosion), especially for tree species; (b) lack of facilities for the proper arrangement of the material to be quarantined; (c) the great heterogeneity in the documentation of the accessions stored at the various institutions, with the consequent difficulty of harmonizing the data contained in the various databases maintained by individual institutions and often specific to only a few species of interest.

PGR stored by the research institutes of the CNR

The National Research Council (CNR) is a public research organisation. The CNR scientific network consists of (a) Departments responsible for programming, coordination and control; and (b) Institutes where the research activities are carried out.

The "Scienze Bio-Agroalimentari" Department (DISBA) consists of institutes that at various levels are involved in conservation and characterization of plant biodiversity and therefore hold collections of genetic resources. In particular, the Institute of Biosciences and Bioresources (IBBR) has, since 1970, a genebank, which was, at the time of its establishment, designed as the reference genebank for all the Mediterranean area. A large fruit tree collection is held by CNR-IVALSA and is also reported within the collections identified by CREA-FRU.

Currently, the DISBA has collections of animal genetic resources (pigs, cattle, sheep, but also insects and nematodes), model plants (*Arabidopsis*, *Medicago*, *Nicotiana*, etc.) and plants of food interest. In detail, the DISBA has the following collections: fruit trees (1860 accessions), *Citrus* (241 accessions), olive trees (about 2500 accessions), grapevine (119 accessions), forage plants (782 accessions of 83 species), vegetables, officinal plants and other species (1270 accessions of more than 200 species). The collections pertain to various institutes of CNR (IBBR, IVALSA, ISAFOM, IBAF, etc.). In particular, in the IBBR genebank in Bari, more than 65,000 accessions of over 600 different species are preserved. Most of the accessions belong to cereals and legumes, but also horticultural species and wild progenitors are maintained, including a living collection of artichoke. Of these accessions, more than 15,000 were directly collected by IBBR in collaboration with other national and international institutions (e.g. FAO, IBPGR, etc.). These samples are also partially duplicated in other genebanks.

An initial investigation aimed at acquiring an overall picture of the situation was carried out by DISBA in 2008. However, there is not a common database which brings all the information together, yet. In addition, it is necessary to find a common and shared protocol for the conservation and utilization of the PGR stored.

Other sources

Of course, in addition to the CNR and the CREA in Italy there are other institutions, both public(e.g. universities) and private (e.g. NGOs) that preserve plant germplasm collections of great value. The problem is that there is not yet a complete census of these institutions and of what precisely they preserve. Some initiative have already arisen with a PGR census as the main aim. Among them there is a survey by the "Istituto Superiore per la Protezione e la Ricerca Ambientale" – ISPRA (Institute for Environmental Protection and Research) produced in 2010 a volume on the *ex situ* conservation of biodiversity of wild and cultivated plant species in Italy, including the state of the art, problems and actions to be taken[8].

In April 2013, the DISBA of CNR created BioGenRes, the Italian Network of Genetic Resources (http://www.biogenres.cnr.it). BioGenRes represents a first step towards the systematic rationalization and harmonization of national genetic resources, for the improvement of the agro-food industry and sustainable forest management. Finally, a project for the constitution of a national inventory is being conducted by CNR, CREA, INEA under the coordination of the Ministry of Agriculture, starting the National Inventory that will provide data to EURISCO.

Some actions to be taken for solving the most critical factors are: a) to define and institutionalize a national institution for the conservation of PGR for agriculture; b) to continue the work of collecting accessions in the national territory which are not yet included in public collections; c) to continue and complete the morphological, agronomical, phytosanitary and molecular characterization of all stored accessions; d) to improve, complete and harmonise the documentation of the stored material (e.g. census of facilities that operate the active conservation of PGR, census of species/varieties stored); e) to define, for each crop, a *core collection*, in order to ensure the efficiency of evaluation and the conservation of essential genetic traits; f) to carry out public awareness-raising activities for the safeguarding of PGR and to create awareness regarding the various potential uses of PGR and the importance of genetic variation within a given species; g) to properly prepare the material, especially that under the FAO Treaty, for exchange with other institutions; h) to create conditions for increasing the duration of the viability of accessions in seed storage (suitable climatic chambers for long-term storage); i) to assess the conservation status of the material currently present in *ex situ* collections in order to effectively intervene on the endangered species from extinction; j) to promote the use of the National Inventory as a general platform for documentation and access to data on the PGR stored *ex situ* in Italy. This will also facilitate the transfer of information into the various European (EURISCO and the European Central Crop Databases, ECCDBs) and global catalogues (WIEWS, Genesys).

