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Agricultural sustainability and underutilized crop species in southern Italy

G. B. Polignano*, G. Laghetti, B. Margiotta and P. Perrino

C.N.R., Germplasm Institute (GI), Bari, Italy

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Abstract

The concept of agro-sustainability is presented and discussed. The paper shows that sustainable farming practices, sustainable development and the preservation of biological diversity require adequate valorization of local biodiversity. Special emphasis is given to neglected and underutilized crop species. The role and importance of these plants, including primitive wheat, wild anise, food legumes, several vegetables and forage legumes in southern Italy is presented. Each case is presented as an example of cultivation linked to different aspects of utilization, conservation, genetic erosion, and of their potential for sustainable agriculture.

Keywords: biodiversity; Italy; sustainability; underutilized crops

Introduction

According to Forman (1995), four alternative perspectives on the concept agricultural sustainability are emerging: maximum yield, based on locally available resources plus long-term environmental conditions; the maintenance of agricultural production through periods of disturbance or stress; an integrated system where soil, water, plant and animal resources are maintained on a whole farm or larger area; low-input agriculture where, instead of increasing productivity, one raises profitability or net gain by sharply decreasing the expensive inputs of fertilizer, pesticides, machinery etc. The World Commission on Environment and Development (1987) proposed a concept of sustainability that went beyond individual disciplines and has become the most widely used concept, namely 'a sustainable condition ... is one in which there is stability for both social and physical systems, achieved through meeting the needs of the present without compromising the ability of future generations to meet their own needs'. This general principle may be summarized by 'a sustainable environment is an area in which ecological integrity and basic human needs are concurrently maintained over generations'. Thus a sustainable agriculture is one that includes aspects of: conservation of crop genetic resources; protection of the environment (against ground-water contamination, soil erosion, pesticide residues in foods, the environmental impact of chemicals such as fertilizers and pesticides, etc.); enhancement of the quality of farmers' lives and the society they serve; and the development of farming systems that are safe, healthful, profitable and productive.

Complex interactions occur among plants, soil, animals and water in agriculture. Farming practices can have subtle but significant effects that occur very slowly over a long period of time (Leigh and Johnston, 1994), requiring the setting up of very long-term treatment differences. Farming practices used in sustainable agricultural systems include the following: crop rotations that help to control weeds, diseases and insects, to provide plant nutrients, to reduce soil erosion and risk of water pollution; integrated pest management practices that can reduce the need for pesticides through techniques such as scouting for pests, use of pest-resistant crops, timing of planting and biological pest controls; and conservation tillage practices that reduce weeds, soil erosion and compaction; use of renewable, on-farm resources such as cover crops and manure (organic farming).

Rural agro-ecosystems represent a dynamic association of crops, pastures, livestock, other flora and fauna,

* Corresponding author. E-mail: giambattista.polignano@igv.cnr.it

atmosphere, soils, and water, and are contained within larger landscapes that include uncultivated land, drainage networks, rural communities and wildlife. They comprise a continuum of integrated units and natural ecosystems where plant gathering and production of locally indigenous crops are actively practised. Such traditional systems are still found throughout southern Italy, where many neglected and/or underutilized crops are still used. Neglected crops are those ignored by science and development but are still being used where they are well adapted and competitive; while underutilized crops were once more widely grown and consumed but have fallen into disuse, endangering their own existence as well as the genetic base for future crop improvement (Eyzaguirre *et al.*, 1999). Both groups of crops have the potential to be deployed more widely in certain eco-systems to enrich biodiversity, improve livelihoods, to broaden the genetic base and increase the security of the genetic resources maintained *in situ*.

Case studies in southern Italy

The most valuable neglected and underutilized species in southern Italy are summarized below. Their possible contribution to the diversification and revitalization of local agriculture is now being re-emphasized in both traditional and agriculturally advanced areas of the world with a Mediterranean climate.

Wheat

The hulled wheats (*Triticum monococcum*, *T. dicoccum* and *T. spelta*) (collectively referred to as 'farro') are ancient cereal crops that have highly influenced the agricultural landscape. Over the millennia they have played an important role in human nutrition (Padulosi *et al.*, 1996). Hulled wheats are among the oldest cereals cultivated by man, but they have been largely replaced by modern and more productive wheats. However, both emmer (*T. dicoccum*) and spelt (*T. spelta*) wheats are still cultivated in Italy (Fig. 1) and in other regions of the world. These two crop species may represent, for certain European regions, a valid alternative to durum and bread wheat, as well as to other crops which produce lower income (Bove, 1994). The cultivation of hulled wheats would satisfy an increased demand for products obtained from these cereals, and would also allow the development of agriculture in marginal areas with a low environmental impact, since they can be grown on poor and stony soils, where other wheats do not perform well (D'Antuono, 1989; Perrino *et al.*, 1994).

