Genet Resour Crop Evol (2012) 59:701–716
DOI 10.1007/s10722-011-9712-7

RESEARCH ARTICLE

Landraces in Inland areas of the Basilicata region, Italy: monitoring and perspectives for on farm conservation

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Received: 30 October 2010 / Accepted: 6 June 2011 / Published online: 19 July 2011

Abstract A collecting expedition has been carried out in the inland areas of the Basilicata Region, South Italy. Each of the 14 selected municipalities was subdivided in three *strata* based on the geographical distribution of population and orography: 1. city boundaries, 2. group of country houses, 3. isolated farm houses. Five sites were selected within each stratum/town for a total of 185 sites. In 101 sites crop species germplasm was collected and the farmer-maintainers were interviewed. Altogether 350 accessions were collected, the most common species were *Capsicum annuum*, *Lycopersicon esculentum* and *Phaseolus vulgaris*. A significant number of landraces are still preserved on farm, mostly in isolated farm houses (average age of farmers: 60 years) adopting traditional farming systems but a number of young farmers were also present. Perspectives for *on farm* conservation and management are discussed and public economic support for "farmer-maintainers" proposed.

Keywords Germplasm collecting · Landraces · On farm conservation · Home gardens · Farmer-maintainer · Regional law

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Introduction

Landraces of many species evolved as the result of adaptation to highly diversified growing environments. They have a distinct genetic identity, are often morphologically recognisable and farmers have specific names for them (Frankel et al. 1995). Farmers' seeds are usually lumped together under the name landraces and they can refer to the traditional origin, the diversity and value for breeding: *a landrace is a proxy for genetic resource* (Brush and Meng 1998); landraces are evolving populations (Berg 2009) grown in remote areas or in small garden plots and, in agreement with Zeven (1998) about the garden-race: remote to those trying to collect, but not for the growers themselves.

The survival of agroecotypes occurs in areas where traditional forms of agriculture are still being practiced and are often associated to the presence of old farmers and their traditions such as dishes prepared with local varieties, religious traditions or

therapeutic applications (Brush and Meng 1998; Negri 2003). Their merits are, from the farmers' view, adaptation and yield stability (Harlan 1975; Brush 1995; Zeven 1998; Saxena and Singh 2006).

A large amount of germplasm of many plant species is still being conserved on farm in Southern Italy and especially in the Basilicata region, where a great number of accessions have been collected and are now conserved in *ex situ* gene banks (Perrino et al. 2004). Over the last years many collecting missions and ethnobotanical studies have been organized in this region (Montesano et al. 2010), with different aims as: (1) to collect and to study landraces, old (folk) varieties or indigenous forms of garden and open field cultivated plants, especially cereals, pulses and grain legumes, vegetables, medicinal and spice plants and related wild relatives to obtain a more complete picture of local plant genetic resources (Hammer and Perrino 1984; Hammer et al. 1989, 1990, 1992, 1996, 2000; Hammer and Laghetti 2005; Laghetti et al. 1993, 1995, 1998; Limongelli et al. 1996; Logozzo et al. 2001; Masi et al. 1999; Perrino and Hammer 1982, 1983, 1985; Perrino et al. 1982, 1984, 2004; Piergiovanni and Laghetti 1999; Piergiovanni et al. 2000; Figliuolo and Masi 2004, Figliuolo et al. 2001, 2006; Montesano et al. 2009) and (2) to obtain ethnobotanical, ethnoveterinary and ethnomedical information on the local plants to document folk agricultural and domestic usages of the plants (Guarrera 2006, Guarrera et al. 2006; Pieroni et al. 2004, Pieroni and Quave 2005; Salerno et al. 2005).

The results of the collecting missions conducted over the last 30 years across the Basilicata region have shown that genetic erosion has been very fast in cereals and other major fields crops, while it is less pronounced in horticultural and minor garden crops which are often preserved in home gardens and at the boundaries of larger cultivations. Another important finding emerging from these surveys is that the transmission of traditional knowledge linked to these plants is subject to continued decline across generations and it is speculated that its loss will be very dramatic in coming years due to the disappearance of aged people who have been safeguarding it insofar. Moreover it has emerged that the particular isolation of the inland mountainous in so far areas of the region and their economy, which is still partially based on small-scale agricultural and pastoral activities (sheep, and to a decreasing extent, the "Podolica" cattle), represents a good opportunity for conducting studies about local varieties and/or the local traditional knowledge linked to these species (Pieroni et al. 2004, Pieroni and Quave 2005).

It is assumed that *ex situ* conservation preserves the genetic diversity as it is at the time of collection. However the risk of genetic erosion is high during seed conservation and especially during periodical regeneration of seeds (Spagnoletti Zeuli et al. 1995; Masi and Spagnoletti Zeuli 1999).

On farm conservation allows the preservation of evolutionary processes that generate new gene combinations under natural and/or traditional farming selection, and is best viewed as a complement to, rather than a substitute for, *ex situ* conservation (Brush 1995; Hamilton 1994; Hawkes 1991; Maxted et al. 1997). *In situ* conservation is immediately useful for local people and it is cost-efficient compared with *ex situ* conservation (Backes et al. 2009). On farm conservation could serve to support and preserve cultural traditions, mitigate the effects of pests, diseases and other environmental stresses, and provide new genetic material in the face of future environmental or economic change (Jarvis et al. 2000).

Landraces, however, survive alongside modern varieties if they are characterised by distinctive traits that make them relevant in the farming system or demanded in the market. On farm conservation of folk varieties can be encouraged by means of interventions in the farming and seed supply systems (Berg 2009; Pistorius 1997).

Recently the European Community has provided new funding to support the on farm conservation of plant genetic resources of cultivated species; specifically we refer to the Commission Directive 2008/62/EC of 20 June 2008, providing for *certain derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties* and to the Council Regulation (EC) No 74/2009 of 19 January 2009 amending Regulation (EC) No 1698/2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD).

