VALERIA NEGRI

AGRO-BIODIVERSITY CONSERVATION IN EUROPE: ETHICAL ISSUES

(Accepted in revised form June 3, 2004)

ABSTRACT. While it is commonly acknowledged that the ecosystemic, and the inter- and intra-specific diversity of "natural" life is under threat of being irremediably lost, there is much less awareness that the diversity in agro-ecosystems is also under threat. This paper is focused on the biodiverse agro-ecosystems generated by landraces (LRs), i.e., farmer-developed populations of cultivated species that show among- and within-population diversity and are linked to traditional cultures. The aim of this work is to arouse concern about their loss, to explain how they can be conserved, and to discuss values that support maintaining and/or restoring on-farm agro-biodiversity. Although agriculture has relied on biodiverse agro-ecosystems for millennia, most of them have disappeared or are disappearing due to profound transformations in the socio-economic context. This is discussed with particular reference to the European situation. The positive values of LRs and LR systems that support their conservation are discussed along with possible objections. The conservation of LRs and LR systems can be well justified on ethical grounds. In particular, the complex intertwining of the biological and cultural contexts of LR systems, which continuously creates new adaptive responses to the changing socio-economic and eco-physical processes, is a value that strongly motivates conservation, particularly when the needs of future generations are considered.

KEY WORDS: biodiversity, complexity, ethics, landraces, on-farm conservation, sustainability

1. INTRODUCTION

Biological diversity exists at three main levels: the combinations of species that make up different ecosystems, the number of different species, and the different combinations of genes within species. Scientists refer to that part of biodiversity that is used by mankind in agriculture as "agricultural genetic resources." In addition to commercial varieties, the genetic resources of a crop species include breeding lines (intermediate breeding products), genetic stocks obtained through different deliberate breeding procedures (natural and induced mutants, substitution and addition lines, interspecific hybrids, etc.), the wild progenitors, related species, and the landraces (LRs), also called "farmer varieties," "local varieties," or "primitive varieties." Later we will see how LRs make up an important segment of plant genetic resources.

Today, it is commonly acknowledged that the ecosystemic, and the inter- and intra-specific diversity of the natural life is under threat of being irremediably lost, while there is much less awareness among the general people that the diversity in agro-ecosystems is also under threat. For example, while there is great concern over the loss of wild orchid populations, very few people have ever heard about the loss of wheat LRs. Environmental ethics literature has given much more attention to biodiversity conservation of wildness, than to the conservation of biological diversity in agriculture. The point being made is that concern for the environment should also include the "agricultural" environment (and it should be noted that it is the only type of "environment" that is widespread in the most densely inhabited countries, such as Europe). Pure wildness is a world that existed before man and deserves the highest priority of conservation; but healthy and diversity-rich agricultural environments, which have been created by the joint forces of nature and mankind, also deserve to be preserved. Agro-ecosystems are undoubtedly important because they are the source of food, fiber, fuel, furniture, drugs, and other services for man. Agriculture is still an important productive sector for many economies and most of present-day societies have their roots in the agriculture-based societies that existed until just a few decades ago.

Agriculture plays a significant role in protecting and enhancing biodiversity (Altieri and Merrick, 1987; Paoletti, 2001; Le Coeur et al., 2002; Marshall and Moonen, 2002) when it is carried out in a sustainable manner and takes into account its genetic resources. Tillman (2000) suggests that ethical reasoning can elicit and shape people's motivations with respect to the importance of safeguarding biodiversity; this should also hold true for agro-biodiversity. The first step in the process of ethical reasoning is to identify the values, if any, that pertain to agro-biodiversity. If, in fact, such values exist, then it should be possible to motivate more forcefully the requests for safeguarding agro-biodiversity. A strongly motivated request for safeguard would consequently lead to more effective policies and actions.

This paper focuses on the biodiverse agro-ecosystems generated by LRs, and is aimed at raising consciousness about their loss, explaining how they can be conserved, and presenting the values that could motivate maintaining and/or restoring on-farm agro-biodiversity. Emphasis is given to European agriculture. This paper is also intended to favor a more extensive discussion than presently carried out among ethicists, political scientists, and sociologists on the above mentioned issues.

2. THE TRANSFORMATIONS OF AGRICULTURE

2.1. *Agro-Ecosystems based on Landraces*

Jack Harlan (1992) clearly describes the processes leading to the evolution of different LRs: the domestication process from wild plants in the areas of original distribution, the emergence of the first crops, their crossing with wild relatives and the subsequent recombination and development of new forms, their spreading to different areas with human migrations, then crossing with the wild, cultivated or weedy forms present in the new areas and the selection pressures imposed by the environment and by humans. These continuous processes have led to the emergence of a wide pattern of variation throughout the millennia.

Initial domestication and subsequent processes have given rise to new forms that were not present in nature, thereby further enriching its diversity. When plants were taken to new environments by man, they were subjected to the selection pressure of the local physical (soil, climate) and biological (pests, diseases, competitors) constraints. Human beings also selected for traits that were useful in agriculture and for an increased nutritional value of a crop. Most of the relevant agronomic traits that have been selected for (absence of seed dispersal, bushy growth habit, lack of antinutrients, light seed color) are severely disadvantageous in the wild and are eliminated by natural selection when they appear. Humans, however, have also selected for traits that they considered important for ritual use or to meet their own fancies and wills.

Consequently, traditional knowledge (information on the type of plant, its uses and role in human nutrition, cropping systems, agronomic practices, its adaptation and quality) and local culture (rites, symbols, language, ways of cooking) have developed in association with local LRs over time. These LRs have been passed down from one generation to the next as a family or farmers' community heritage along with the traditions and uses that were related to them. But over time, the LRs have been continuously changing, since the environmental pressures (intended here *sensu latu*, i.e., including human pressures) have also been changing.

Many LRs that differed with respect to their adaptation to the various environmental constraints, the agricultural techniques adopted, and destination uses, emerged throughout the area of distribution of a certain crop and became a constituent part of the rural landscapes and cultures. Each LR was constituted by different morphotypes. Modern genetics has shown that among- and within-LR differences are determined by molecular differences at the DNA level.

LRs of seed-propagated crops can, therefore, be defined as variable populations characterized by a specific adaptation to the environmental conditions of the area of cultivation (tolerant to the biotic and abiotic stresses of that area) and by relatively low but stable yields that are closely associated with the traditional uses, habits, dialects, and celebrations of the people who developed them (Brush, 1992; Harlan, 1992; Papa, 1996, 1999; Zeven, 1998; Asfaw, 2000). They represent a subset of biodiversity that has been created through the joint action of the environment and people for human use. The tight intertwining of the biological and cultural heritage and the complexity of the system where LRs have evolved, and are still evolving, is their most particular and intriguing trait.