Farro are low-input cereals well suited to a sustainable agriculture system. Recent studies have shown that the rheological and baking properties of farro are similar to those of common wheat (Perrino *et al.*, 2000). It is considered to be a high-quality product both with respect to protein composition and mineral content (e.g. selenium, zinc, magnesium, calcium, etc.). The Germplasm Institute of C.N.R. of Bari, Italy has characterized its entire collection of farro (*ca* 700 populations) for both agronomic and nutritional traits, so that the best adapted genotypes can be identified for nearly any specific environment in Europe (Laghetti *et al.*, 1999a). For the wide range of environments tested above, accessions can be identified with high-yield stability and these can be recommended for other similar hilly zones of southern Europe. Highly fertile fields should be avoided because of the strong tendency of hulled wheat to lodge. Moreover, although the best accessions of emmer and spelt yielded less than common wheat and durum wheat, the value of farro is higher. According to Bove (1994), farro in Basilicata will be competitive with durum wheat only when yields higher than 3 t/ha can be obtained under conventional production systems, or 2.1 t/ha if cultivated under an organic production system. However, the success of farro is not linked to its competitiveness with modern non-hulled wheat, but rather in its place as a niche crop for marginal areas. However, the recent expansion of farro cultivation in Italy does run the risk of saturating the market, thereby lowering product quality, and ultimately lowering its price.

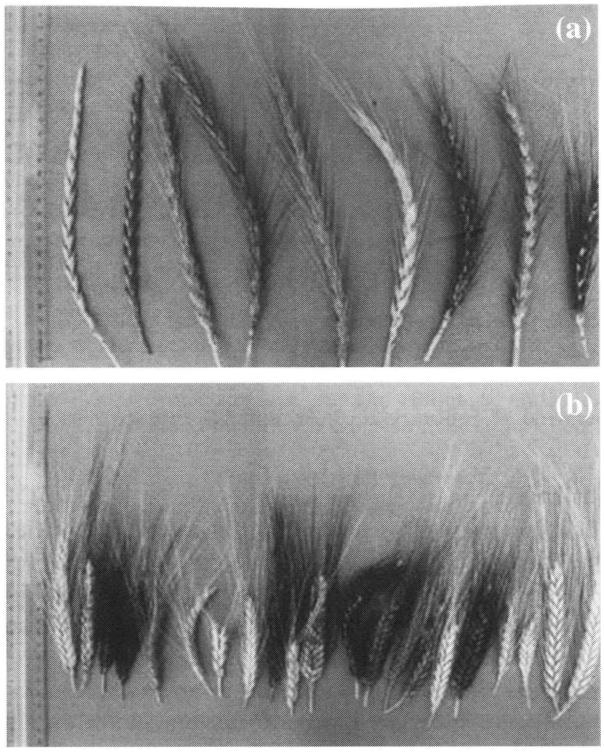

Fig. 1. Spikes of 'farro'. (a) Spelt (*Triticum spelta*); (b) emmer (*T. dicoccum*).

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Vegetables

African eggplant (Solanum aethiopicum L.)

The African eggplant, locally named 'merlingiana a pummdore' (Fig. 2), is grown on a small scale in Basilicata (Laghetti *et al.*, 1995). This niche crop feeds an economically important local market. The Basilicata Region has included this landrace among its typical horticultural products to improve its popularity and use. It has been suggested that the species could be used in breeding work as a source of resistance to drought and several diseases (Defrancq, 1984; Hebert, 1985; Ano *et al.*, 1991). The crop is agronomically robust and requires a lower level of input (i.e. irrigation, fertilizers, pesticides) than does the common eggplant (*Solanum melongena* L.) (Laghetti *et al.*, 1995). It is reputed that the fruit is eaten in Ethiopia to enhance resistance to malaria.

Wild anise (Pimpinella anisoides Brig.)