In Italy national and regional projects have been developed accordingly. Based on a Regional Law (Regional Law RL 64/2004), a system of protection

of the landraces and local varieties on farm, was implemented in Tuscany, a region of northern Italy, where farmers maintainers were identified to rejuvenate and to preserve the seeds stored at the regional gene bank (Regione Toscana 2004). Over time, more similar Regional Laws (RL) have been implemented (Regione Lazio 2000; Regione Umbria 2001; Regione Friuli Venezia Giulia 2002; Regione Marche 2003), and recently also Basilicata (Regione Basilicata 2008) voted in favour of financial support for activities related to genetic resources conservation.

Due to social and technological changes, also in the Basilicata region genetic erosion has occurred during the second half of the last century (Hammer et al. 1996; Piergiovanni and Laghetti 1999) but still today orography and the lack of good roads are a major limit to exchange with neighboring regions. Seed trade is mostly restricted to local markets, traditional forms of agriculture are still practiced and many locally adapted varieties are still grown. Probably the tall mountainous agglomerates that characterizes the regional morphology has conserved the ecology and agriculture by hindering access (Laghetti et al. 1993). Compared to other Italian agricultural areas, Basilicata is likely still affected by crop genetic erosion because of geographical, historical and cultural factors (Laghetti et al. 1998).

In the light of the topics discussed above we can state: (1) South Italy, and the Basilicata Region in particular, is an important centre for plant genetic resources, (2) the process of genetic erosion is affecting all crops, (3) but garden crops have a good chance for on farm conservation, because genetic erosion does not proceed quickly and, thus, it is possible to find still a high amount of biological diversity, while the high speed of genetic erosion for the open field crops does not allow a similar approach, and (4) in the inland mountainous areas of the region, landraces are still cultivated as if the mountainous areas provide suitable niches for their preservation.

Despite many collecting missions and ethnobotanical studies that have focused in Basilicata, it is possible to underline a need of studies based on the effort of conservation activities and on creating the possibility for maintaining landraces on farm; researchers used to visit the territory crossing the roads and, in many cases, taking the useful information from local people or by local expert met during their runs, taking the materials principally from fields and farmers' stocks and, occasionally, from local market-places.

It is, in fact, fundamental to plan conservation activities and without monitoring is difficult to verify the success of conservation.

Objectives of the study

The study has been carried out in the territory of 14 towns in inland areas of the Basilicata Region with the aims: (1) to assess the presence of on farm plant genetic resources, (2) to determine the species and the amount genetic diversity still cultivated and their territorial distribution, (3) to study within the territory of each town, the distribution of sites where germplasm is preserved and (4) to obtain information from germplasm owners to be used to evaluate the feasibility of on farm conservation program that could be supported by the already approved LR 26/2008 above mentioned.

Methodologies

Before implementing an on farm conservation programme it is necessary to understand the factors that influence the level of crop genetic diversity. In fact while *ex situ* conservation is functional to preserve germplasm, a complex range of factors, over time, influences the conservation of genetic diversity in farmers' fields, such as the farmers' decision-making, the local environmental changes and the interactions between and within crop populations.

Identification of collecting sites: the distribution of population

Basilicata (historically known as Lucania), a region of southern Italy bordering the Tyrrhenian and Ionian Seas, is divided into two Provinces: Potenza and Matera. It is bounded by the regions of Puglia (north and east), Calabria (south) and Campania (west). The territory is roughly divided into a mountainous western section, which is dominated by the Lucano Appennine, an eastern section of wide valleys and low hills and flat plains to the south along the Ionian Sea (Fig. 1).

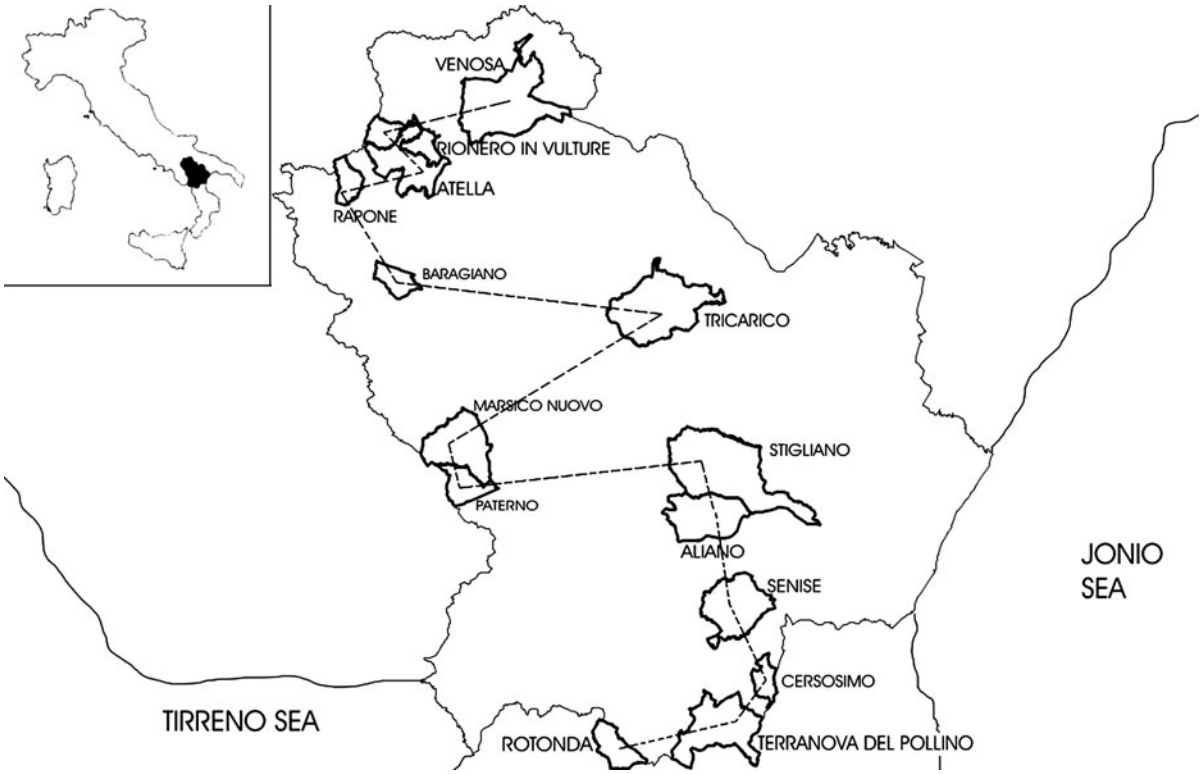

Fig. 1 Geographical position of Basilicata and towns visited during the collecting mission

