agriculture

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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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Received: 3 May 2018; Accepted: 26 June 2018; Published: 2 July 2018

Abstract: This study attempts, above all, to provide a summary, on a strictly scientific basis, about the strategies of conservation of autochthonous agrobiodiversity followed in Italy. A special focus is dedicated to 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 ex situ conservation and actions which need to be taken. Some examples of 'novel' recovered neglected crops are also given. Finally a case study is proposed on 'Mugnolicchio', a neglected race of *Brassica oleracea* L., cultivated in Altamura (Ba) in southern Italy, that 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

1. Introduction

The present study is a small review reported by the authors after a number of safeguarding projects and collecting missions had been carried out, since the 1970s, in all Italian agricultural districts [1,2], including small islands [3] and linguistic areas [4].

1.1. 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 standing 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 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., Protected Designation of Origin (PDO) as the scarlet eggplant (*Solanum aethiopicum* L.), "Melanzana rossa del Pollino", as the common bean "Fagiolo poverello bianco di Rotonda", Protected Geographical Indication (PGI) as the common beans "Fagioli di Sarconi", and Traditional Specialities Guaranteed (TSG) represent 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 of 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 from 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 only 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 places 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 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 collection of Plant Genetic Resources (PGR). They have anticipated policies at national and European level, even if operating in line with the objectives of the principles of the Convention on Biodiversity, failing to implement the simplifications ensured by the Multilateral Systems of the International Treaty (such as most importantly the use of a standard material transfer agreement with standard terms of access and benefit sharing). In Italy, however, in addition to the regions, there are several entities, variously integrated with each other, depending on the territorial dynamics, that 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 programs 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 most 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 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 (e.g., scientific journals, descriptive sheets of Guide Lines by INEA [6]). 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".

1.2. 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 [7].

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, [8]) and the National Research Council (CNR, [9]).

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, as well as 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 centers 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 [10,11].

1.3. PGR Stored by the Research Institutes of the CREA

The MiPAAF (Italian Ministry of Agriculture), to deal with these and other international commitments, 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 (Institution acronyms are explained in Table 1 below.), which, over the years, has established itself as the reference point for the MiPAAF both nationally and internationally with regard to the PGR.

Table 1. Plant genetic resources of agricultural interest and research units of the project "Plant Genetic Resources/Implementation of the FAO Treaty" (modified from [12]).

Plant Genetic Resources	CREA Institutes	No. Accessions (CREA)	CNR Institutes	No. Accessions (CNR)	Other Research Units	No. Accessions ("Semi Rurali")
cereals	ACM, CER, GPG, MAC, QCE, RIS, SCV	17,496	IBBR	34,920	"Semi Rurali" Network	1190 (total, mostly cereals)
vegetables	ORA, ORL, ORT	–	IBBR, ISAFOM	3844	"Semi Rurali" Network	
fruits and nuts	ACM, FRC, FRF, FRU, SCA	8787	IVALSA	6160	"Semi Rurali" Network	
fodder species	FLC	7776	IBBR	6561	–	–
Industrial crops	API, CAT, CIN	2714	–	–	–	–
olive	OLI	3243	IVALSA, ISAFOM, IBBR	2500	–	–
grape	VIT	793	IBBR	119	–	–
ornamental species	FSO, SFM, VIV	266	–	–	–	–
medicinal and aromatic plants	MPF	586	IBBR	448	–	–
forest species	SEL, PLF	3.744	IBBR	5.326	–	–

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), GPG (Unità di ricerca per la genomica e la postgenomica, Fiorenzuola d'Arda), 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, Città S. Angelo e Spoleto), 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 and 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). CNR Institutes belongs to CNR DISBA Department.

In 2004, with the approval of the FAO—International Treaty on Plant Genetic Resources for Food and Agriculture, one of the first binding global agreements on PGRFA in harmony with the CBD, the 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 share 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 centers 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 holds many different plant and microbial collections through its network of institutions.