Pimpinella anisoides (Fig. 3) has been recently put forward as a novel minor crop plant in Basilicata. It is used in some parts of the region particularly for flavouring traditional pastries (Hammer *et al.*, 2000). Local knowledge of the plant is decreasing more and more: both genetic and cultural erosion have been recorded; today many traditional habitats for *P. anisoides* have been anthropogenically altered. According to local plant collectors, it is still possible to find good specimens of *P. anisoides* only in a very few areas. The wide phenotypic variability observed in the past is decreasing rapidly. Another cause of genetic erosion has been over-exploitation over recent years. Indeed, in our collecting expeditions it has been difficult to gather contiguous samples of fruits, so that only two accessions have been sampled: one from a primary forest, near the town of Marsico Nuovo (at *ca* 900 m above sea level) where the species is still widespread, and the other one from a jealously guarded locality. Within the framework of a recent agreement with the Basilicata Region, it has been proposed that the domestication of this wild and endangered plant should be carried out in the context of agricultural sustainability.

'Peperone di Senise' (Capsicum annuum L.)

Peppers are commonly cultivated in Italy, especially in the southern regions. They have an economic importance second only to tomato. They can be used as a food, as natural colourants, for conservation of food and as for medical application. A world-wide collection of more than 200 accessions of *Capsicum* spp. has been created, and an investigation has been initiated to characterize the variability of this collection with respect to qualitative biochemical determinants such as fruit colour (carotenoid pigments) and capsaicin, which confers the characteristic pungency to fruits and seeds. A specific target has been to characterize 20 populations of the landrace 'Peperone di Senise' (awarded with the European Union (EU) mark IGP: indication of geographic provenance) by spectroscopic determination of various pigments and quantification of capsaicin content, as well as to assess certain agronomic traits. Capsaicin content was generally lower than 20 μg/g dry paprika, except for one accession. ASTA values, an indicator of the total colour index, were expressed as units/g dry paprika and ranged

Fig. 2. Fruit of the African eggplant (*Solanum aethiopicum*) belonging to the landrace 'merlingiana a pummdore'.

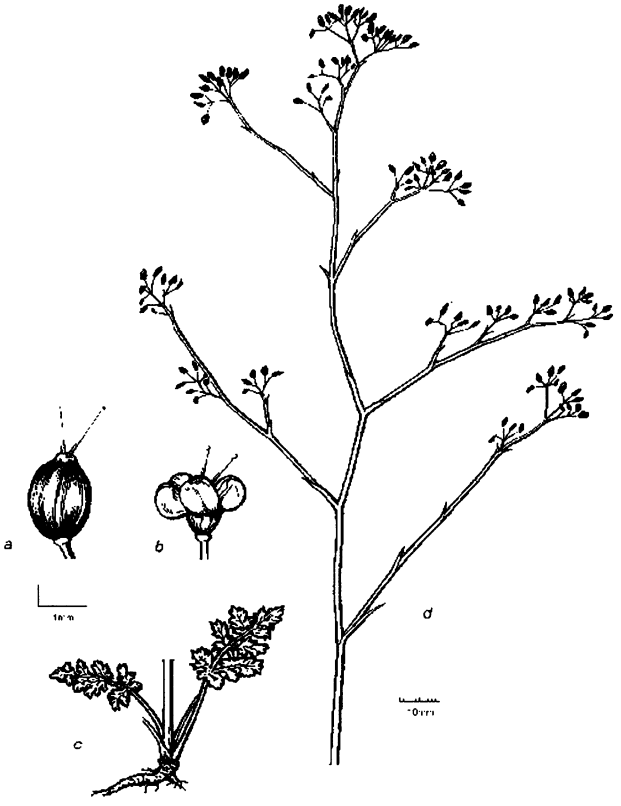

Fig. 3. Wild anise (*Pimpinella anisoides* Brig.).

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between 100 and 150. Variability in pigment contents was limited among accessions. Thus, all the peppers tested can be definitely considered as sweet and highly coloured, like the paprika commonly used for industrial purposes. Peperone di Senise is a particularly thin-skinned fruit with a low water content which makes it perfect for natural drying, and is readily recognizable by its distinctive taste. It is still grown in some parts of Basilicata following a traditional cultivation technique, which is consistent with sustainable agriculture (Fig. 4). Its cultivation seems to be inherently more sustainable than that of other cultivars, since several attempts to increase yield through heavier energy inputs (e.g. chemical fertilizers, irrigation, deep ploughing, etc.) have resulted in higher levels of disease and a worsening of fruit quality (De Nigris, 1992; Quagliotti, 1992; Siviero and Gallerani, 1992; Miccolis, 2002; and several personal communications by local agronomists and farmers).

