



# Agricultural heritage systems and agrobiodiversity

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## Abstract

Agriculture is one of the main human activities with direct and indirect effects on the environment. The abandonment of many traditional agricultural practices, mainly for their inability to meet the current requirements of industrial agriculture, has brought to unsustainable agricultural systems characterized by high external energy inputs and by a high fragility to environmental and political shocks. Therefore, sustainable agriculture is nowadays crucial for preserving the environment. Agricultural heritage systems are receiving increasing attention at the international level, as testified by the establishment of the Globally Important Agricultural Heritage Systems (GIAHS) Programme by the Food and Agriculture Organization (FAO). The aim of the GIAHS Programme is, in fact, to identify and safeguard agro-silvo-pastoral systems resulting from the co-existence between humans and nature, which survived using traditional techniques are still providing many ecosystem services, while maintaining magnificent landscapes, wild and agricultural biodiversity, ancestral knowledge, and strong cultural and social values. These systems, based on sustainable practices, are still able to provide food and livelihood security, resources and services to local communities, but are also examples of adaptation and mitigation to climate change and to different and often difficult environmental conditions, as well as models of resilience and sustainability. In 2018 the Italian Agency for Development Cooperation (AICS), together with the Department of Agriculture, Food, Environment and Forestry (DAGRI) of the University of Florence, developed a project called “GIAHS Building Capacity”, aimed at identifying agricultural heritage sites in different parts of the world. This Special Issue collects the results of investigations carried out in thirteen sites in Central and South America, Europe, Africa and Asia offering a wide and coherent perspective on agricultural heritage systems across the world. The papers included in the Special Issue proved that agricultural heritage systems, despite some vulnerabilities mainly due to socio-economic causes rather than to environmental ones, still provide different ecosystem services to local communities, including: food and byproducts supply, soil erosion protection, hydrogeological risk and deforestation defense, agrobiodiversity and biodiversity conservation, cultural landscape preservation, agro-tourism; at the same time they can be important for transmitting traditional knowledge to new generations and for the local identity. The GIAHS programme can play a key role in preserving traditional agricultural systems, and their related agrobiodiversity and ecosystem services, both in

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developing and developed countries. In fact, its aim is not limited to the conservation of these systems, but the whole Programme is based on the concept of dynamic conservation, as sustainable innovations are needed for the preservation of agricultural heritage systems and, therefore, for the future of rural areas and of rural communities. The research is part of the activities promoted by the UNESCO Chair on Agricultural Heritage Landscapes established at the University of Florence.

**Keywords** Cultural landscapes · Agrobiodiversity · Agricultural heritage · GIAHS

## Introduction

Today the world is facing numerous challenges in the face of changes in almost every sphere of life. This clearly seems to be a transition period in the economic, social, ethical, cultural, and technological fields, and this is in addition to modifications in weather conditions and cycles of nature, caused by a harsh and sudden climate change occurring in our planet. According to the analysis of scientists, the impact of these changes is stronger due to the effect of unsustainable practices carried out by human activities. Examples of these practices are the incorrect, imbalanced and unsustainable use of natural resources, as well as untenable development models, which do not consider long term impacts or “side effects” (Tsiafouli et al. 2015; Karp et al. 2012; Rezzoug 2019; IPBES 2019). All this is worsened by inadequate policies and insufficient actions (Sutherland 2002).

One of the human activities which has a direct relationship with nature and environment, is agriculture (including forestry, fisheries, and livestock) which is considered as one of the main drivers of this negative trend, representing the greatest immediate threat to species and ecosystems. In fact, unsustainable farming practices result in land use changes, habitat loss, inefficient use of water, soil erosion and degradation, pollution, and genetic erosion, among many other negative impacts on wild and human life (Robertson et al. 2000; Bindi and Olesen 2011). Simultaneously, agriculture is suffering from climate change and natural resource loss, being a direct user of soil, water and biodiversity.