In the light of the above considerations, a plan of action for Italy should include the following tasks:

1. To develop new (bio) informatics systems that can facilitate both the management of the utilization of stored genetic resources, making them readily available, and doing work together data of different nature (passport data, evaluation, images, GIS mapping, etc.).

2. To develop (bio) informatics systems that will aid researchers to census the level of synonymy/duplication internal to the collections. Unwanted duplication may be due to obtaining the same genotypes from different sources, or from the fact that the same genotype is called by different names in different areas (a typical example is the olive germplasm).

3. To assess the level of safety duplication of the material stored, i.e. whether each sample has a “backup copy” stored at another centre for the conservation and, if not, developing it also using innovative techniques of *in vitro* conservation.

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4. To establish contacts and to formalize interactions with major international institutions for safeguarding plant biodiversity, such as CGIAR (Consultative Group on Agricultural Research) and Bioversity International.

Genetic resources of the main vegetables cultivated in Italy and their safeguarding

Vegetable crops in Italy, covering a total area of about 530,000 hectares, belong to about 40 species, forming a very heterogeneous group. With the exception of tomato (123,000 hectares), potato (80,000 hectares), artichoke (49,000 hectares), fresh green bean, cauliflower, fennel, lettuce and melon (22,000–24,000 hectares each), the area of all other vegetables comprises only a few thousand hectares.

The conservation of genetic resources in the process of rapid and final extinction has become, for some decades, one of the most urgent objectives of genetic research applied to plants, including vegetables. In fact, the relentless progress of cultivation techniques can provide income gains only if they are applied to genotypes resistant to pests, suitably adapted to high fertilization, integral mechanization, chemical weed control, crop protection, and artificial substrates. Commercial distribution of vegetable seeds, which has almost completely replaced the seed harvested by the farmer himself, enhances improved cultivars and hybrids according to the requirements cited above, the presence of which in the market, as a result of the rapid varietal evolution, usually does not exceed three to four years. In addition, a new vegetable cultivar, to be profitable for the breeder, has to be protected: this is the reason why, beyond the undeniable merits, the F1 hybrids have become more widespread, and have drastically reduced the use of open-pollinated cultivars, the cost of multiplication of which is similar to that of hybrids, but their pay-back for the seed producer is much lower.

The seed industry is increasingly concentrated in the hands of a few multinational corporations; it engages mainly in obtaining F1 hybrids resulting from a narrow range of parental lines, or “engineered” varieties providing, consequently, to the preservation of only a small number of traditional cultivars of particular notoriety and gradually abandoning all the others. This has caused, and still causes a rapid loss of genetic variation. The old local populations (or landraces) perfectly adapted to their environment, the nowadays obsolete commercial cultivars, the lines already used in the work of breeding and today discarded, are, however, a wealth of unique genetic variability, the loss of which cannot be remedied. The collection, characterization and conservation of genetic resources are, therefore, of particular importance, especially in the field of vegetable crops, of which Italy is historically very rich. To face the problems of genetic erosion, the “National Register of Horticultural Varieties” has been established in Italy in the 1970s (Ministerial Decree of 17.07.1976) in which 726 local varieties called “*ante ‘70*” were recorded. Later, because of the constant negative feedback relating to the varietal identity of samples stored at seed industries responsible for their conservation and the lack of available subjects to carry out their

maintenance in purity, it has come to a renewal of the above mentioned register that led to the cancellation of 326 varieties. To them should be added other 46 varieties cancelled due to lack of identity requirements and varietal homogeneity. Today, the new list includes both open-pollinated varieties (506 from the old list and 350 made after 1977), and 74 F1 hybrids from the old list and 490 hybrids registered after 1977. Seed companies or public institutions keep them in genetic purity.

The promotion and development of local products is one of the most important agricultural policy strategies for the revitalization of the Italian agricultural economy, in particular for the South, where agriculture often does not have the technical and economic conditions necessary to compete with the more advanced agricultural systems or to cope with the competition from foreign countries producing at lower costs. The promotion of local products also contributes to the preservation of agrobiodiversity: a large amount of crop germplasm would be lost (or would have already disappeared) if not properly valued and promoted through collective marks (PDO, PGI, AS, STG), which represent important regulatory instruments to protect consumers and to support small and medium farms.