The region covers 9,994 square km and, based on the 2001 census of the Italian National Statistical Institute (ISTAT), updated to 2005, has a population of about 597,768 inhabitants and has one of the lowest Italian percentage of urban population (17%), one of the lowest average demographic density (60 inhabitants per square Km), one of the highest life expectancy (75.7 years) and the migratory dynamics rate (incoming–outcoming) is -2%. Population aging is occurring, and the region old-aged index is 118.90 (the number of over 60 years old is higher than those under 14 years old). The aging of the population is measured as decrease of the rate of generational exchange: every 100 elderly people, there are only 72 young people under the age of 14 years (ISTAT 2001).

The Lucano Appenine (whose altitude does not exceed 2,000 m a.s.l) divides the Region into two climatic areas: east, flat with high values of aridity, and center-west, hilly and mountainous, more rainy and, with lower values of aridity (Cantore et al. 1987; Bove et al. 2005).

Fourteen towns in the inland central-western area of the Basilicata province were the focus of a collecting mission (Montesano et al. 2009). These towns were selected for the overt strong genetic erosion that characterized their territories (Stigliano, Tricarico, Venosa, Rionero in Vulture and Atella) or because of their richness in agricultural biological diversity (Rapone, Baragiano, Marsico Nuovo, Paterno, Rotonda, Terranova del Pollino, Cersosimo, Aliano and Senise).

The selected towns and their territories were submitted to ecological and socio-economical analysis: landscape, climate and socio-economical information were obtained. The territories under study were 1,274.69 square km (13% of the whole region), 56% of which is agricultural land. A wide variety of environments were present ranging from 200 to 1.100 m a.s.l.: eight towns were classified in the altimetric typology "Mountain" (>600 m a.s.l.) while six were "Hill" (<600 m a.s.l.). The climate of the territories was "Mediterranean" (very dry summers and rainfall mostly during the autumn–winter period), with marked winter (4–6 months with mean temperature near 10°C) and moderate temperatures during the summer (mean temperature of

20–24°C) but very dry (summer rains about 150 mm). The annual rainfall average was 730 mm, ranging between the 416.1 mm of Senise and 1,211.1 mm of Terranova di Pollino (Petrarca et al. 1999; Fiorenzo et al. 2008) (Table 1).

Total population of the areas under study was 68,784 inhabitants, the resident population density range was 13.3–252.7 inhabitants per square km and the medium old-aged index is 150.9% (higher than the whole region), ranging between 84.83% in Senise and 258.16% in Aliano. As showed in Table 2, families are distributed alongside the whole territory of the towns: people live principally in the inhabited centre (85.7%), only 3.3% live in groups of country houses, that are groups of houses distant from the inhabited centre in which farmers usually live and small activities of tourist reception or other urban services are practiced. This form constitutes an intermediate between centralization of inhabited centre and dispersal of isolated houses and may have agricultural or other functions. Of the families 9.2% live permanently on the farms, isolated and surrounded by their own fields; this is the typical distribution of populations in the rural small towns of the region: many families still have a strong connection with traditional agricultural and pastoral activities.

Based on this information and focusing attention to determine the genetic diversity of species still preserved and their territorial distribution, in order to improve the efficiency in the collection and to get a better definition of the on farm conservation strategy, the collecting mission was setted as follows: by means of GIS software GvSig 1.1 (GvSig 1.1 2007) the whole territory of each selected town was subdivided in three *strata*, based on the geographical distribution of population and on the orography: 1. city boundaries, 2. groups of country houses, and 3. isolated farm houses. From each of these *strata* five sites were randomly sampled from a grid representative of the parameters cited above. In five towns the *stratum* "group of country houses" was not present. In total 185 sites for the collecting expedition were identified.

This new methodological approach we have proposed represents the novelty of our collecting mission in this region. In fact, we wanted to introduce a method based on the "pre-determination" of sites to be explored, selected not *"by chance"* or by the help of key informants—mainly local authorities that dealt with farming and people in charge of cultivation of local ecotypes—but according to preliminary economic and social investigations of the countries.

Germplasm collection

At each selected site, where farmers donated a seed sample, passport data was recorded (altitude, longitude, latitude, local name of the site, soil texture, purpose of cultivation). Farmers were interviewed to

Table 1 Ecological data of the selected towns of the inland areas of Basilicata region

Towns	Rainfall (mm)	Temperature		Altitude (m a.s.l.)	Surface area (km^2)	UAA (km^2)	UAA/surface (%)
		Min (°C)	Max (°C)				
Rotonda	803.2	7.5	15.8	580	42.33	20.51	48.5
Terranova di Pollino	1,211.1	7.4	14.8	926	112.30	52.82	47.0
Cersosimo	732.0	6.2	17.5	548	24.65	8.60	34.9
Paterno	514.7	7.6	17.5	644	39.25	18.48	47.1
Marsico Nuovo	719.5	8.5	17.0	780	101.03	29.21	28.9
Senise	456.1	8.6	18.9	335	96.61	33.83	35.0
Aliano	719.4	7.9	15.9	555	96.29	61.61	64.0
Stigliano	623.3	8.3	16.2	909	209.96	149.63	71.3
Tricarico	525.2	9.2	18.8	698	176.93	104.95	59.3
Baragiano	840.7	6.0	16.2	624	29.45	15.78	53.6
Rapone	914.0	6.9	16.4	838	29.14	13.30	45.6
Atella	750.8	6.3	16.9	500	88.28	47.63	54.0
Rionero in Vulture	760.5	8.2	18.5	656	59.13	30.48	51.5
Venosa	612.3	8.9	18.9	415	169.34	126.24	74.5