LRs (and local breeds) characterized the complex and diversity-rich agro-ecosystems that were present until industrial development became entrenched. Before World War II, rural economies were prevalently, though not exclusively, aimed at being self-supporting, which means that different animals and crops, as well as the means of production, were produced on the farm to satisfy the needs of the families. Consequently, such agro-ecosystems were quite diverse due to both the within species (i.e., within LR) diversity and the number of different species.

The complexity of these systems was able to buffer the environmental constraints so that throughout history, epidemics or climatic stress have seldom completely destroyed a LR. LR tolerance to biological and environmental stresses and epidemics has relied on their innate diversity, as well as on the diversity of different species present in an agro-ecosystem. For example, the different species present in the agro-ecosystems hosted the natural enemies of a pest or acted as physical barriers to its diffusion. Within species (i.e., within LR), some genotypes were disadvantaged under the selection pressures of that pest, other genotypes were tolerant. In addition, within species diversity allowed a co-evolution of pests and hosts. It has been shown that pathogens that have co-evolved with a certain LR have particular genetic traits (Geoffroy et al., 1999), just as the LR itself has.

2.2 *Agro-Ecosystems based on "Modern" Varieties*

Until the beginning of the last century, all agricultural activity was based on a large number of LRs with a complex pattern of diversity. The first "modern" varieties were bred in maize and wheat (in USA and Italy, respectively) in the early 1900s. Since then, breeding activities have increased, involved other species, and continued to take advantage of the progress made in genetics (see a critical review on the topic in Gepts, 2002).

Initially, the primary aim of plant breeding was to increase yield. Breeders used the best performing genotypes found in LRs to make crosses, then selected superior recombinants from among their progenies and multiplied them to produce genetically uniform varieties (pure lines or hybrids). Genetic uniformity, which determined morphological uniformity and, as in the case of maize, hybrid vigor, led to the development, standardization, and diffusion of new agronomic techniques, such as fuel-powdered mechanical tools, chemical fertilizers, irrigation, pesticides, etc., which were made available on a large scale and at relatively low cost by industrial development. In turn, these agronomic techniques, which minimize the differences among different environments, favored the widespread diffusion of uniform varieties. New seeds and new technology were widely marketed by companies.

The overall diffusion of modern varieties produced a sharp decrease in the number of cultivated LRs, which resulted in a great loss of diversity in the fields.

New technology continued to be developed and integrated into agriculture and genetics kept pace with it by further breeding work with which a few genes were progressively introduced into the genetic background of the already developed varieties. This has further reduced within-crop genetic diversity. The aim of most of the recent breeding work, including that which has led to genetically engineered varieties, has been to increase tolerance to biological and environmental stresses by introducing a few genetic traits. In fact, modern varieties can generally be defined as concentrates of good genes that maximize the expression of traits of agronomic interest (Gepts, 2002).

Consequently, modern varieties often show high levels of resistance/tolerance to a certain pest race/pathotype/population or to a certain environmental constraint, but they are vulnerable to changes in biotic and abiotic stress due to their genetic uniformity. In addition, modern crops are more vulnerable to stress due to the over-simplification of the systems and landscapes in which the crop is produced.

As a matter of fact, concurrent with the transformation of the varieties used in agriculture has been the profound transformations in the productive systems due to wide-scale industrialization (see Grigg, 1992/1994 for a more detailed picture). Industrial development increased the demand for factory workers, which led to higher salaries and *pro-capite* income. Expectations of a better life and higher off-farm income caused an exodus from the country to the city, an abandonment of land, and an increase in the demand for agricultural products by urban people. As a consequence, agriculture became more market-oriented and specialized. Most farms stopped breeding animals and started to produce only a few crops, rather than all that was needed for the family, and bought production means (labor, machinery, fertilizers, seeds), as well as other goods, on the market. The areas used for the production of services and the means of production (for example, the wooded areas for family fuel or the forages for feeding work animals) also disappeared and were replaced by the main crops. The imperative became to increase productivity per unit of land by increasing the use of productive means, such as machinery, fuel, and chemicals. The adoption of extreme mechanization, which required the removal of barriers, such as living fences, the spatial rearrangement of fields and the spraying of many chemicals greatly reduced both the habitat and the number of pest-controlling organisms.

The agro-ecosystem became much less diverse. In the end, intensification and abandonment were the main causes of decline in farmland biodiversity.

Both reduced among- and within-species diversity have resulted in the inability of modern agro-ecosystems to counteract changes in biotic and abiotic stress (Matson et al., 1997). Even if these systems are immediately more efficient than the LR systems in counteracting adversities due to the specific breeding activities carried out to date, of themselves they are generally unable to withstand the long term selective pressures. To cope with the changing selective pressure, new resistant varieties, new technical devices, and/or new means of production must be created. The modern system requires external supplies to replace the capacity to counteract adversities that was once present on the farm.

Besides, modern agro-ecosystems have higher leaching losses and this consequently compromises non-terrestrial and aquatic ecosystems. It should also be noted that the recent intensification of agriculture and the prospects for future intensification, will likely have a further detrimental impacts on the other ecosystems of the world (Tilman, 1999).

However, the modernization of agriculture has certainly resulted in a spectacular increase of productivity and contributed to alleviate poverty in the country. From the early 1900s to now, wheat productivity has increased from an average of 1.2 to 4 t ha^{-1} in Europe (and over 10 t ha^{-1} have been recorded in some countries). It is estimated that about half of this increase is due to breeding activities and half to a more intense use of other production means (Grigg, 1992/1994).

The significant increase in food production triggered a perverse mechanism in the primary production sector: high yields kept crop prices low, which compelled farmers to try to remain on the market by doing scale economies. This, in turn, facilitated further yield increases and lower crop prices. Since the beginning of the 1980s, farm income (in real terms) in the EU has decreased by about 20%, taking inflation into account. However, if the data relative to income are combined with the substantial decrease of labor in agriculture, income per unit of work has increased by about 30% in real terms (EUROSTAT, 1999). It should also be noted that the lowering of crop prices has led to a widespread use of public subsidy in agriculture. Presently, most farms in Europe (particularly in the EU) cannot survive without the subsidies that make up a large part of a farmer's income.

Industrial development and low food prices have made large quantities of cheap (in terms of family income that is spent on food), standard food available on the market. Though hunger has not completely disappeared (for reasons that would take too long to discuss here), food is no longer "the means" for life in Europe. Consequently, the value attributed to food has decreased and the perception that most people have of food has changed. In contrast to when most people lived in the country and farmed, today most people have little or no consciousness of their dependence on primary production and many do not know where food comes from or how it is produced.

The transformations described above have profoundly changed the environments where food is produced, processed, and sold as well as how it is consumed and perceived. However, it must also be acknowledged that these changes have produced a general improvement in the standard of living.