The whole Italian territory, but particularly inland areas of South Italy where small family-owned farms still exist, is particularly rich in vegetable germplasm represented by different landraces clearly distinguishable from other similar cultivars (for morphological characteristics, sensorial, etc.) and closely linked to the historical memory of their places of origin.

Main safeguarding problems

The numerous scientific activities undertaken so disconnected from the actors in the territory, threaten to undermine the work already carried out with considerable financial resources at regional, national and EU level. Therefore, it is necessary that all steps of recovery, characterization, conservation and exploitation are taken only and exclusively in agreement or at the suggestion of local actors, public or private, located and operating in the territory concerned. In particular, a lack can be observed of homogeneity of methodological approaches adopted in the collection, classification, measurement and characterization of the material. In addition, the exploration of the territory is not always followed by adequate preservation of the collected material.

The lack of coordination has often led to overlapping of initiatives and a confusion of roles which would be appropriate to bring order to better leverage the work already conducted and efficiently address future activities. In addition, the lack of appropriate funding necessary to develop further the activities of *ex situ* conservation, with costs generally high, has brought more problems and confusion in the work.

The evaluation activities of the stored material and studies on the genotype × environment interaction on the most interesting landraces are insufficient. In the same way the knowledge about the most effective methods of *ex situ* conservation is incomplete. The

currently existing genebanks have played and continue to play, an important role in the collection and preservation of plant genetic resources, but it is equally true that *ex situ* conservation alone does not guarantee the actual conservation of the resources and their durable use. Another important priority is to define the risk threshold beyond which the varieties are considered at risk of extinction and therefore would need protection. These thresholds must be recognized and shared by all scientific and non-scientific subjects working in this field.

Some actions to take for solving the most critical factors of vegetable landraces

Very important is to guarantee the maintenance and management of existing collections and to survey and to conduct a census of ecotypes of vegetable species originating and/or historically present in the regional agricultural areas. It is of great practical importance to collect morphological, chemical, agronomic and molecular data for the widest possible characterization of germplasm, in order to identify the potentially most interesting traits, such as the production of bioactive compounds (e.g. vitamins, fibre, minerals, antioxidants, enzymes, etc.) important in the prevention of many diseases.

It might be useful to evaluate existing genebanks, in terms of functionality and capabilities, study and develop specific methodologies and equipment for the seed preservation, to ensure the integrity of the genetic material in the long term.

Some multiplication problems can be solved improving the study on micropropagation techniques, which for many vegetables could be a great help, as they require less space and costs to store and to periodically rejuvenate the material.

An ‘official’ database of genetic material collected, possibly on-line, is essential together with evaluation of the agronomic and commercial potential of the best landraces.

To perform better actions for a targeted breeding we have to improve the quality and usability of information about evaluation data regarding accessions in the collections of germplasm.We must increase the spread of the technological and scientific results obtained during the investigation, the best characteristics of traditional products under investigation and pilot actions to diffuse the cultivation of the most typical neglected vegetable landraces.

Additional useful actions might be: a) draft cultivation specifications and application for release of protection collective marks; b) trade promotion activities of neglected local vegetables through awareness and information campaigns; c) to implement the collections through exchange with other research institutes and Italian and foreign genebanks, seeking to create synergies and ways of interaction as part of the multiplication and rejuvenation of the seed, in order to optimize the *ex situ* conservation of germplasm; d) to prepare guidelines for the definition of a programme of activities for the protection of national biodiversity, to be carried out according to the indicators for the quantification of the specific objectives of the Rural Development Programme 2014–2020; e) to define management protocols nationwide standardized for the *ex situ* conservation of the main

local varieties; f) to create networks of "guardian farmers", such as contacts and responsible for the renewal and multiplication of biodiversity products recovered in the territory, recognizing the work so "loving" which they have done over the years; g) to ensure the economic sustainability of conservation actions (guardian farmers or any person involved in safeguarding of germplasm); h) to stimulate multifunctionality of farms as a tool for possible economic sustainability of conservation actions (e.g. farmhouses offering product of landraces produced on-site).

Conclusions

This study attempted, above all, to provide a summary, with a strictly scientific basis, about the *ex situ* conservation of Italian agricultural biodiversity and, therefore, could represent a small contribution to the national strategy for the protection of its agrobiodiversity in general.