Nevertheless, when agriculture is practiced in a sustainable way, it can contribute to the preservation and restoration of habitats, to the protection of watersheds, and to the preservation and improvement of soil health and water quality (Howden et al. 2007). In addition, sustainable farming and fisheries areas represent important habitats for many wild species (Harvey et al. 2005).

The use of sustainable and ecological practices is the key feature distinguishing traditional agriculture from modern and intensive one. Traditional agricultural practices developed over decades, even centuries, based on long experience and proven traditions. Traditional agriculture does not provide enormous yields, but ensures sustainable yields over time, thanks to time-tested technologies and traditional know-hows, being more sustainable and less polluting than industrial techniques, as it has to rely on local and sometimes scarce resources (water, soil, etc.) with low external energy inputs. This type of agriculture can be found most often in small scale farms and as subsistence agriculture. In addition, traditional agricultural practices are related to the concept of biocultural diversity, a dynamic aspect arising from the links between cultural and biological diversity, and resulting from the combination of historical and on-going environmental and land use processes and cultural

heritage (Agnoletti and Rotherham 2015). Cultural landscapes managed through traditional agro-silvo-pastoral practices, became reservoirs, and even hotspots, of biocultural diversity, especially the ones with complex land-use mosaics, such as those existing in Europe in the 19th century before agricultural industrialization (Agnoletti and Rotherham 2015). This is not true only for agricultural landscapes, as also cultural forests and agroforestry systems based on traditional forest knowledge are also rich in biological diversity. This knowledge is not only important as a historical or cultural heritage, but is crucial for the future of rural areas, as traditional agricultural and/or forest knowledge and related landscapes support the economic development of rural areas, also through tourism and promotion of local products, contributing to the conservation of the biodiversity generated by human influence on the landscape, and to the quality of life of the local communities (Parrotta and Agnoletti 2007).

Based on this new approach to sustainable rural development, in 2002 FAO launched the concept of Globally Important Agricultural Heritage Systems (GIAHS), to identify and safeguard agricultural sites which have survived using traditional techniques and are still providing many ecosystem services, while maintaining magnificent landscapes, wild and agricultural biodiversity, ancestral knowledge transmitted through generations, and strong cultural and social values (Koochafkan and Altieri 2011). From 2015, based on the outcomes of the 39th FAO Conference, GIAHS has become an FAO corporate programme, with a stable structure and clear contribution to FAO's mandate and objectives. The background of creation and maintenance of these systems are farmers' efforts to overcome disadvantageous and even harsh environmental conditions and to increase and stabilize crop yields in a sustainable manner. Building on generations of accumulated knowledge and the experience of smallholders, family farmers, and indigenous communities, these systems have been adapted to ever changing environment and climate conditions, finally acquiring resilience and robustness so as to ensure food and livelihood security to the local communities; at the same time, they proved to be capable of reducing risks, such as hydrogeological ones. In addition, these traditional systems are currently receiving increasing attention at the international and policy level as examples of sustainable adaptation and mitigation to climate change and as models of resilience and sustainability, and this is why they are not "out-dated" (Zhang et al. 2017; Kajihara et al. 2018; Santoro et al. 2020).

These traditional systems become crucial not only in cases of climate conditions worsening, but also when political and economic shocks occur, as in the case of the current war between Russia and Ukraine. The globalization of cereal production, with few countries producing most of the amount traded, few companies controlling the market and some North African countries almost entirely depending on imports from Russia and Ukraine, may turn a local crisis into a world food crisis, because there are no longer local small producers capable of providing enough cereals (Ali et al. 2022; Glauben et al. 2022). Globalization has put small famers in many regions of the world "out of the market" basically because they are no longer competitive with prices and amounts. Nevertheless, traditional agricultural systems could ensure local food security if supported by specific national and international policies.

GIAHS are defined as "remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development" (FAO, 2002). As stated in the above definition, GIAHS are living and evolving systems of human communities in an intricate relationship with their territory, in connection with culture, the

agricultural landscape, or biophysical and wider social environment. Human communities and their livelihood activities have continuously adapted to the potentials and constraints of the environment and have shaped the landscape and the biological environment at different degrees. The resilience of many GIAHS sites has been developed and adapted to cope with climatic variability and change, natural hazards, new technologies and changing social and political situations, so as to ensure food and livelihood security and alleviate risks.