Table 2 Distribution of inhabitants over the territory of 14 towns in the inland areas of Basilicata region, South Italy

Towns	Population (n)	Demographic density (inhab./km^2)	Old-aged index (%)	Farms (n)	Families (n)		
					City boundaries	Group of country houses	Isolated farm
Rotonda	3,882	91.8	140.41	745	759	174	561
Terranova di Pollino	1,534	13.7	188.52	547	500	0	158
Cersosimo	847	34.4	189.17	202	341	0	15
Paterno	3,991	101.8	109.15	529	1,213	125	115
Marsico Nuovo	5,119	50.8	153.00	989	992	782	178
Senise	7,172	74.3	84.83	721	2,151	0	150
Aliano	1,284	13.3	258.16	518	457	29	33
Stigliano	5,605	26.7	211.64	1,421	2,241	55	53
Tricarico	6,185	35.7	142.98	1,000	1,926	32	59
Baragiano	2,741	93.4	136.34	268	650	0	431
Rapone	1,200	41.3	187.28	228	334	0	139
Atella	3,722	42.2	103.79	398	1,183	52	132
Rionero in Vulture	13,403	252.7	105.60	667	4,582	7	149
Venosa	12,099	71.7	102.00	1,800	4,152	0	131

The number of inhabitants, the old-aged index, the demographic density and the number of farms are reported. The distribution of families in three classes of houses is also shown

obtain information about their life (age, family structure, work), about their farm (crops grown, management, etc.), about the landraces (local name, adaptive, agronomic and qualitative traits, etc.) and information related to the use, traditions and social context of the species and on the purpose of the conservation.

Species identification was according to the "Flora d'Italia" by Pignatti (Pignatti 1982) and its nomenclature was updated by Conti et al. (2005) and Bianco and Pimpini (1990).

Back at base, each collected accession was subjected to standard conservation procedures: seeds were cleaned and vacuum sealed in packets and stored in a cold room at +4°C (Toll 1995).

Data analysis

To quantify diversity, or rather the "richness in diversity" was used the H diversity index of Shannon–Weaver. This index provides a measure of rarity or abundance of a species in a community through a single number (Magurran 1988; Jarvis et al. 2000). The index is calculated using the following formula:

$$H - \Sigma p_i \ln(p_i)$$

where p_i is the proportion of the i-th species on the total number of species, and ln is the symbol of the natural logarithm. The higher the richness or biodiversity in a given territory, the higher the H. H is zero if there are no accessions belonging to one species. Also considered were two other factors: the species richness (S), which is the number of collected species, and total abundance (A) of accessions found in a given territory. The H index was estimated for each of the fourteen towns and for each *strata*; because of its additivity properties, this measure is useful in studies on germplasm resources (Jain et al. 1975).

Descriptive statistical analysis and analysis of variance of the collected data were performed with SAS 9.1 (Statistical Analysis System 2003).

Results

Germplasm collection

Out of 185 explored sites, only in 101 sites were grown landraces and in all instances seeds could be obtained.

Three-hundred-fifty accessions from 36 different crop species were collected, belonging to 10 botanical Family, of which Solanaceae was the most

represented (38%) followed by Leguminosae (21%) and Cucurbitaceae (18%), others are shown in Fig. 2.

The largest number of accessions collected in one site was 11 ("C. da Destra delle Donne" in Terranova di Pollino), five of these were common bean. Only one vegetable accession was kept in nine sites. In most sites three to five accessions were obtained.

All the collected accessions were grouped in classes as follows (Table 3): vegetable crops (VC): lettuce, chicory, cabbage, sprouting broccoli, savoy cabbage, rocket, beet, melon, watermelon, fennel, cucumber, pumpkin and zucchini, bottle gourd, onion, garlic, tomato, pepper, hot pepper, eggplant, scarlet eggplant, stubble turnip, mustard and endive; pulses (P): common bean, peas, chickpea, beans, grasspea, lentil; cereals (C): corn and wheat; spices (wild and cultivated) (S): basil, parsley, celery, oregano. VC (66.7%) and P (16.6%) (largely common bean) were the most abundant both in number of species and in accessions collected.

Of all the collected accessions, three species were the most frequent: tomato (*Lycopersicon esculentum* Mill.) 19.7%, common bean (*Phaseolus vulgaris* L.) 18.9% and pepper (sweet and hot) (*Capsicum* spp.) 16.6%. Along with traditional garden crop vegetables, other species were collected: scarlet eggplant (mock tomato, *Solanum aethiopicum* L.), mustard (*Sinapis* spp.) and one accession of oregano.

Concerning the species, tomato and pepper were collected in all locations except in the territory of Cersosimo (PZ).

Tomato (*Lycopersicon esculentum* Mill.) was the most collected and had many different forms, characterised by different fruit shape, size and colour are cultivated. Large size fruits are used for fresh consumption while many small-sized fruits are utilized for winter storage (called in vernacular language *"pummodor d'inverno"* or *"vernili"*).

Sweet pepper (*Capsicum annuum* L.) represented 70.7% of the total Capsicums collected and had a widespread diffusion (ranging between 280 to 1100 m a.s.l.). Hot peppers (*Capsicum* spp.) were collected mostly at Senise, Rotonda and towns at lower altitude (between 280 and 692 m a.s.l.). Almost all the sweet pepper accessions have a thin epicarp, to be easily dried and then stored as "*serte*" (necklaces of dried fruits) (Fig. 1); the fruits are harvested and dried in necklace form during the summer, and crisply fried in olive oil and eaten all over the year as a main dish; the diffusion of this species is also due to the use as spice to flavour locally prepared pork dried meat such as sausages and hams.