3. THE IMPORTANCE OF AGRO-BIODIVERSITY AS PERCEIVED BY SCIENTISTS, FARMERS, AND THE COMMON PEOPLE

The overall reduction of biodiversity in today's agro-ecosystems causes great concern among some scientists who deal with agricultural production and sustainability. The present productive systems maximize production, but are relatively unstable, have high energy costs (Black, 1971; Pimentel and Heichel, 1991), high leaching loss of nutrients, and high incidence of weedy species, diseases, and pests, which, in turn, causes a heavy use of chemicals. Consequently, they have a severe impact on the environment (through soil erosion, air and water pollution, loss of biological diversity) and on the services it provides to the society (Faeth, 1993; Brummer, 1998; Tilman, 1999). These systems appear to be unsustainable, while, on the contrary, sustainable systems are needed to meet the needs of a currently growing population and those of future generations.

Many plant breeders are very concerned about the loss of crop genetic diversity *per se*. About LRs in particular, Esquinas-Alcazar (1993) writes,

> The heterogeneous varieties of the past have been and still are the plant breeder's raw material. They have been a fruitful, sometimes the sole, source of genes for pest and disease resistance, adaptation to difficult environments, and other agricultural traits like the dwarf-type in grains that have contributed to the green revolution in many parts of the world.

Intense and widespread agricultural modernization, largely financed by multinational companies and international assistance programs since the 1950s, has greatly reduced the areas devoted to primitive local varieties, which have been replaced by genetically homogeneous cultivars. The continued erosion of genetic diversity alarms geneticists and breeders, since lack of diversity severely impairs future improvement of crops and/or the possibility to face new forthcoming production constraints. In addition, students of human sciences are also alarmed because of the loss of crop related culture. This culture can be of use not only in breeding activities, but also for developing further culture for the community (see for example Worede et al., 2000; Negri, 2003). The disappearance of LRs not only means genetic erosion but also "local cultural erosion;" both biological and cultural evolution are hampered.

Examples from outside of Europe show that individual farmers and farming communities highly value diversity. In southern Mexico, farmers rely on maize LR diversity because of the heterogeneous soils and production conditions, risk factors, market demand, consumption, and uses of different products from a single crop species (Bellon, 1996). Likewise, a wheat farmer in Turkey may grow different types of wheat in different agronomic conditions or for different uses (Brush and Meng, 1998). Moreover, farmers rely on the diversity of other farms or communities to provide new seeds when a crop fails and seed is lost or to renew seed that no longer meets the farmer's criteria of good seed (Louette, 2000). In contrast, most farmers in Europe have completely discarded LRs and are no longer conscious of the importance of diversity in agricultural production, due to the profound transformation already described (Zeven, 1996; Hammer et al., 2003; Negri, 2003).

The general attitude of the common people in Europe toward agrobiodiversity appears to be multifaceted. In contrast to when living in the country was synonymous with cultural backwardness and poverty, today many people desire to live in the country to enjoy a less polluted environment and beautifully diverse countryside. Elements such as countryside, agriculture as a spectacle, nature, picturesqueness, community, peace and quiet, traditions, all emphasized by comparisons to the urban, are components of a countryside idyllic image that circulates in popular discourses (Halfacree, 1995; Jones, 1995; Van Dam et al., 2002). Agri-tourism has become a thriving business and a growing number of people declare they are ready to pay more taxes to help support programs that protect the environment and biodiversity. A growing number of people aspire to have a healthier, safe, and high quality food, such as that obtained from LRs, and are willing to pay a higher price for it (Archer, 2003; Archer et al., 2003; Negri, 2003; Ziemann and Thomas, 2003). The growing market for organic food and high quality niche products attests to this change. This is now possible because of a higher standard of living achieved with industrialization. Paradoxically, the same system of production that has destroyed, and continues to destroy, a great part of the resources in agriculture is the driving force for this new wave. This longing for something better is rather vague, and is probably dictated more by fears that pollution and eating unhealthy food may damage ones health rather than by a profound concern for the environment. I wonder how many of these people would be willing to give up something in terms of comfort and ease-of-life for the environment.

However, today people recognize that agriculture not only produces food, but also protects the diversity of life, the landscapes, the territory, and the waters, prevents disasters, promotes the vitality of rural areas (favoring employment, strengthening farm-related economies, and maintaining local culture), alleviates their poverty, and offers recreation possibilities to urban people. Among this wide range of functions important for the society, biodiversity and landscape maintenance are clearly at the heart. It is multifunctionality of agriculture that justifies the large use of subsidies in European agriculture. The multifunctional agriculture has been included into European legislative frameworks since the end of the 1980s. These frameworks are now well established and are becoming the catalyst for conservation work. They have already been put into action in programs aimed at conserving the remaining ''biodiversity-rich'' farmland areas and in ''horizontal'' measures, such as those aimed at controlling the levels of nitrates and pesticides used and those that promote sustainable (such as organic) agriculture, which mitigate the negative effects of agriculture on the environment. Nevertheless these measures are still insufficient, or insufficiently applied, and the conservation issues remain critical. It is estimated that 15–20% of the European farmland is still rich in biodiversity, but this percentage is progressively shrinking (Van Dijk, 2001).

4. CONSERVATION OF PLANT GENETIC RESOURCES

4.1. Ex Situ *and On-farm Conservation*

Conservation has been defined as a system of resource management that yields the greatest benefit to the present generation without impairing benefits for future generations (IUCN, 1980).

Among plant genetic resources, LRs are an important segment of diversity that continues to disappear. They should be preserved because they harbor a diversity that is of interest for future breeding work, future development of farming systems, and local culture (Altieri and Merrick, 1987; Brush, 2000).

Until recently, germplasm conservation of crop LRs, as well as their wild relatives, relied on *ex situ* methods, (i.e., the conservation of biological material outside its natural habitat, UNCED, 1992), mostly in germplasm banks. More recently, *in situ* (on-farm) conservation (i.e., the conservation of biological diversity in its natural habitat) has been proposed as a conservation strategy that allows evolutionary processes to continue rather than being halted as occurs, to a large extent, in *ex situ* conservation (Frankel et al., 1995; Maxted et al., 1997). Emphasis to *in situ* conservation of crop plants has also been given by the Convention on Biological Diversity (CBD), Agenda 21 Global Plan of Action (GPA), and other influential international documents. In on-farm conservation, the farmer or farmer communities are considered to be the stewards and managers of the agro-ecosystem. They should be the ones to maintain LRs in the field under the conditions found in the area of cultivation. This means that the natural selection pressures are at work as well as the selective pressures (deliberate or not) applied by the farmers. For example, a farmer uses an agronomic techniques he/she considers to be the most appropriate in that year, or he/she may select a different type of colored seed. Clearly, on-farm conservation is not an open-air museum of conservation.

4.2. *The European Situation*

To preserve agricultural genetic resources, many *ex situ* activities are currently being carried out in plant genetic resource networks organized at the international level that favor the exchange of information and of plant material from germplasm banks (see http://www.ipgri.cgiar.org/networks/ecpgr/ for general information and useful contacts).