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 [13] and in vitro conservation.

The documentation of the characterization data regarding PGR is indispensable in making 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.

1.4. PGR Stored by the Research Institutes of the CNR

The National Research Council (CNR) is a public research organization. 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 (International Board for Plant Genetic Resources, today Bioversity International), 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.

1.5. 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 initiatives 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)—which 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 [12].

In April 2013, the DISBA of CNR created BioGenRes, the Italian Network of Genetic Resources [14]. 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 is providing data to EURISCO. The European Search Catalogue for Plant Genetic Resources (EURISCO) provides information on 1.9 million accessions of crop plants and their wild relatives, preserved ex situ by almost 400 institutes. It is based on a network of National Inventories of 43 member countries and represents an important effort for the preservation of the world's agrobiological diversity by providing information about the large genetic diversity kept by the collaborating institutions. The central goal of EURISCO is to provide a one-stop-shop for information for the scientific community and for plant breeders. EURISCO contains both passport data and phenotypic data. EURISCO is being maintained on behalf of the Secretariat of the European Cooperative Programme for Plant Genetic Resources (ECPGR), in collaboration with and on behalf of the National Focal Points for the National Inventories.

2. A General Plan of Action for Italy to Improve the Safeguarding of Crop Genetic Resources

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

1. To develop new (bio) informatics systems that can facilitate both the management of the utilization of stored genetic resources (e.g., finding duplicates of accessions, defining core collections), making them readily available, and doing work together on data of different nature (passport data, evaluation, images, GIS mapping, etc.) to help breeders to select the best parents for their breeding programs.
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 center for the conservation and, if not, developing it also using innovative techniques of in vitro conservation.
4. To establish contacts and to formalize interactions with major international institutions for safeguarding plant biodiversity, such as, CGIAR (Consultative Group on Agricultural Research), Bioversity International, the European Network ECPGR (some important Italian genebanks only a few months ago joined to EURISCO and AEGIS, others have not yet!).
5. 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 organizations 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 have almost been completely replaced by a few commercial varieties. The consequence is the decrease of genetic

variability in the fields. 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.

6. Some additional 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 harmonize 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).

3. Genetic Resources of the Main Vegetables Cultivated in Italy and Their Safeguarding

3.1. Italian Situation

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 providing

genetically improved crop varieties, 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" was 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. More details on the "National Register of Horticultural Varieties", its updated list and the implications for a variety being included in that list are here reported [6].

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 or Attestation of Specificity, GTS or Guaranteed Traditional Specialty), which represent important regulatory instruments to protect consumers and to support small and medium farms.

The whole Italian territory, but particularly inland areas of southern 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 [5].

3.2. 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 of homogeneity of methodological approaches adopted in the collection, classification, measurement, and characterization of the material can be observed. 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 to 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 (e.g., for some crops there are

no experimental data on the best conservation parameters and conditions). 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.

3.3. Some Actions to Take for Solving the Most Critical Factors of Vegetable Landraces

It is very important to guarantee the maintenance and management of existing collections and to survey and to conduct a complete census of ecotypes of vegetable species originating and/or historically present in the regional agricultural areas, in the way of what regional laws foresee. 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, fiber, 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, and to study and develop 'specific' methodologies and equipment for the seed preservation, to ensure the integrity of the genetic material in the long term. For example: (a) are we sure that we can store in the same storage room about 1000 different species (this is common in many genebanks) thinking that the climatic parameters used, are the best for all of them? (b) many wild relatives of pulses need specific rhizobium to grow but usually genebanks do not care for this; (c) the same for plants that need specific pollinators, no part of genebank is dedicated to them; (d) almost no genebanks monitor the genetic erosion which occurs in them!