Also Cucurbits (*Cucurbita maxima* Duch. ex Lam., *Cucurbita moschata* Duch. ex Lam. and *Cucurbita pepo* L.) were widespread and were collected everywhere but in Paterno. Great variation

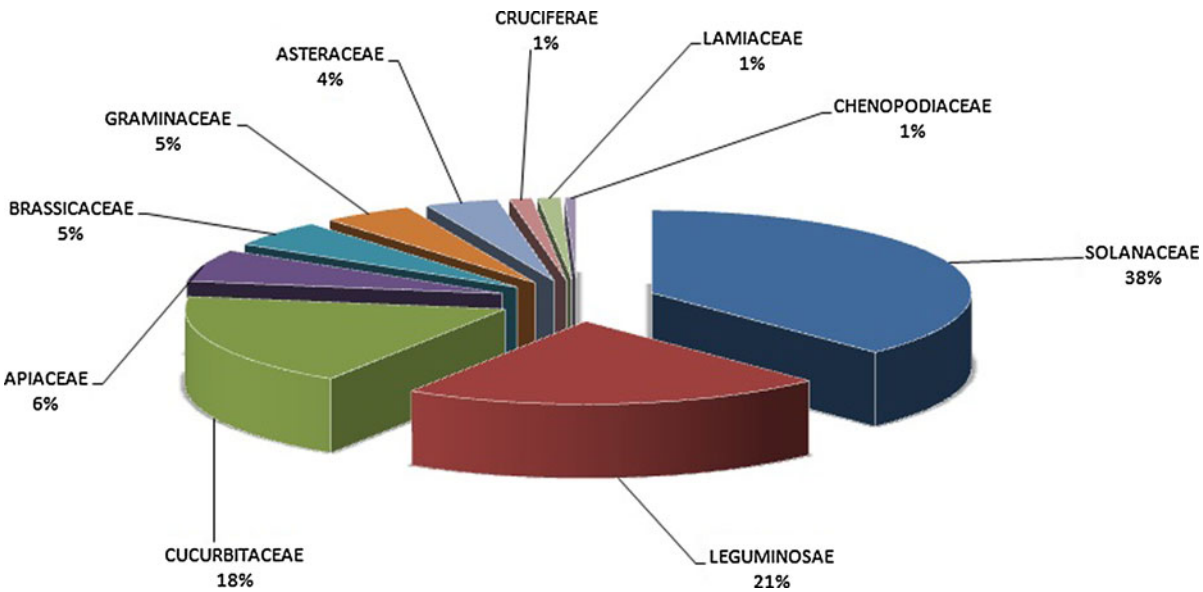

Fig. 2 Botanical families to which belong the 350 accessions of species collected on farm in the inland areas of Basilicata region

Table 3 Number and frequency of the accessions (grouped in classes) of 36 species collected in the territory of 14 towns in inland areas of Basilicata region, South Italy

Common name	Crop	Classes	Accessions (n)
Tomato	*Lycopersicon esculentum* Mill.	VC	69
Common bean	*Phaseolus vulgaris* L.	P	66
Pepper	*Capsicum* spp.	VC	58
Pumpkin and Zucchini	*Cucurbita* spp.	VC	47
Corn-Maize	*Zea mays* L.	C	15
Broad Bean	*Vicia faba* L.	P	4
Chickpea	*Cicer arietinum* L.	P	2
Grasspea	*Lathyrus sativus* L.	P	1
Lentil	*Lens culinaris* Medik.	P	1
Pea	*Pisum sativum* L.	P	1
Durum Wheat	*Triticum durum* (Desf.)	C	1
Sunflower	*Helianthus annuus* L.	VC	3
Stubble turnip	*Brassica rapa* L. em. Metzg. subsp. *Óleifera* (DC.) Metzg.	VC	9
Melon	*Cucumis melo* L.	VC	8
Parsley	*Petroselinum crispum* (Mill.) Nym.	S	7
Celery	*Apium graveoleus* L. var. dulce (Mill.) Pers.	S	6
Lettuce	*Lactuca sativa* L.	VC	5
Cucumber	*Cucumis sativus* L.	VC	4
Scarlet eggplant	*Solanum aethiopicum* L.	VC	4
Onion	*Allium cepa* L.	VC	4
Endive	*Cichorium endivia* L.	VC	4
Rocket	*Eruca sativa* Mill.	VC	4
Mustard—senape	*Sinapis* spp.	VC	4
Bottle gourd	*Lagenaria siceraria* (Molina) Standl.	VC	3
Basil	*Ocimum basilicum* L. subsp. *minimum* (L.) Danert	S	3
Fennel	*Foeniculum vulgare* Mill.	VC	3
Cabbage	*Brassica oleracea* var. *capitata* DC.	VC	3
Eggplant	*Solanum melongena* L.	VC	2
Beet	*Beta vulgaris* L.	VC	2
Water melon	*Citrullus lanatus* (Thunb.) Matsum. et Nakai	VC	1
Shallot	*Allium ascalonicum* auct. non L.	VC	1
Garlic	*Allium sativum* L.	VC	1
Chicory	*Cichorium intybus* L.	VC	1
Sprouting broccoli	*Brassica oleracea* L. var. *italica* L.	VC	1
Savoy cabbage	*Brassica oleracea* L. var. *sabauda* L.	VC	1
Oregano	*Origanum vulgare* L.	S	1
Total classes	VC	24 (66.7%)	242 (69.1%)
	P	6 (16.6%)	75 (21.4%)
	C	2 (5.6%)	16 (4.6%)
	S	4 (11.1%)	17 (4.9%)
Total		36	350