In contrast, on–farm conservation activities are locally carried out by single farmers. LRs of different crops (forages, cereals, grain legumes, garden crops and fruit trees) can still be found, but few data are available on them and on the human motivation behind on-farm conservation (Hammer et al., 1999; Negri et al., 2000; Nowosielka and Podyma, 2001; Negri, 2003). The little information that is available shows that, while there is no one typical situation in on-farm conservation and management, the main factors that often appear are a fragmented habitat (such as that present in hills and mountains) and the presence of relatively elderly farmers. Most LRs are directly used by the farm families, but a part is sold at local or wider range markets. The main reasons why the LRs have been maintained on-farm are their resistance and good productivity under difficult or harsh climatic conditions, traditions or particular organoleptic characteristics, which make them highly valued in local and urban markets, and/or simply because they are prized by the families. The adoption of LRs should not be equated with a backward agriculture, since they are often grown using modern devices and practices.

However, social problems, such as decreased and ageing rural populations, cause progressive genetic erosion. For example, the farmers who currently maintain LRs of garden crops in central Italy are, on the average, over 63 years old and often declared that they felt they would not be able to carry on their activity much longer (Negri, 2003). The younger people who live in the country are often employed in agriculture part-time and often find it more convenient to buy seeds on the market rather than reproduce them themselves. Besides the lack of time needed to harvest, clean, and condition the seeds, the appropriate equipment is often not available on the farm. Loss of a crop-related culture is another constraint to reproducing seed or propagating plants, since younger farmers often lack the practical know-how that was generally used in the past (e.g., grafting). All this makes it difficult to increase cultivation or even to continue cultivation (which is more troubling for plant genetic resource conservation).

Expanding the market for typical products could help maintain on-farm those LRs that are already appreciated in niche markets (Piergiovanni and Laghetti, 1999; Negri, 2003). However, most LRs seem to be condemned to extinction.

5. WHICH VALUE-CONFERRING PROPERTIES DO LRs AND LR SYSTEMS HAVE?

In the following pages, I will briefly sketch and discuss possible values associated with the conservation of LRs and LR systems in an attempt to elicit a more profound awareness of the issues related to the conservation and maintenance of complex agro-ecosystems and to provide material for discussion, rather than to dwell on conservation philosophy or definitions.

5.1. *Direct and Indirect Utility*

LRs and LR systems should eventually be valued because they contribute to the good of agriculture, that is, because they have a direct or indirect utility.

Some possible reasons for not supporting the conservation of LRs and LR systems could be the following:

- It is possible to rely on more productive, stable, and uniform varieties (the above-mentioned "modern varieties") that give farmers a higher income than LRs. Income is certainly important for a farm family and unlike modern varieties, the economic potential of LRs in farming is considered to be low in most situations.
- There is no need to rely on already-adapted crop populations since the environment can be adapted to the crop (through irrigation, fertilization, pest control, and other agronomic devices and techniques) or new varieties can be bred.
- There are other, more important issues that need to be addressed in biological conservation and protection, e.g.:

  (a) Preserving wild populations of crops is much more important than preserving cultivated populations, such as LRs, which possess less genetic diversity.

(b) Reconstructing the landscape, which is now greatly simplified, by using different species is needed more than protecting different populations of a certain crop.
(c) In rebuilding the social context that has been destroyed by the exodus of families from the country, efficient services for rural populations are more deserving of the limited financial resources than reinforcing the pride in rural traditions or in family heritage.

- LRs can always be preserved *ex situ* (in germplasm banks);
- LRs that are presently conserved in germplasm banks or segregating populations obtained from crosses between modern varieties can be used if a variable population is needed to buffer attacks caused by biological agents or to help decrease the use of pesticides.

Some reasons for supporting the conservation of LRs and LR systems could be the following:

- LRs have a direct economic value because their products are often sold at much higher prices than those obtained from modern varieties.
- LRs have an indirect economic value, i.e.:

(a) They attract tourism and the people who want to enjoy something from the past, which for the most part, has been lost and to taste flavors that are particular to a given region.
(b) They have potential future use in breeding and in developing new farming systems. Some agriculture is evolving towards "low input" practices for which new varieties are needed. Locally adapted populations, whose innate diversity can withstand pest attacks, reduce the need for chemical control and lower the risk of environment pollution, could well suit the purpose. A growing number of organic farmers in Europe are looking for LRs in germplasm banks to reintroduce them into cultivation. The hope is that the LRs will perform better than modern varieties, even though no scientific evidence is available on this, yet. Regarding breeding, the LRs that have been maintained on-farm are in a continuous *equilibrium* with the environment and are always an "updated" source of useful genes.
(c) The cultural and familial substrate of LRs favor a social identity and cohesion in rural communities.
(d) On-farm evolution continues under complex selection pressures, which are often impossible to analyze as single factors. Since the future needs are not known, on-farm conservation could meet the demands of an unpredictable future.
(e) Besides biological evolution, new cultures, traditions, uses, and identity could be developed from already established LR traditions.
(f) Both biological and human-driven cultural evolution generate new resources for the future.

The decision to conserve LRs on the farm is often only based on the farmer's income, and the decision may vary from one farmer or farmers' community to another, depending on the possible economic returns in a local agricultural setting. Where agriculture is favored by soil fertility and/or climatic advantages, it would be difficult for a farmer to give up modern varieties for the generally lower-yielding local varieties. The opposite could be true where local production constraints favor more rustic crops the innate diversity of which gives a more stable production (Ceccarelli and Grando, 2000) and that consumers consider to be of better quality. The same holds true in situations where potential returns are considered, i.e., when a loss of income can be tolerated as a trade-off for less pollution, more stability, or greater biological safety.

The adaptation of the environment to the crop (through the use of irrigation, fertilizers and pesticides and purposely developed, genetically uniform varieties) instead of using variable populations, such as LRs, is the agricultural model used up to now, which many scientists reject because it is not sustainable.

The argument of inadequate economic resources to meet all the environmental conservation needs is a strong one. Limited resources dictate that a selection must be made among different needs in conservation. It would seem obvious that, when there are not enough financial resources for all the projects, the funds should be allocated according to the most important needs. Setting criteria and priorities is the key point and should depend on rating the values of the various alternatives. The fact is that priorities established by humankind may change unpredictably in the future with respect to people, environmental transformations, and availability of resources. In addition, the allocation of funds is often a response to transitory needs of particular groups of people rather than to scientifically sound needs. For the sake of biological conservation and environmental protection issues, let us assume that the degree of diversity is the value-conferring element. In such a case the maximum value should be assigned to the most diverse ecosystems (natural) and the lowest value to the least diverse systems (agro-ecosystems). Limiting the present discussion to agro-ecosystems, a higher value should first be assigned to systems based on more species, followed by those with more within-species diversity (LR systems), and lastly by the most simplified ones. Consequently, in the first instance, funds should be allocated to reconstructing the inter-specific level of diversity in agro-ecosystems.