The features of these systems, in terms of their agricultural and cultural heritage value, their relevance to global concerns addressing sustainable development, biocultural diversity, including agro-biodiversity and ecosystems management, have been categorized into five criteria. These five criteria have been developed to represent the totality of the functionalities, goods, and services provided by agricultural heritage systems, reflecting the complex relationships and linkages between the different system's features:

1. Food and livelihood security.
2. Agro-biodiversity.
3. Local and traditional knowledge systems.
4. Cultures, value systems, and social organisations.
5. Landscapes and seascapes features.

One of the five criteria of the GIAHS Programme is specifically devoted to agrobiodiversity, testifying the strong interlinkages between agricultural heritage systems, traditional knowledge, and agrobiodiversity preservation and valorization. This concept has become increasingly important in the last three decades, and, according to the FAO definition, it corresponds to “the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems” (FAO 1999). Agrobiodiversity preservation is not only crucial *per se*, but, according to different studies it can effectively contribute to food security, to reduce the pressure of agriculture on fragile areas and endangered species, to make farming systems more resilient and sustainable, to pest management, to preserve soil and soil fertility, to diversify products and income opportunities, and to reduce dependency on external inputs and in particular on fossil fuels and chemicals (Thrupp 1997, 1998; Kahane et al. 2013). Supporting and promoting traditional agricultural systems and related cultural landscapes is therefore the best strategy to preserve and valorize agrobiodiversity and biodiversity in agricultural areas, at the same time dealing with current global challenges, such as migration, climate change, and food security (Jackson et al. 2007; Zimmerer 2014).

Considering the above, in 2018 the Italian Agency for Development Cooperation (AICS), together with the Department of Agriculture, Food, Environment and Forestry (DAGRI) of the University of Florence, developed a project called “GIAHS Building Capacity”, aimed at identifying agricultural heritage sites in Asia, Africa, Central and South America. The project is today part of the activities of the UNESCO chair on agricultural heritage landscapes, established at the University of Florence. This paper's collection represents the

results of the investigations carried out in these regions, as well as in some areas of Europe, focusing on the relationships between agricultural heritage systems and biodiversity.

The papers included in this special issue, all linked to the concepts of biodiversity and of agrobiodiversity, explore different aspects and issues, highlighting the key role of traditional knowledge in the preservation and enhancement of agrobiodiversity, but also in providing different Ecosystem Services to local communities around the world.

## Adaptation to difficult environmental conditions

One of the concepts raised in various included papers relates to the adaptation of farmers to difficult environmental conditions through the application of different, and sometimes ingenious, techniques in order to make the most of the scarce environmental sources. This can include water scarcity or steep slopes, as in the case of dry, rocky and steep Mediterranean slopes, as reported for the terraced landscapes next to the Shouf Biosphere Reserve (Lebanon), for Vallecorsa (Italy) or for Southern Tunisia. In the Shouf Biosphere Reserve the diversity of the land uses, and the richness of the biota also raise the importance of the role of the reserve in maintaining the complex ecosystem and increasing its resilience capacity. In this study, it was shown that distance from roads to terraced areas is a fundamental factor in the preservation and maintenance of terraces, in addition to the aspect and the slope that influence the positioning of the terraces and therefore the species cultivated on them. The terraces themselves, with various types of stones and different arrangements, constitute a source of biodiversity because they allow having a diversified landscape mosaic that gives an added value to the environment (Corrieri et al. 2021).