VC vegetable crops, *P* pulses, *C* cereals, *S* spices

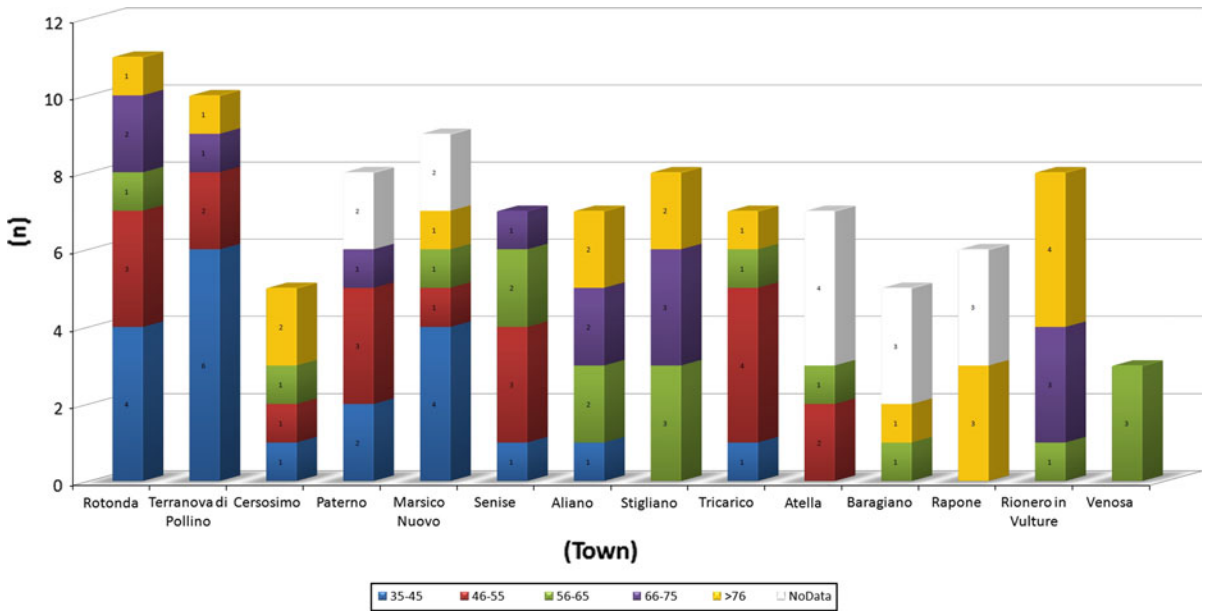

Fig. 3 Absolute frequency of farmer-maintainers according to their age class interviewed in the inland areas of Basilicata region, South Italy ($\chi^2 = 323.14$, $^{***}P < 0.001$)

of fruit shape has been observed in all areas; today cucurbits are not very important crop and the most common types grown are: one with large fruits used as vegetables and as fodder for animals and others with smaller fruits ("*zucchini*") used as vegetables. In many cases, farmers cultivate pumpkin (*Cucurbita pepo* L.) because their young shoots are harvested in May, lightly boiled, fried with garlic and olive oil, and then consumed with home-made noodles.

Eggplant (*Solanum melongena* L.) accessions were collected only in Senise and Paterno, new cultivars are replacing the old landraces.

All Common bean accessions but two (97%) were collected in the south-western part of the region in towns that are very close to each other (Terranova di Pollino—Cersosimo—Rotonda, Marsico Nuovo—Paterno, Atella—Rionero in Vulture). Supposedly the spread of this species was facilitated by territorial contiguity and similarity of environments, in fact all the accessions were collected at sites between 515 and 1,100 m a.s.l. Seeds show great variation in colours and colour pattern and are grown mostly for dry bean production, only the types with small seed are used for green pod consumption.

Variable landraces of maize (*Zea mays* L. convar. *mays* and *microsperma* Körn.) have been often found, mostly in the mountainous parts (average elevation 603 m a.s.l.) of the study area. Great variation in the colours of the grain and in the height of the plants was observed. The grains are used as a fodder for animals or as vegetables. Many landraces are still cultivated because of their early ripening cycle, required for the resistance to the cold climate.

The vegetable crop species that were collected mostly (87.8%) in the towns near the Appenine crest, characterized by similar climatic mean data, showed low variability, this is probably because their spread is localised to similar environments.

As to the frequency of the predominant collected species (>10 accessions): *Lycopersicon esculentum, Phaseolus vulgaris, Capsicum* spp. and *Cucurbita* spp., accessions have been collected mostly at sites between 500 and 700 m a.s.l.; also maize was found mainly (80%) between 525 and 700 m a.s.l.

In all the selected towns it was possible to collect germplasm, confirming that Basilicata is a region where landraces and folk varieties are still grown.

Germplasm distribution

Aggregation of data by *strata* showed that total abundance (A) of accessions is mostly present in the

"isolated farm houses" of the explored sites (166), as well as the number of species (28). This information is also confirmed by the Shannon–Weaver Index (H) (Table 4). Statistic significance ($P < 0.001$) is observed when the farmer's residence is used as the source of variation in the analysis of variance, while no significance was observed when analyzing on the towns (Table 5).

The average altitude of the isolated farms is 561.0 m a.s.l (ranging from 200 up to 829 m a.s.l.) and the landraces are on average cultivated by old farmers (Fig. 4) (ranging from 35 to 88, mean 60, mainly between 56 and 65 years), adopting some traditional farming system such as manual harvesting of the vegetables, fertilising the land with matured manure (68.6%), adopting the slide irrigation (43.2%), and almost always (86.1%) using mechanical tools for soil preparation.

People that live within the city boundaries are abandoning the traditional practices to cultivate horticultural species in the house-garden, preferring to purchase the products from the surrounding farms.

Farmers interviews

All 101 germplasm-owners were interviewed (45% women and 55% men). For privacy reasons, specific complete personal data were obtained only from 87 out of 101 informants. Their age (Fig. 3) ranged from 35 to 88 years old and most of them were retired farmers or housewives; only one farmer was 35 years old and 11 (12.65%) were younger than 42 years old. Fifty percent of the interviewed farmers were under 60 years old. In Terranova di Pollino and in Rotonda, the age of most interviewed farmers was lower than 55 years (8 and 7, respectively). In these towns many young farmers, while keeping on with traditional farming, have developed agro-tourism activities like renting rooms, cooking traditional foods for their hosts and organizing outdoor activities. So, with the EU and national support (Repubblica Italiana 2006), they can keep living on the farm while these new economic activities grow. In Marsico Nuovo, another "young" town, landraces were collected on organic farms, where young farmers, with the EU economic support (European Community Council 2007) make a living by growing high value organic products (it is also to remark that the difference observed in the frequencies are statistically significative, as confirmed by the chi-square test (323.14) whose P value is <0.001).

Concerning the purpose of cultivation, it must be noted that in the "isolated farm houses" landraces were used within the family, while for the other *strata*, farmers cultivate landraces to also sell to the local market (12%).