With regards to conserving LRs only *ex situ,* it has been argued that this type of conservation is basically a static conservation, i.e., it does not allow the genetic composition of the LRs to change in response to environmental changes (*sensu latu*) (Frankel et al., 1995; Maxted et al., 1997). Conservation *ex situ* maintains a LR as it was when it was collected in the field, but not as it would be in the field today. This, then, is really not conservation as intended by the previously mentioned IUCN statement (i.e., the maintenance of benefits for future generations is questionable because evolution has been stopped). Nonetheless, *ex situ* conservation is surely a complementary approach to *in situ* conservation. It deters the risk of immediate extinction of certain populations when timely collection missions are carried out and sound sampling procedures of the genetic diversity are applied. It also meets the breeders' need for genes that are useful in breeding programs.

Finally, replacing LRs with other variable populations is an option that could be pursued. It could succeed if the LRs chosen to replace the former ones would have the characteristics needed to adapt to the proposed environment. The same is true if segregant populations or variable varieties were derived from crosses between lines that are adapted to the proposed environment and are resistant to the most common pests. In general, the use of variable populations to combat stresses deserves more attention by researchers, since very little data are available on the matter. However, to replace LRs as outlined above may satisfy the needs for a safer and less polluted environment, but it dispossesses the farmers' communities of their own biological material and culture related to it (knowledge, practices, uses, traditions, dialects). This also prevents new biological material and new culture evolving from the existing ones and inhibits the possibility of putting both to use. Consequently, replacement is an option to consider when LRs are no longer found in that territory, where LRs still exist, all efforts should be made to extend their use in crop production and recover the culture related to them.

Of all the points presented above, the instrumental motivations that are related to immediately improving the farmer's income are likely to be those most directly understood by the farmers whose activity is prevalently oriented to the market, as it is in most of Europe. There are examples of farmers who have resumed using LRs (though without restoring the complex systems where they had been generated) because the product obtained is of higher quality and has a more profitable market than that obtained with modern varieties. Instrumental motivations in favor of on-farm LR conservation easily prevail over those against it when this sort of opportunity value is recognized by the farmers.

This way of justifying on-farm conservation, however, is not fully convincing because it does not give due weight to the time dimension and it mostly stresses the importance that LRs can have *per se*, without considering them as an integral part of a very particular agricultural system.

The conservation concept cannot omit the "time" dimension: conservation and protection are *per se* related to the future and at this point, "the future" has to be considered indeterminate by definition. An egoistical approach related to the farmer's income can only have a term, such as years, during which it can be seen if the chosen approach (LRs conserved on-farm or not) yields the foreseen benefits for the farm family or farmers' community. This approach relies on personal (restricted community) interest, only. So, if farmers merely consider the economic balance of the alternative choices, they will miss considering the time dimension and the consequences that their choices will have on the future of the agro-ecosystem.

The identification of the future role of agriculture is also crucial at this point. Agriculture has a productive role, but can also furnish other services to the society and, in particular, the protection of the diversity of life and of territory. Which role should prevail in the future?

Presently, agriculture mostly has a productive role and feeds the world through intensive, not sustainable agricultural systems (Matson et al., 1997; Rasmussen et al., 1998). As the world enters into an era in which global food production is likely to double in order to continue to feed a growing population, human needs related to food production must be met without compromising the health of agro-ecosystems, i.e., their normal ecological processes and functions and without depleting resources (i.e., through sustainable agriculture). Consequently, the protective role of agriculture must prevail over the productive one. This is in accord with the concept of "ecological sustainability" proposed by Callicott and Mumford (1997), which is informed principally by population biology and evolutionary and community ecology and is aimed at preserving ecological integrity and biodiversity at every level of organization. In order to minimize the environmental impact, a shift toward agricultural systems that are more complex in terms of biodiversity and productive strategies is critical (Tilman, 1999).

Sustainable agricultural systems are in many ways similar to those based on LRs, because they give importance to among- and within-species diversity, recycling of organic matter, wise use of external inputs, etc. Unfortunately, these systems are likely to increase the costs of production, which makes it difficult to restore/maintain them.

On this topic Callicott and Mumford (1997) have noted that sustainable development should involve the reassessment of human wants, i.e., "the shifting of human demands from an environmentally destructive, manufacturing/consuming economy to an environmentally benign amenity/service economy." The substantial point then is the meaning we give to the term "economy." Does it merely refer to income for man today or does it refer to the wealth for the whole ecosystem in the future?

If "economy" means to estimate possible returns in a defined period of time, the benefit is intended for man only and man is seen as if he is outside of the ecosystem. Farmers could decide to continue to manage their crops (even including LRs), without considering the opportunity of restoring a greater complexity into agricultural production.

In contrast, if "economy" means to promote an unlimited wealth for the future, the maximum benefit is that for the whole ecosystem and humankind is seen as integral part of it. In this view the maintenance and/or restoration of dynamic, sustainable agro-ecosystem should be pursued even though they are likely to increase the costs of production.

Since farmers, and most people, are usually more concerned about immediate income rather than with the needs of future generations, everything possible should be done to elicit a reflection and discussion on the above-mentioned issues.

5.2. *Is There Something other than Actual and Potential Utility?*

It is certainly understood that LRs systems have an integrity of their own when the complex pattern of dynamic relationships between the physical environment and living beings is maintained. This complex pattern is the result of their long natural and cultural history. Some people perceive themselves as belonging to these systems because present-day society is rooted in them; farmers perceive this more than most other people.

Recalling the words of Aldo Leopold (1949), "We abuse land because we regard it as a commodity belonging to us. When we see land as a community [of soils, water, plants and animals] to which we belong, we may begin to use it with love and respect ... " because we attribute a value to it that is not merely an economic value, but an intrinsic value. Following his legacy of love and respect for the integrity, stability, and beauty of a biotic community ("the land") we can then attribute, beside an instrumental value, an intrinsic value to LR systems because of their integrity and the farmer's perception of belonging.

Intrinsic value has been defined as the non-anthropocentric, non-relational, non-instrumental goodness or worth that a thing has in and of itself, something that is not even possible to define or identify by any property (Pence, 2000; Russow, 2002; *The Internet Encyclopaedia of Philosophy*, 2002). It is not my intention to get into the debate about intrinsic/instrumental value in nature, but I would like to recall some main points that may be useful in formulating and carrying on a discussion about the reasons for conserving genetic resources in agro-ecosystems.

The development of the intrinsic value concept in environmental ethics and its relevance in the environmental debate and in decision-making has been clearly outlined and reviewed by Callicot (2002). For biocentric theories, all living beings (and for part of them, also populations, species, and ecosystems) have purposes (*teloi*) of their own. This characteristic of being "teleological centres of life" confers an intrinsic value to them. In turn, having an intrinsic value makes them worth being considered as "ends" (objects of moral concern), thus maintaining the Kantian architecture of a close linkage between moral end, intrinsic value, and value-conferring property. Callicott further explains that humans can value whatever they wish in nature: "most of us value things intrinsically when we perceive them as being part of a community to which we also belong," when we realize that our community is embedded in nature, and strongly defends the pragmatic efficacy of the intrinsic-value-in-nature discourse.