Some other examples, including species of *Cucurbita*, *Cynara* and *Allium*, have been discussed in the literature (Baser *et al.*, 2002; Sarli *et al.*, 2002).

Grain legumes

Grass pea (Lathyrus sativus)

In Italy, grass pea is cultivated (Fig. 5) both for animal and human consumption. Over the past five decades, many constraints, such as poor income, changing dietary habits and the presence of anti-nutritional factors, have contributed to both limiting production and reducing the growing area. Grass pea is still cultivated in a few hilly areas in central and southern Italy (Infantino *et al.*, 1994; Tavoletti and Capitani, 2000; Alba *et al.*, 2001), and it is considered to be an underutilized crop (Eyzaguirre *et al.*, 1999). The development of sustainable and environmentally sound agricultural systems has re-stimulated an interest in the role of grass pea, especially given the need for rational crop rotation in areas over-exploited by cereal cultivation, and the demand for protein concentrates for animal feed. However, the reintroduction of grass pea into crop rotations will require an intensive breeding effort to generate productive lines with an erect growth habit, even maturation, non-dehiscent pods and lower levels of the neurotoxin 3-(*N*-oxalyl)-L-2,3-diamino propionic acid (ODAP) in the seed, which is responsible for lathyrism in both humans and livestock (Robertson *et al.*, 1996; Hanbury *et al.*, 2000). According to Hanbury *et al.* (1995), *Lathyrus sativus* is variable for many traits, including yield and ODAP content. Consequently, conventional breeding approaches should be successful in substantially improving adaptation and yield. Whether grass pea will eventually find a significant role in Italian agriculture is uncertain, but the wide distribution of *L. sativus* in temperate, Mediterranean and tropical environments, its varied roles as a forage and grain crop, its extensive genetic diversity, and its tolerance to drought, resistance to pests of stored grains and adaptability to different types of soil all suggest a species of potential world-wide economic value.

To protect the primary gene pool of this endangered crop, a number of research programmes have been started aimed at new collections, and the safeguarding and diversity evaluation of current collections (Infantino *et al.*, 1994; De La Rosa and Varela, 1998; Jubete, 1998; Przybylska *et al.*, 1999; Chowdhury and Slinkard, 2000; Granati *et al.*, 2001). A number of organic farmers have

Fig. 4. Fruits of *Capsicum annuum* L. landrace 'Peperone di Senise'.

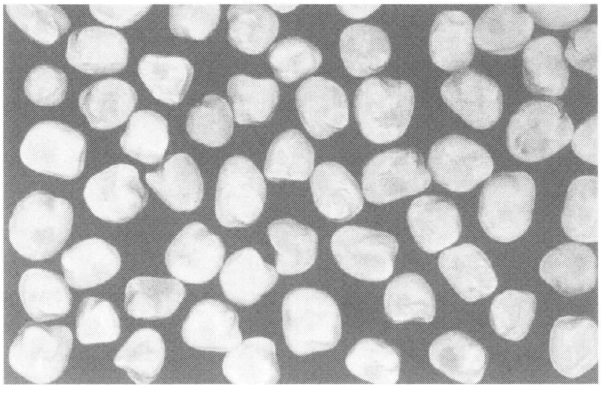

Fig. 5. Seeds of grass pea (*Lathyrus sativus* L.).

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shown interest in the cultivation of grass pea, particularly in the Marche, Basilicata, Sicily and Apulia.

Common bean (Phaseolus vulgaris L.)

A wide range of bean (*Phaseolus vulgaris*) landraces are still grown in Basilicata, particularly in the Agri and Mercure valleys around the towns of Sarconi and Rotonda (Fig. 6). The potential and constraints of *ex situ* and *in situ* conservation of this type of genetic resource have been investigated, and examples of on-farm and *in situ* conservation have been described (Piergiovanni and Laghetti, 1999). However, their future is uncertain without appropriate government regulation. Recent EU rules have allowed the possibility of attributing marks of origin and quality to local products, both of which can be an important support to stimulate on-farm maintenance of elite crop landraces. A joint project for *ex situ* and on-farm conservation was started to safeguard common bean landraces from Basilicata (Brandi *et al.*, 1998). The main result of this work was the attribution of the EU mark IGP to some of the tested landraces. Several ecotypes were evaluated for biological and agronomic traits, and the farming system proposed to local farmers was the organic one, which was considered to be the best adapted to the traditional agricultural environment of these beans (Piergiovanni *et al.*, 2000). Interestingly, no statistically significant differences were demonstrable between yields obtained using organic farming methods as against conventional chemical-based ones, so the former system could be recommended on the grounds of its reduced environmental impact.