In addition to the technical and methodological problems, however, the *ex situ* conservation is also affected by a general unavailability or shortage of funds, which limits its development. The phenomenon involves the majority of genebanks around the world and is accompanied in many cases by a lack of interest of policy makers in the subject. There is no doubt that the focus on *ex situ* conservation, very strong in the 1960s and 1970s, when the first genebanks arose, has been gradually reduced.

According to FAO (2010), the world's genebanks store *ex situ* ca. 7.4 million accessions of cultivated species (e.g. cereals, legumes, vegetables, fodder, officinal, medicinal, aromatic, etc.), wild relatives of the cultivated species, and other wild species, threatened by genetic erosion and/or extinction.

In the future there will be an increasing need to develop sustainable agricultural systems, for both food and energy and to preserve cultivated and wild species against genetic erosion. The genebanks can definitely play a decisive role, complementary to the *in situ* conservation (incl. on-farm conservation) and to a more careful territory planning. In this perspective, a greater economic effort is desirable aimed at the development of research, the maintenance of genebanks and the continuous monitoring of the state of the collections. A political and normative commitment in this sense is crucial, supporting the *ex situ* conservation. In general, a greater involvement by governments of different countries is desirable to support the networks of genebanks and the activation of participatory systems that involve the entire chain of production, from farmers to end users, in order to develop a territory management seriously and concretely oriented to sustainability.

CASE STUDY: ''MUGNOLICCHIO'': A NEGLECTED RACE OF *BRASSICA OLERACEA* L. FROM ALTAMURA (ITALY)

The *Brassicaceae* plants are among the most consumed vegetables in the world. They feature a large biodiversity, in which landraces and primitive cultivars still play a major role on the cultivation systems of many countries. Brassicas and especially broccoli are closely linked to antioxidant compounds that play a key role for human health especially in traditional cuisine [10]. Italy is widely regarded as the centre of genetic diversity for several cultivated *Brassica* races, such as *B. oleracea* L. var. *botrytis* L. (cauliflower) and var. *italica* Plenck (broccoli). Therefore, many specific exploration missions have been carried out in Italy to collect *Brassica* germplasm both cultivated [11, 12] and wild [13, 14].

This rare landrace of *Brassica oleracea* was found (Figs. 1, 2, 3) in Altamura (Ba) and for the first time a preliminary characterization was made. It is called ‘‘Mugnolicchio’’ or ‘‘Migniolicchio’’ and is cultivated traditionally in the Altamura area (Apulia region, south Italy).

“Mugnolicchio” is similar to the broccoli of which, according to recent investigations, it is (probably with “Mugnoli” of Salento - Figs. 4 and 5), the progenitor from which the latter were selected but, only a specific genetic study, considering all together its wild and cultivated relatives, will clarify if ‘‘mugnoli’’ is an ancestor or whether it is a parallel development [15].

Morphologically it is clearly distinguishable from the broccoli (Figure 6,7) for the smaller and less compact inflorescence; the single flowers of the “Mugnolicchio” are white, larger and with bracts larger than those of broccoli. Also its organoleptic characteristics are peculiar and often they prefer it to broccoli. There are many traditional recipes that see him protagonist, all aimed at enhancing its sweet and aromatic flavor.

‘‘Mugnolicchio’’ is a surviving landrace because in the area of Altamura (Ba) there isn’t a lot of this cultivation (Figure 8, 9). The standardization of modern cultivars caused a rapid decline of landraces unable to compete in the market place for is little inflorescence and for the scalar production. Nowadays it is still produced from small farmers for family use, and very much appreciated by local people.

It is still cultivated in small plots of land by some horticulturists. It is sown in August and transplanted in the fall in order to collect the inflorescences from March onwards. The plant can survive for four years, then it ages and is replaced. In the past, farmers sowed this crop to separate plots from neighboring areas, as a kind of demarcation. Some plants were also sown in April for the exclusive use of the leaves in summer cooked with pasta. There are two morphological types. One with smooth and slightly lobed leaves (Fig. 10), the other one with fleshy and very lobed leaves (Fig. 11). The second type is probably the typical landrace of the past, because the characteristics of the leaves would make it usable for food.

References

1. Hammer, K., Knüpffer, H., Laghetti, G. and Perrino, P. Seeds from the past. A catalogue of crop germplasm in South Italy and Sicily. Germplasm Institute of C.N.R. (ed.), Bari, Italy. **1992**, pp. II + 173.