Some multiplication problems can be solved by 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 effective and unique '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 on the best characteristics of traditional products under investigation, and pilot actions to diffuse the cultivation of the most typically 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) 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 (this is the aim of the AEGIS, the European Genebank Integrated System, of which Italy is a member); (d) to prepare guidelines for the definition of a program 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 (in this respect the national guidelines of the "Piano Nazionale sulla Biodiversità di Interesse agricolo", is too general); (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, as defined also by the National Law on Agriculture and Food Biodiversity N.194, of 2015; (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).

4. Conclusions

This study attempted, above all, to provide a summary, with a strictly scientific basis, on 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. This phenomenon applies to 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 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 (at the moment this support is still ineffective). 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 territory management seriously and concretely oriented to sustainability.

5. 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 in the cultivation systems of many countries. Many cultivated *Brassicaceae* and especially broccoli are rich in antioxidant compounds that play a key role for human health especially in traditional cuisine [15]. Italy is widely regarded as the center of genetic diversity for several cultivated *Brassicaceae*, 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 [16,17] and wild [18,19].

This rare landrace of *Brassica oleracea* was found in the 2014 (Figures 1–3) in Altamura (Bari) and for the first time a preliminary characterization was made. It is called "Mugnolicchio" or "Mignolicchio" and is cultivated traditionally in the Altamura area (Apulia region, southern Italy).

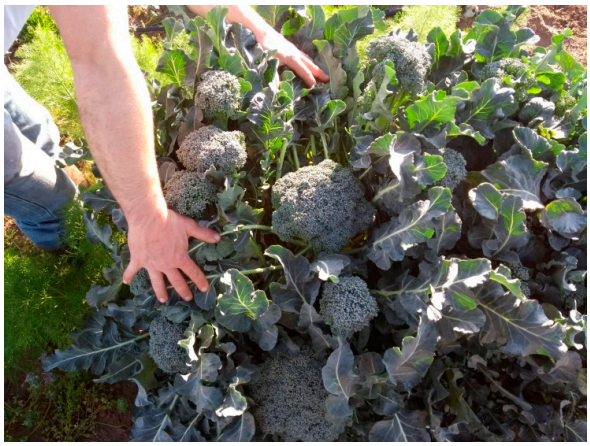

Figure 1. Different big inflorescences of "Mugnolicchio" in the same plant.

Figure 2. Plant and inflorescences of "Mugnolicchio".

Figure 3. Flowers of "Mugnolicchio".

"Mugnolicchio" is similar to the broccoli of which, according to recent investigations, it is (probably with "Mugnoli" of Salento—Figure 4), the progenitor from which the latter were selected.

However, 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 [20].

Figure 4. "Mugnoli" of Salento.

Morphologically it is clearly distinguishable from the broccoli (Figures 5–7) for the smaller and less compact inflorescence; the single flowers of the "Mugnolicchio" are white, larger and with bracts larger than those of broccoli. Its organoleptic characteristics are peculiar too and often people prefer it to broccoli. There are many traditional recipes with "Mugnolicchio" in the AltaMurgia area, all aimed to extoll its sweet and aromatic flavor.

"Mugnolicchio" is a relict landrace because in the area of Altamura (Ba) its cultivation is decreasing (Figures 8 and 9). The standardization of modern cultivars caused a rapid decline of this landrace unable to compete in the market because of its small inflorescences and lack of scalar production. Nowadays it is still produced by small farmers for family use, and very much appreciated by local people.

Figure 5. Commercial broccoli variety.

Figure 6. Height difference from "Mugnolicchio"(left) and broccoli (right).

Figure 7. Cultivation of "Mugnolicchio".

Figure 8. Cultivation of "Mugnolicchio".

It is still cultivated in small plots of land by some horticulturists. It is sown in August and transplanted in autumn in order to collect the inflorescences from March onwards. The plant can be grown for four years, after that it is replaced. In the past, farmers sowed this crop to separate their own plots from neighboring areas, as a kind of demarcation. Some plants were also sown in April for the exclusive use of the fleshiness of the leaves in summer, cooking them with pasta, mainly when in the middle of summer there are no other cultivated *Brassicacae*. There are two morphological types cultivated in the same area. Until now only the morphotype with smooth and slightly lobed leaves is stored in a genebank (i.e., in Bari at IBBR-CNR). One morphotype is characterized by smooth and slightly lobed leaves (Figure 9), the other one by fleshy and very lobed leaves (Figure 10). This last morphotype is probably the typical landrace of the past, because the characteristics of the leaves would make it more appreciated for food.