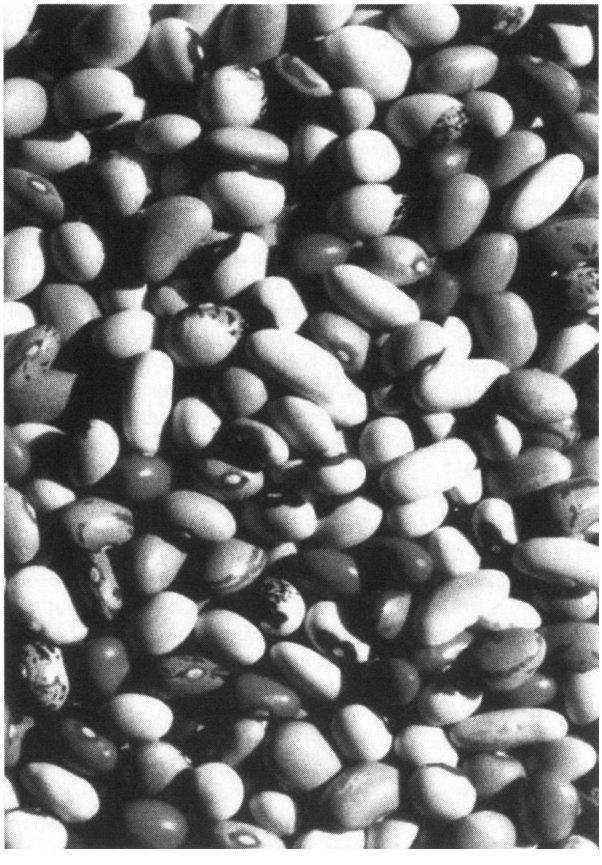

Fig. 6. Seeds of common bean (*Phaseolus vulgaris* L.).

Forage crops

Single-flowered vetch (Vicia articulata Hornem.)

This vetch, a native of the Mediterranean region and grown for human and animal nutrition (Fig. 7), was last cultivated in Italy in Sicily until about 1950. By 1999, it was considered extinct, until a relict population was found in Sardinia (Laghetti *et al.*, 1999b). Laghetti *et al.* (2000) characterized the species from a botanical, nutritional and cytological point of view, and concluded that it was lower in nutritional quality compared to lentil. However, the possibility of genetic improvement led the above authors to propose this neglected species as an alternative crop in some barren areas. Within the framework of a sustainable agriculture, *V. articulata* could find interesting opportunities, in particular playing a role in soil conservation and rescue of marginal areas. It may also serve as a source of useful genes (e.g. for resistance to insects such as red-legged earth mite, alfalfa flea and pea weevil) in *Vicia* spp.breeding programmes.

Conclusions

We have described some examples of approaches to the conservation of neglected and underutilized crops in mountainous areas. We suggest that species valorization (such as via EU marks like IGP) can alleviate the problem of maintaining agro-biodiversity in a sustainable way. Of particular importance is to generate links between

Fig. 7. Single-flowered vetch (*Vicia articulata* Hornem.).

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scientists concerned with the conservation and characterization of agro-biodiversity, and farmer's associations, as these can provide focus for further agricultural development. In Italy, the need to promote conservation strategies for several crops (cereals, grain legumes, vegetables, etc.) has stimulated the use of crop diversity to develop sustainable agriculture in marginal areas and has underlined the necessity to promote actions aimed at understanding the potential value of the local germplasm. Relicts of old landraces of the various species described above have been found in marginal areas, where improved cultivars have not been competitive, and where mechanization cannot easily be practised. We suggest that the species described in this paper can serve as models for the conservation and use of genetic resources of other minor and local species. In order to further enhance joint research on the biodiversity of native crops, we have established a website (http://biodiversita.ba.cnr.it).

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