Figure 4 shows the frequency of the collected accessions (grouped in landraces classes) for each explored town (the differences between these factors are statistically significant as showed by the chi-square test (142.03) whose P value is $P < 0.001$).

Table 4 Shannon–Weaver diversity index (H), Species richness (S) and total abundance (A) calculated on the explored fourteen towns of the Basilicata region and within the three *strata* used as collecting strategy based on the geographical distribution of population

Towns	Ter.	Cer.	Sen.	Ali.	Sti.	Tri.	Rot.	Pat.	Mar.	Ate.	Rap.	Bar.	Rio.	Ven.
Shannon–Weaver index (H)	0.58	0.25	0.59	0.35	0.54	0.51	0.46	0.24	0.56	0.37	0.39	0.59	0.61	0.27
Species richness (S)	9	6	15	9	15	8	6	6	11	11	3	10	15	5
Total abundance (A)	41	11	27	16	25	28	34	28	40	26	12	19	32	11

Farmer's residence	Isolated farm houses	Groups of houses	Inhabitated centre
Shannon-Weaver index (H)	0.753	0.546	0.154
Species richness (S)	28	27	15
Total abundance (A)	166	142	42

Ter. Terranova di Pollino, *Cer.* Cersosimo, *Sen.* Senise, *Ali.* Aliano, *Sti.* Stigliano, *Tri.* Tricarico, *Rot.* Rotonda, *Pat.* Paterno, *Mar.* Marsico Nuovo, *Ate.* Atella, *Rap.* Rapone, *Bar.* Baragiano, *Rio.* Rionero in Vulture, *Ven.* Venosa

Table 5 Analysis of variance (ANOVA) of shannon–weaver diversity index (H), species richness (S) and total abundance (A) calculated on the explored towns and on the *strata* used as collecting strategy based on the geographical distribution of population

Source of variation	D.F.	M.S.	F.	
Shannon–weaver index (H)				
Town	13	0.250	1.051	n.s.
Farmer's residence	2	5.379	22.542	***
Town × farmer's residence	21	0.332	1.394	n.s.
Error	148	0.239		
Species richness (S)				
Town	13	1.958	0.942	n.s.
Farmer's residence	2	54.274	25.941	***
Town × farmer's residence	21	2.644	1.264	n.s.
Error	148	2.093		
Total abundance (A)				
Town	13	4.095	1.093	n.s.
Farmer's residence	2	98.599	26.325	***
Town × farmer's residence	21	4.200	1.121	n.s.
Error	148	3.746		

n.s. not significant

*** $P < 0.001$

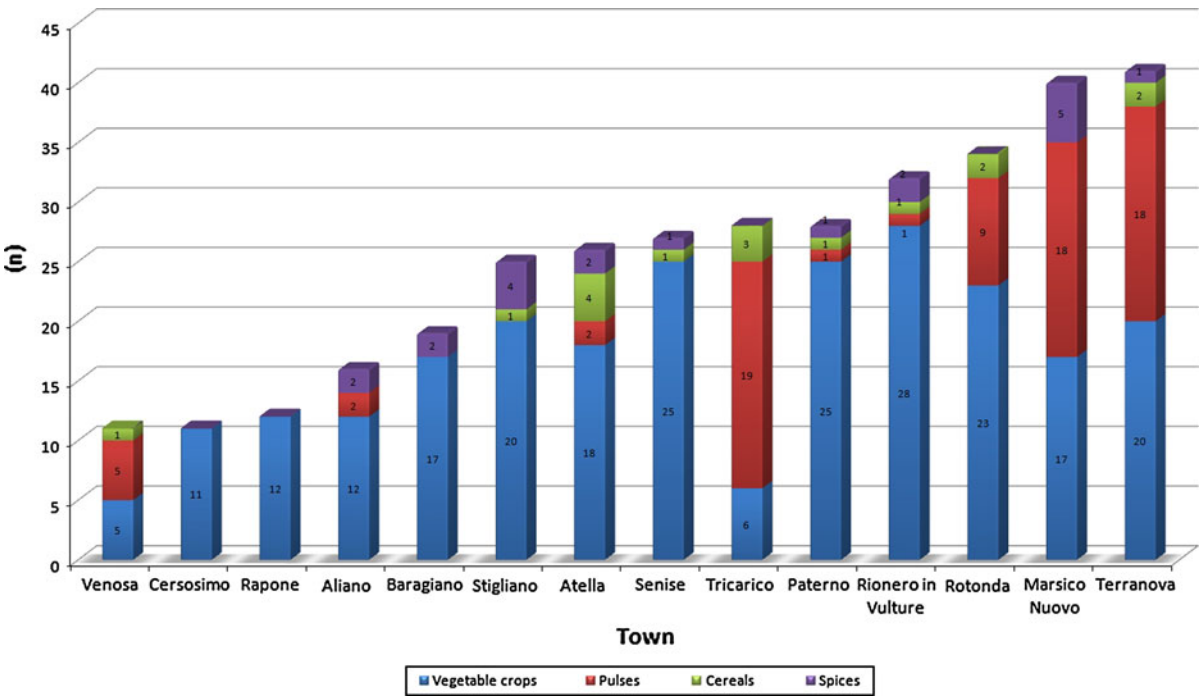

Fig. 4 Frequency of the accessions of 36 species grouped in four classes found in 14 towns of the inland areas of Basilicata region ($\chi^2 = 142.03$, ***$P < 0.001$

Terranova di Pollino, Marsico Nuovo, Rotonda, Rionero in Vulture and Paterno are the towns where we found most accessions (50% of the total).

Field level land quality, availability of the water for irrigation and biotic/abiotic stresses were the major factors for farmers to grow a landrace. This is similar to that outlined by Brush (1995) for on farm conservation of landraces in centres of crop diversity and by Negri (2005) which focused the attention on the agro-biodiversity conservation in Europe. The

Photo 1 *Serte'*: drying pepper fruits hung to the beams of a roof of an old residence in the province of Matera (Basilicata, Italy). (Photo by V. Montesano)

Photo 2 An old farmer and his "private gene bank" (Stigliano, MT). (Photo by Vincenzo Montesano)

presence or absence of a species in an area seems to depend both on the pedo-climatic factors and the use/traditions of the farmers.