Figure 9. Morphotype with smooth and slightly lobed leaves.

Figure 10. Morphotype with fleshy and very lobed leaves.

The case of "Mugnolicchio" is only one out of a number of other examples of old Italian landraces that are now being broadly cultivated, as the lentil "Lenticchia di Altamura" [21], the common beans "Fagioli di Sarconi" [22] and "Fagiolo poverello bianco di Rotonda" [23], the scarlet eggplant (*Solanum aethiopicum* L.) "Melanzana rossa del Pollino" [24], the eggplant "Melanzana Bianca di Senise" [25], the old agroecotypes of potato of the Pollino National Park [26], hulled wheat (*Triticum dicoccon* Schrank and *T. spelta* L.) [26,27], etc.

Author Contributions: K.H. and G.L. conceived and designed the study; all authors performed the exploration and collecting missions used as source of data and information to write the article; K.H. analyzed the data; G.L., K.H., V.M., and P.D. wrote the paper.

Acknowledgments: This study was supported by the project "Implementazione del Trattato Internazionale FAO sulle Risorse Genetiche Vegetali per l'Alimentazione e l'Agricoltura' (RGV-FAO) funded by the Italian Ministry of Agriculture (MiPAAF).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Hammer, K.; Knüpffer, H.; Laghetti, G.; Perrino, P. *Seeds from the Past. A Catalogue of Crop Germplasm in South Italy and Sicily*; Germplasm Institute of C.N.R.: Bari, Italy, 1992; pp. II–173.
2. Hammer, K.; Knüpffer, H.; Laghetti, G.; Perrino, P. *Seeds from the Past. A Catalogue of Crop Germplasm in Central and North Italy*; Germplasm Institute of C.N.R.: Bari, Italy, 1999; pp. IV–254. ISBN 88-900347-0-X.
3. Hammer, K.; Laghetti, G. *Small Agricultural Islands and Plant Genetic Resources—Le Piccole Isole Rurali Italiane*; IGV-CNR: Bari, Italy, 2006; pp. X–246. ISBN 88-900347-4-2.
4. Hammer, K.; Laghetti, G.; Pignone, D. *Linguistic Islands and Plant Genetic Resources—The Case of the Arbëreshë*; ARACNE: Rome, Italy, 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*, 701–716. [CrossRef]
6. Ministero delle Politiche Agricole Alimentari e Forestali. *Linee Guida per la Conservazione e la Caratterizzazione della Biodiversità Vegetale, Animale e Microbica di Interesse per L'agricoltura*; INEA—Piano Nazionale sulla Biodiversità di Interesse Agricolo: Roma, Italy, 2013.
7. Hammer, K.; Laghetti, G. Genetic erosion—Examples from Italy. *Gene. Res. Crop Evol.* **2005**, *52*, 629–634. [CrossRef]
8. CREA. Available online: http://www.crea.gov.it/?lang=en (accessed on 30 June 2018).
9. CNR. Available online: https://www.cnr.it/it (accessed on 30 June 2018).
10. Aitken-Christie, J.; Kozai, T.; Smith, M.A.L. (Eds.) Glossary. In *Automation and Environmental Control in Plant Tissue Culture*; Kluwer Academic Publishers: Dordrecht, The Netherlands, 1995; pp. IX–XII.
11. 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 Organ. Culture* **2007**, *88*, 117–120.
12. 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: Roma, Italy, 2010; ISBN 978-88-448-0416-9.
13. Lambardi, M.; de Carlo, A. Tecniche ed applicazioni della criogenia alla conservazione ed al risanamento di germoplasma vegetale. *Italus Hortus* **2009**, *16*, 79–98.
14. BioGenRes. Available online: http://www.biogenres.cnr.it (accessed on 30 June 2018).
15. Nicoletto, C.; Santagata, S.; Pino, S.; Sambo, P. Antioxidant characterization of different Italian broccoli landraces. *Horticult. Bras.* **2016**, *34*, 74–79. [CrossRef]
16. Laghetti, G.; Hammer, K.; Olita, G.; Perrino, P. Collecting vegetable crops in Basilicata, Italy. *Plant Genet. Resour. Newslett.* **1993**, *96*, 35–37.
17. 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, Wellesbourne: Warwick, UK, 1993.
18. Gustafsson, M.; Gomez-Campo, C.; Perrino, P. Germplasm conservation of the wild Mediterranean *Brassica* species. *J. Swed. Seed Assoc.* **1986**, *26*, 347–360.
19. Perrino, P.; Pignone, D.; Hammer, K. The occurrence of a wild *Brassica* of the *oleracea* group (2n = 18) in Calabria (Italy). *Euphytica* **1992**, *59*, 99–101. [CrossRef]
20. Laghetti, G.; Martignano, F.; Falco, V.; Cifarelli, S.; Gladis, T.; Hammer, K. "Mugnoli": A neglected race of *Brassica oleracea* L. from Salento (Italy). *Genet. Resour. Crop Evol.* **2005**, *52*, 635–639. [CrossRef]