However, regarding intrinsic value, Rolston (1994) notes that "intrinsic value in the realized sense emerges rationally with the appearance of a subject-generator [of value][man]." "Actual value is an event in our consciousness, though natural items … have potential intrinsic value." In other words, elements of nature or natural systems have a value only when man attributes it to them, they do not have a value *in se*. Also Russow (2002), discussing whether nature can be a subject of moral concern, stipulates that "harm" and "benefits" are to be understood as a matter of moral concern referred to someone or something, and demonstrates that nature cannot be harmed, since it is not sentient and has no interest to care about. Lack of identity has also been invoked to explain why an intrinsic value cannot be applied to "nature": LR systems are certainly not sentient beings or subjects capable of evaluating what is worthwhile for themselves; they lack a precise identity, are contingent and transitory.

Consequently, if it is possible to elicit motivations for on-farm conservation by relying on the integrity and the sense of belonging to the LR systems, it is certainly more troublesome to compose the above-mentioned theoretical questions. Philosophers will do a much better job than I can on the topic, and I would just like to recall that for a growing number of environmental philosophers, it makes no difference to environmental practice and policies whether we think of nature as having intrinsic or only instrumental value.

Norton, for example, (2000) argued that both the instrumental and the intrinsic value theories share four questionable assumptions: (1) a sharp distinction between intrinsic and instrumental value; (2) an entity orientation; (3) moral monism; and (4) placeless evaluation. He suggested that by rejecting these premises a more pluralistic and comprehensive approach could be followed.

It should also be noted that a comprehensive environmental ethics reallocates the value across the whole continuum made up of species, ecosystems, and, finally, the whole Earth. Many biologists already recognize the complexity of biodiversity as a value-conferring property (see for example

Rosa, 2000), but also philosophers, like Rolston (1991), note that both instrumental and intrinsic value are unsatisfactory concepts when applied to nature. The value in nature cannot be considered simply as the aggregation of the values of its individual components (individuals, species, ecosystems), since it is their integration and interaction that really counts. The whole complex of relationships that has given (and still gives) rise to products and processes, or in other words, the systemic creativity of the Earth, is a value. We cannot risk losing it, otherwise we will lose too much of value (Rolston, 1991, 1994, 2000, 2003). Rolston (1994) also reconciles a whole range of varied values, while attributing a foundational role to the systemic value. "All value does not end in either human or non-human intrinsic value." … "Values are intrinsic, instrumental and systemic and all three are interwoven, no one with priority over the others in significance, although systemic value is foundational." … "There are no intrinsic values, nor instrumental ones either, without the encompassing systemic creativity."

In summary, therefore, LRs should be valued not so much for themselves, but for the complexity and creativity of the agro-ecosystems that they have generated and of which they are an integral part. The LR system is a different form of agriculture, which is rich in traditions, and helps maintain the biological diversity and amenity of the countryside, as well as vibrant rural communities that should be able to generate and maintain sustainable ecosystems. The deep interrelationship between the biological and cultural contexts, where LRs have developed and can be maintained and further developed, is a force that is creating new adaptive responses to changing socio-economical, as well as eco-physical, processes.

6. CONCLUSIONS

LRs have played an important role in the development of agriculture throughout the centuries, and are also pivotal components of sustainable agro-ecosystems. Some of these systems still exist in Europe, and are partially taking advantages of "modern" devices and practices.

Considering the needs of future generations, it can be said that both the instrumental and the complexity- and creativity-based motivations in favor of LR-based systems prevail, justify their maintenance, and encourage their restoration. If this shift toward a different system has an added cost with respect to the present, we should be willing to pay it for future wealth.

Although a simple "return to the past" is not possible, especially with respect to the use of mechanical tools, it is at least possible to change oversimplified production systems, restore fences and wooded areas on the farm, recycle organic matter, and use variable populations such as LRs, instead of uniform varieties, to a wider extent. These types of changes are being facilitated by the existing framework of agricultural policies and by a general improvement in the standard of living in most parts of Europe. A better advantage of this favorable situation should be taken.

The longing of people for a better environment and diversity conservation does not appear to be deeply motivated, because biological processes of crop production and the interactions among living beings are poorly understood and there is little consciousness of how human life depends on primary production. On the contrary, the consciousness that we depend on other living beings, that we have broken many of the bonds among living beings and their environment, and that these bonds must be tied again for sustainable development should be at the basis of environmental concern.

Until people's desires are not profoundly substantiated by this sort of motivation, a more robust request for a better environment and the full use of the legislative framework, which already exists in Europe, will be hampered. At the same time most of the resources that give diverse food, have less polluting systems of production, provide variety of landscapes, and favor the maintenance of links between culture and crop will continue to disappear.

Reflecting on the values of the environment could help people to acquire a greater awareness of importance of the agro-biodiversity, reinforce the links between rural communities, their environment and plant genetic resources, foster pride among young farmers with regards to their natural and cultural heritage and, in the end, favor conservation. In this respect people should be educated to rediscover the interdependence of human life and other creatures and to really respect and care for the environment, so to ask for a higher quality environment more forceful. As for the farmers' attitudes, a change in the rural, social, and cultural context is also needed to shift the present systems towards environment friendly agricultural systems. Some studies indicate that future policies should put more emphasis on farmer environmental education in order to help move farmers along the conservation spectrum in Europe (Pyrovetsi and Daoutopoulos, 1999; Beedell and Rehman, 2000; Wilson and Hart, 2001). Farmers, as people in general, should be made aware of the fact that agriculture is more than a source of actual or potential income, since it also plays a role in sustainability and in the protection of environmental biodiversity.

Circulating ideas about on-farm conservation could also move sociologists and politicians to take responsibility and re-direct their action to more properly conserve biodiversity in agriculture. Policy makers concerned with agro-ecosystems should support activities aimed at helping people reflect on what will bring about the greatest good for the future. Referring in particular to farmers, activities should be undertaken to promote the awareness that they are the prime stewards and managers of the environment. This awareness can then be handed down from one generation to the next. When farmers or farmers' communities finally recognize the important role that agriculture plays in ecological sustainability, it will then be easier to maintain agro-biodiversity in the field.

ACKNOWLEDGEMENTS

Thanks are due to Prof. Steven Brush, University of California, Davis, Prof. Humberto Rosa, University of Lisbon, and to four anonymous referees for helpful suggestions during the preparation of this paper.

REFERENCES

Altieri, M. A. and L. C. Merrick, ''*In Situ* Conservation of Crop Genetic Resources through Maintenance of Traditional Farming Systems,'' *Economic Botany* 41(1987), 86–96.