Accessions number varies with altitude, in fact it is greater (46.6%) at mid-altitude (between 600 and 800 m a.s.l.). This is probably due to adaptive selection, in fact both cooler climate of the highland and stress conditions (i.e. pests) of the lowland do not favour the adaptation of the species to the changing environments.

In almost all selected towns, through the years, researchers have found the same species but collected fewer accessions: this is probably due to the collecting strategy that is more detailed and leads to visit several sites for each town.

Taking into consideration that in isolated farm houses there are fewer people and they are on average older, landrace extinction could increase and will depend on the ageing of the farmer-maintainers.

Young people remaining in the country often find it more convenient to buy the seeds or plants from the market than to reproduce them by seeds. In fact when associations between landraces and, classes of age were found, the data showed that young people (<55 years) preserved mainly pulses rather than vegetables. On the other hand people >70 years old conserve mainly vegetables. This makes conservation difficult, and even more so, the increase of cultivation of plant genetic resources. On the other hand we found that despite the mean age of farmer-maintainers being moderately high, young people (<55 years) still preserve landraces, both for family use as foodstuff and for selling to the local market additionally, young people continue to live on farms because they have economical support from European Union.

In addition it is important to remark that some "young" farmers preserve more than one accession of the same species, each kept for particular trait(s), and in same cases maintained in mixtures, as observed with the findings of Cleveland et al. (1994) who introduced the term of "folk varieties" and Berg (2009) who affirmed that "*folk varieties are not limited to traditional farming systems but may become part of the modern intensified forms of agriculture*", also in agreement with Brush (1995).

Discussion and conclusions

Despite considerable *ex situ* conservation efforts have been made in the Basilicata Region during the last 30 years, our concern is that the landraces still in cultivation might be soon replaced by monoculture accessions (introduction of improved varieties and generalized hybrid use). The production of certified products, or the incentive to still cultivate, in fact, could ensure comparable or greater income as compared to switching to modern varieties, and could encourage younger farmers to continue cultivating these vegetable crops. Our research showed that, even though quite small (9%), there is a number

of young farmers under 40 years old, localised mainly in the western part of the region, and that could be the focus of the regional law on economic incentives to "farmer-mainteiners" or "custodian of diversity".

The main objective of an on farm strategy of germplasm preservation should be to ensure that the maximum range of genetic diversity of the target landraces is maintained by farmers in a given area (Maxted et al. 2002). On farm conservation is a dynamic process, with the crop adapting to the changing environmental conditions (Wood and Lennè 1997). Several studies also highlight the complementarity of *ex situ* and *in situ* storage in order to preserve all landrace adaptations to their respective environments (Gòmez et al. 2005).

On the other hand, the majority of the collected landraces were grown for private use or consumption and just for this reason the choice to adopt conservation strategies on farm cannot only be based on the demand of genetic resources management. Qualified scientific and technical assistance is fundamental to guarantee correct on farm maintenance. In order to provide a scientific basis for the design of effective, long-term strategies to conserve crop genetic diversity on farm, there are many questions to answer, concerning what is the amount and distribution of genetic diversity maintained by farmers over time and space, what processes are used to maintain this genetic diversity on farm, what factors influence farmer decision-making to maintain diversity on farm and furthermore who maintains this diversity *on farm* (men, women, young, old, rich, poor), in accordance of Jarvis et al. (2000).

As argued by Dennis et al. (2007), to preserve traditional varieties requires policies built upon local values, cultures and traditional resource rights. Conservation proposals should begin by identifying the shared values useful to create incentives to promote the exchange of local plant varieties. The protocols farmers use to preserve and plant germplasm provide useful information about the local capacity of communities to manage plant genetic resources. As a result, it may be possible to develop policies that support and complement local practices, rules, and community-based institutions that comprise the farmers'system for managing and using agricultural biodiversity. As for the creation of a custodian farmer network for the Basilicata region, the establishment of a databases for on farm diversity in close collaboration with local communities and possible linkages with the agritourism, sector through which local crops/species can be promoted sustainably, .

In conclusion, in 14 towns of internal areas of Basilicata Region most of the germplasm of old landraces still survives, old people (>60 years) still preserve garden crops species (mostly tomato and pepper) at middle altitude (<600 m asl), while young farmers (<50 years old) conserve pulses (principally common bean) at higher altitude. The principal explanation, for this difference, given by respondents (young and old) was just "easiness" to manage/store pulses by young people rather than the greater attention on the horticultural crops that older people could offer. All of these farmers live principally in the isolated farm houses of their country (Figs. 3 and 4).

In addition, in this region the RL 26/2008 for the "preservation and the protection of the landraces and local varieties" in the next years will involve farmers directly in the cultivation and maintenance of *on farm* local species/varieties. The right starting point to prepare this form of preservation is to search the "farmer-maintainers" in the centre-west part of the region (Terranova di Pollino, Marsico Nuovo, Rotonda *et similia*), where younger (<50 years old) people still preserve accessions of grain legumes (common bean in particular) and vegetables principally in home gardens and also in agritourisms or organic farms. To our knowledge, the present report is the first to define this particular way to discover and to preserve *on farm* genetic patrimony in the Basilicata region.

In conclusion shared lessons from this study might be useful beyond regional boundaries. This is to say that the experience of Basilicata, as well as those from other regions, demonstrate that a regional law is a good tool to preserve agricultural biodiversity and to promote the use of landraces. In fact, Regional Governments, having a good knowledge of the territory, could better promote the constitutions of the local repertories of landraces, economically support the custodians of diversity and promote biodiversity across communities, with the establishment for instance of diversity fairs (or Sagre), which are important opportunities for promoting biological diversity and its sharing across communities.

Acknowledgments The authors are grateful to Basilicata Region for financial support to the project 'Salvaguardia della

biodiversità vegetale per il mantenimento e la tutela di varietà locali lucane di specie ortive'.

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