21. Laghetti, G.; Volpe, N.; Sonnante, G.; Pignone, D.; Sonnante, G. On the old Apulia lentil agroecotype 'Lenticchia di Altamura' (Apulia, Italy). *Italus Hortus* **2006**, *13*, 467–471.
22. Piergiovanni, A.R.; Brandi, M.; Cerbino, D.; Olita, G.; Laghetti, G. The agro-ecotypes of common bean from Sarconi and Rotonda (PZ). Results of a triennal agronomic and biochemical study. (Gli agro-ecotipi di fagiolo di Sarconi e Rotonda (PZ). Risultati di una sperimentazione agronomica e biochimica triennale.). In Proceedings of the V National Congress on Biodiversity "Biodiversità e Sistemi Ecocompatibili", San Leucio (CE), Italy, 9–10 September 1999; Volume 13, pp. 571–578.
23. Brandi, M.; Cerbino, D.; Laghetti, G.; Piergiovanni, A.R.; Olita, G.; Rizzi, R.; Martelli, S. Una carta di identità per il fagiolo di Sarconi e Rotonda. *Inf. Agrar.* **1998**, *27*, 55–61.
24. Laghetti, G.; Hammer, K.; Brandi, M.; Cerbino, D.; Olita, G.; Perrino, P. Ritrovamento di una coltivazione di melanzana africana. *Inf. Agrar.* **1995**, *39*, 52.
25. Cerbino, D.; Laghetti, G.; Piergiovanni, A.R. Studi morfologici e biochimici per rilanciare la 'Melanzana Bianca di Senise'. *Agrifoglio* **2010**, *37*, 38–39.
26. Cerbino, D.; Illiano, M.; Cirigliano, M.; Di Napoli, A.; Zienna, P.; Gallo, S.; Laghetti, G.; De Lisi, A.; Direnzo, P.; Giunta, R.; et al. *Le Antiche Varietà di Patata del Pollino*; Laghetti, G., Cerbino, D., Eds.; I Quaderni dell'ALSIA n.12/2016—Supplement to N. 55 of Agrifoglio; ALSIA: Matera, Italy, 2016; Volume 124, ISBN 978-88-95110-20-2.
27. Perrino, P.; Volpe, N.; Laghetti, G. "Lucanica" e "Forenza": Due nuove varietà di farro. *Inf. Agrar.* **1996**, *47*, 34–35.