Archer, G., ''A Study of Farm Outlets in North West England,'' *British Food Journal* 105 (2003), 531–541.

Archer, G., J. G. Sánchez, G. Vignali, and A. Chaillot, ''Latent Consumers' Attitude to Farmers' Markets in North West England,'' *British Food Journal* 105 (2003), 487–497.

Asfaw, Z., ''The Barleys of Ethiopia,'' in S. B. Brush (ed.), *Genes in the Field* (IPGRI, Rome; IDRC, Ottawa; Lewis, Boca Raton, FL, 2000), pp. 3–26.

Beedell, J. and T. Rehman, ''Using Social-Psychology Models to Understand Farmers' Conservation Behaviour,'' *Journal of Rural Studies* 16 (2000), 117–127.

Bellon, M. R., ''The Dynamics of Crop Infraspecific Diversity: A Conceptual Framework at the Farmer Level,'' *Economic Botany* 50 (1996), 26–39.

Black, J. N., ''Energy Relations in Crop Production – A Preliminary Survey,'' *Annals of Applied Biology* 67 (1971), 272–278.

Brummer, E. C., ''Diversity, Stability and Sustainable American Agriculture,'' *Agronomy Journal* 90(1) (1998), 1–2.

Brush, S. B., ''Ethnoecology, Biodiversity and Modernization in Andean Potato Agriculture,'' *Journal of Ethnobiology* 12 (1992), 161–185.

Brush, S. B., ''The Issues of *In Situ* Conservation of Crop Genetic Resources,'' in S. B. Brush (ed.), *Genes in the Field*, (IPGRI, Rome; IDRC, Ottawa; Lewis, Boca Raton, FL, 2000), pp. 3–26.

Brush, S. B. and E. Meng, ''Farmers' Valuation and Conservation of Crop Genetic Resources,'' *Genetic Resources and Crop Evolution* 45 (1998), 139–150.

Callicott, J. B., ''The Pragmatic Power and Promise of Theoretical and Environmental Ethics: Forging a New Discourse,'' *Environmental Values* 11 (2002), 3–25.

Callicott, J. B. and K. Mumford, ''Ecological Sustainability as a Conservation Concept,'' *Conservation Biology* 11 (1997), 32–40.

Ceccarelli, S. and S. Grando, ''Barley Landraces from the Fertile Crescent: A Lesson for Plant Breeders,'' in S. B. Brush (ed.), *Genes in the Field* (IPGRI, Rome; IDRC, Ottawa; Lewis, Boca Raton, FL, 2000), pp. 51–76.

Esquinas-Alcazar, J. T., "Plant Genetic Resources," in M. D. Hayward, N. O. Bosemark, and I. Romagosa (eds.), *Plant Breeding: Principles and Prospects* (Chapman & Hall, London, 1993), pp. 33–51.

EUROSTAT – II Sole 24 Ore, *L'Europa in Cifre* (CECA-CE-CEEA, Bruxelles, Luxembourg, 1999).

Faeth, P., *Agricultural Policy and Sustainability: Case Studies from India, Chile and The U.S.* (World Research Institute, Washington, DC, 1993).

Frankel, O. H., A. D. H. Brown, and J. J. Burdon, *The Conservation of Plant Biodiversity* (Cambridge University Press, Cambridge, 1995).

Geoffroy, V., D. Sicard, J. C. F. de Oliveira, M. Sevignac, S. Cohen, P. Gepts, C. Neema, T. Langin, and M. Dron, "Identification of an Ancestral Resistance Gene Cluster Involved in Coevolution Processes between *phaseolus vulgaris* and Its Fungal Pathogen *Colletotrichum lindemuthianum,*" *Molecular Plant Microbe Interactions* 12(9) (1999), 774–784.

Gepts, P., "A Comparison between Crop Domestication, Classical Plant Breeding and Genetic Engineering," *Crop Science* 42 (2002), 1780–1790.

Grigg, D., *Storia dell'Agricoltura in Occidente* (The Transformation of Agriculture in the West, Oxford, Basil Blackwell, 1992) (Il Mulino, Bologna, Italy, 1994).

Halfacree, K. H., "Talking About Rurality. Social Representations of the Rural as Expressed by Residents of Six English Parishes," *Journal of Rural Studies* 11 (1995), 1–20.

Hammer, K., H. Knupffer, G. Laghetti, and P. Perrino, *Seeds From The Past. A Catalogue of Crop Germplasm in Central and North Italy* (Germplasm Institute of C.N.R., Bari, Italy, 1999).

Hammer, K., Th. Gladis, and A. Diederichsen, "*In Situ* and On Farm Management of Plant Genetic Resources," *European Journal of Agronomy* 19 (2003), 509–517.

Harlan, J. R., *Crops and Man*. 2nd edn (ASA-CSSA, Madison, WI, 1992), pp. 117–133.

IUCN, *The World Conservation Strategy* (IUCN, Gland, 1980).

Jones, O., "Lay Discourses of the Rural: Developments and Implications for Rural Studies," *Journal of Rural Studies* 11 (1995), 35–49.

Leopold, A., *A Sand County Almanac and Sketches Here and There* (Oxford University Press, New York, 1949). Foreward, viii.

Le Coeur, D., J. Baudry, F. Burel, and C. Thenail, "Why and How We Should Study Field Boundary Biodiversity in an Agrarian Landscape," *Agriculture*, *Ecosystem and Environment* 89 (2002), 23–40.

Louette, D., "Traditional Management of Seed and Genetic Diversity: What Is a Landrace?" in S. B. Brush (ed.), *Genes in the Field* (IPGRI, Rome; IDRC, Ottawa; Lewis, Boca Raton, FL, 2000), pp. 109–142.

Maxted, N., B. V. Ford-Lloyd, and J. G. Hawkes, "Complementary Conservation Strategies," in N. Maxted, B. V. Ford-Lloyd, and J. G. Hawkes (eds.), *Plant Genetic Conservation*, (Chapman and Hall, London, 1997), pp. 15–39.

Marshall, E. J. P. and A. C. Moonen, "Field Margins in Northern Europe: Their Functions and Interactions with Agriculture," *Agriculture, Ecosystem and Environment* 89 (2002), 5–21.

Matson, P. A., W. J. Parton, A. G. Power, and M. J. Swift, "Agricultural Intensification and Ecosystem Properties." *Science* 277 (25 July 1997), 504–509.

Negri, V., "Landraces in Central Italy: Where and Why they Are Conserved and Perspectives for their On Farm Conservation," *Genetic Resources and Crop Evolution* 50(8) (2003), 871–885.

Negri, V., H. Becker, J. Onnela, A. Sartori, S. Strajeru, and B. Laliberté, ‘‘A First Inventory of On Farm Conservation and Management Activities in Europe Including Some Examples of Cooperation between the Formal and Informal Sector,’’ in B. Lalibertè, L. Maggioni, N. Maxted, and V. Negri (compilers), *Report of the ECP/GR In situ/on farm Conservation Network Task Forces Meeting*, Isola Polvese, Perugia, 19– 21 May (IPGRI, Rome, 2000), pp. 14–30.