2. Hammer, K., Knüpffer, H., Laghetti, G. and Perrino, P. Seeds from the past. A catalogue of crop germplasm in Central and North Italy. Germplasm Institute of C.N.R. (ed.), Bari, Italy. **1999**, pp. IV + 254. ISBN: 88-900347-0-X.

3. Hammer, K. and Laghetti G. Small Agricultural Islands and Plant Genetic Resources – Le piccole isole rurali italiane. IGV-CNR (ed.), Bari, Italy. **2006**, pp. X + 246. ISBN: 88-900347-4-2.

4. Hammer K, Laghetti G and Pignone D (eds.). Linguistic Islands and Plant Genetic Resources - The Case of the Arbëreshë. ARACNE, Rome. **2011**, ISBN 978–88–548–3958–8.

5. Montesano, V.; Negro, D; Sarli, G; Logozzo, G; Spagnoletti Zeuli, P. Landraces in inland areas of the Basilicata Region Italy: monitoring and perspectives for on farm conservation. *Genet Res Crop Evol.* **2012**, *59*, 701-16. DOI 10.1007/s10722-011-9712-7.

6. Aitken-Christie J., Kozai T., Smith M.A.L. Glossary. Pp. IX-XII. In: Aitken-Christie J, Kozai T., Smith M.A.L. (Eds.). Automation and Environmental Control in Plant Tissue Culture. **1995**, Kluwer Academic Publishers, Dordrecht.

7. Germanà M.A, Hafiz I.A., Micheli M., Standardi A. Preliminary research on conversion of encapsulated somatic embryos of *Citrus reticulata* Blanco, cv. Mandarino Tardivo di Ciaculli. Plant Cell Tissue and Organ Culture. **2007**, vol. 88: 117-120.

8. Piotto B., Giacanelli V., Ercole S. (Eds). La conservazione ex situ della biodiversità delle specie vegetali spontanee e coltivate in Italia. Stato dell'arte, criticità e azioni da compiere. *Manuali e linee guida ISPRA* 52. **2010**. ISBN 978-88-448-0416-9.

9. Lambardi M., de Carlo A., 2009. Tecniche ed applicazioni della criogenia alla conservazione ed al risanamento di germoplasma vegetale. Italus Hortus. **2009**, 16(1), pp. 79-98.

10. Nicoletto C., Santagata S., Pino S., Sambo P. Antioxidant characterization of different italian broccoli landraces. Horticult. Bras. **2016**, 34: 74-79.

11. Laghetti G., Hammer K., Olita G., Perrino P. Collecting vegetable crops in Basilicata, Italy. FAO/IBPGR Plant Genet. Resour. Newslett. **1993**, 96: 35–37.

12. Massie I. Report on Research Trip to Italy to Assess Genetic and Ecogeographic Variation and Genetic Erosion of Cauliflower and Broccoli Crops and to Collect Seed Samples. Horticulture Research International (ed.). **1993**, Wellesbourne, Warwick, UK.

13. Gustafsson M., Gomez-Campo C., Perrino P. Germplasm conservation of the wild Mediterranean *Brassica* species. Report from explorations in Sardinia, Corsica, France, Spain and Great Britain in 1986. **1986**.

14. Perrino P., Pignone D., Hammer K. The occurrence of a wild *Brassica* of the *oleracea* group (2n = 18) in Calabria (Italy). Euphytica. **1992**, 59(2–3): 99–101.

15. Laghetti G., Martignano F., Falco V., Cifarelli S., Gladis Th., Hammer K. "Mugnoli": a neglected race of *Brassica oleracea* L. from Salento (Italy). Genet. Resour. Crop Evol. **2005**, 52, 635 - 639.

Figures

Fig. 1 – Plant and inflorescence of “Mugnolicchio”

Fig. 2 – Plant and inflorescence of “Mugnolicchio”

Fig. 3 – Flowers of “Mugnolicchio”

Fig. 4 – “Mugnoli” of Salento

Fig. 5 – Flower of “Mugnoli” of Salento

Fig. 6 – Commercial broccoli variety

Fig. 7 – Height difference from “Mugnolicchio” and broccoli

Fig. 8 – Cultivation of “Mugnolicchio”

Fig. 9 – Cultivation of “Mugnolicchio”

Fig. 10 – Morphotype with smooth and slightly lobbed leaves

Fig. 11 – Morphotype with fleshy and very lobbed leaves