Norton, B. G., ‘‘Biodiversity and Environmental Values: In Search of a Universal Earth Ethic,’’ *Biodiversity and Conservation* 9 (2000), 1029–1044.

Nowosielka, D. and W. Podyma, ‘‘Collection Missions in the Territory of Poland During 1998–1999,’’ in W. Swiecicki, B. Naganowska, and B. Wolko (eds.), *Broad Variation and Precise Characterisation*, Proc. Eucarpia Genetic Resources Section Meeting, Poznan, Poland (May 16–20, 2001), pp. 67–70.

Paoletti, M., ‘‘Biodiversity in Agroecosystems and Bioindicators of Environmental Health,’’ in M. Shiyomi and H. Koizumi (eds.), *Structure and Function in Agroecosystems Design and Management. Advances in Agroecology* (CRC press, Boca Raton, FL, 2001), pp. 11–44.

Papa, C., ‘‘The ‘farre de Montelione’: Landrace and Representation,’’ in S. Padulosi, K. Hammer, and J. Heller (eds.), *Hulled Wheats. Promoting the Conservation and Use of Underutilised and Neglected Crops. 4*. Proceedings of the First International Workshop on Hulled Wheats, 21–22 July, 1995, Castelvecchio Pascoli, Italy (IPGRI, Rome, 1996), pp. 154–171.

Papa, C., ‘‘Il farro a Monteleone di Spoleto: Pratiche Agrarie, Consuetudini Giuridiche e Ritualità,’’ in C. Papa (ed.), *Il Farro. Saperi, Usi e Conservazione Delle Varietà Locali*. Quaderni del CEDRAV 1 (CEDRAV, Cerreto di Spoleto, Italy, 1999), pp. 9–26.

Pence, G., *A Dictionary of Common Philosophical Terms* (The McGraw-Hill Companies Inc., New York, 2000).

Piergiovanni, A. R. and G. Laghetti, ‘‘The Common Bean Landraces from Basilicata (Southern Italy): An Example of Integrated Approach Applied to Genetic Resources Management,’’ *Genetic Resources and Crop Evolution* 46 (1999), 47–52.

Pimentel, D. and G. H. Heichel, ‘‘Energy and Sustainability of Farming Systems,’’ in R. Lal and F. J. Pierce (eds.), *Soil Management for Sustainability* (Soil and Water Conservation Society, Ankeni, IA, 1991), pp.113–123.

Pyrovetsi, M. and G. Daoutopoulos, ‘‘Farmers Needs for Nature Conservation Education in Greece,’’ *Journal of Environmental Management* 56 (1999), 147–157.

Rasmussen, P. E., K. W. T. Goulding, J. R. Brown, P. R. Grace, H. H. Janzen, and M. Korschens, ‘‘Long Term Agroecosystems Experiments: Assessing Agricultural Sustainability and Global Change,’’ *Science*, 282, (30 October 1998), 893–896.

Rolston, H. III., ‘‘Environmental Ethics: Values in and Duties to the Natural World,’’ in F. H. Bormann and S. R. Kellert (eds.), *The Broken Circle: Ecology, Economics, Ethics* (Yale University Press, New Haven, 1991), pp. 73–95.

Rolston, H. III., ‘‘Value in Nature and the Nature of Value,’’ in R. Attfield and A. Belsey (eds.), *Philosophy and the Natural Environment*, Royal Institute of Philosophy Suppl. 36 (Cambridge University Press, Cambridge, 1994), pp. 13–30.

Rolston, H. III., ‘‘The Land Ethic at the Turn of the Millennium,’’ *Biodiversity and Conservation* 9 (2000), 1045–1058.

Rolston, H. III., ‘‘Environmental Ethics,’’ in N. Bunnin and E. P. Tsui-James (eds.), *The Blackwell Companion to Philosophy* (Blackwell Publ., Oxford, 2003), pp. 517–530.

Rosa, H. D., "Conservação da Biodiversidade: Significado, Valorização e Implicações Éticas," *Revista Jurídica do Urbanismo e do Ambiente* 14 (2000), 179–204.
Russow, L-M., "Environment. Case Study: Marie the Envinronmentalist," in G. Comstock (ed.), *Life Science Ethics* (Iowa State Press, Ames, 2002), pp. 93–123.
The Internet Encyclopaedia of Philosophy. http://www.utm.edu/research/iep/.
Tilman, D., "Global Environmental Impacts of Agricultural Expansion: The Need for Sustainable and Efficient Practices," *Proceeding of the National Academy of Science*. *USA* 96 (May 1999), 5995–6000.
Tilman, D., "Causes, Consequences and Ethics of Biodiversity," *Nature* 405 (11 May 2000), 208–211.
UNCED, *Convention on Biological Diversity* (Geneva, United Nations Conference on Environment and Development, 1992).
Van Dam, F., S. Heins, and B. S., Elbersen, "Lay Discourses of the Rural and Stated and Revealed Preferences for Rural Living. Some Evidence of the Existence of a Rural Idyll in the Netherlands," *Journal of Rural Studies* 18 (2002), 461–476.
Van Dijk, G., "Biodiversity and Multifunctionality in European Agriculture: Priorities, Current Initiatives and Possible New Directions," in Laura Buguna-Hoffmann (ed.), *Agricultural Functions and Biodiversity – A European Stakeholder Approach to the CBD Agricultural Biodiversity Work Programme* (European Center for Nature Conservation, Tilburg, 2001), pp. 123–140.
Zeven, A. C., "Landraces: A Review of Definitions and Classifications," *Euphytica* 104 (1998), 127–139.
Zeven, A. C., "Results of Activities to Maintain Landraces and Other Material in Some European Countries *In Situ* Before 1945 and What We May Learn from Them," *Genetic Resources and Crop Evolution* 43 (1996), 337–341.
Ziemann, M. and S. Thomas, "Wer Kauft Bio-Handelsmarken?" *Ernährungs-Umschau,* 50 (2003), b21–b24.
Wilson, G. A. and K. Hart, "Rural Co-operation and Participation. Farmer Participation in Agri-Environmental Schemes: Towards Conservation-Oriented Thinking?" *Sociologia Ruralis* 41 (2001), 254–274.
Worede, M., T. Tesemma, and R. Feyssa, "Keeping Diversity Alive: An Ethiopian Perspective," in S. B. Brush (ed.), *Genes in the Field* (IPGRI, Rome; IDRC, Ottawa; Lewis, Boca Raton, FL, 2000), pp. 143–161.

Dip. Biologia Vegetale e Biotecnologie Agroambientali
(Department of Plant Biology and Agro-Environmental Biotechnology)
Università degli Studi
Borgo XX Giugno 74
06121 Perugia
Italy
E-mail: vnegri@unipg.it