In Vallecorsa (Italy) dry-stone terraces and “*ciglioni*” (earth terraces) cover 17.86% of the study area and are mainly occupied by olive groves. The construction of terraces and dry-stone walls to obtain a suitable surface for crops represents an adaptation to a hostile environment over time and an expression of the biocultural diversity of the area. Dry-stone walls provide breeding and/or feeding sites for the small local fauna and can be a great habitat for local plants, lichens and mosses living among the stones. The extensive system of dry-stone walls also acts as an ecological corridor, along with hedges and land cover heterogeneity, and at the same time they became the main feature characterizing this unique cultural landscape (De Pasquale and Sagliocco 2022). In other cases, we have the example of adaptation to very arid climates, as with *jessour* of southern Tunisia, a special type of embankment that permits the cultivation of small surfaces of land which are crucial to the livelihood of local farmers operating in harsh climatic conditions. The traditional water conservation system of *jessour* is widely spread in Southern Tunisia but also in neighboring countries where it is used for obtaining suitable conditions for the cultivation of olive, fig and other fruit trees, while cereals and vegetables can also be cultivated in the same plots (Piras et al. 2021). Opposite conditions are found in the agricultural system of the Inle Lake (Myanmar), where the local Intha people adapted to the excess of water by developing a system of floating islands used for the cultivation of vegetables. This system effectively contributed to the socio-economic development of the area, also because the resulting landscape became one of the major touristic attractions in Myanmar (Oo et al. 2022).

## Sustainable productions and food security

The case of the Inle Lake (Myanmar) is also an example of how traditional forms of adaptation are not important only for agrobiodiversity preservation, but can also generate effective and productive systems capable of providing good incomes for local farmers, as with local tomatoes now marketed all over the country (Oo et al. 2022). In other cases, traditional agroforestry and agricultural systems effectively contribute to local farmers' incomes and food security, thanks to the sustainable production of cash crops, as in the case of the agroforestry systems of Sierra del Rosario and Sierra Maestra (Cuba) as a result of local coffee production, or in the Viñales valley (Cuba) where small farmers produce high quality tobacco leaves. In Sierra del Rosario and in Sierra Maestra, the complex system created thanks to the preservation and introduction of shade trees and other cultivated species contribute to multiple benefits from both an ecological and an economic point of view. In fact, shade trees play an important role in erosion control and in maintaining soil productivity while generating additional products, such as timber, firewood, and fruits, providing important contributions to farmers' livelihoods, especially in seasons where other productivity is low. Considering this and that these systems are free from chemical inputs, they effectively contribute to the local mitigation of the effects of climate change by propitiating a favorable microclimate and increasing carbon storage. The present study, that contributed to give a framework of the traditional structure of agroforestry systems for coffee production in Cuba, provides at the same time an extensive list of the species involved in the systems, highlighting the contrast with intensive coffee plantations (Agnoletti et al. 2022). The information on the cultivation methods of coffee are rarely advertised when selling coffee or other traditional agricultural products to the general public, also when these products are included in international lists, such as the UNESCO Lists of Intangible Cultural Heritage. In the case of Viñales the landscape shows a high degree of diversity and cultural variety resulting from the specific management system and a strong social and environmental involvement. This study reviews the essential features of such an important agricultural heritage system as a complex, adaptive system, to improve the existing set of criteria for sustainable agroecological management contributing to the preservation of biodiversity. One of the most relevant characteristics of Viñales is the high degree of endemism, which places Cuba island as the main centre of evolution and speciation in the Antilles, making it one of the most important islands in the world (Fariás et al. 2021).

## Protection from soil erosion, hydrogeological risk and deforestation, conservation of agrobiodiversity and biodiversity

The development of terraces on steep slopes corresponds to the necessity of obtaining suitable surface for agricultural activities, but is also crucial for hydrogeological protection and soil conservation. The multifunctional role of these traditional systems is largely assessed by several papers in this special issue, i.e. in relation to the conservation of agrobiodiversity, as in the case of Teglio area in Valtellina (Italy) or the jhumscape of the Eastern Himalayas (India). In the Alpine area of Teglio, cultivations mainly concern rye, buckwheat, corn, barley, alpine wheat, chestnuts, and small orchards, supporting a wide range of agrobiodiversity, and especially an historical and cultural value. The local land-race varieties of

crops, formed over time, are a resource of genotypes adapted to high altitude agricultural environments; they have important nutraceutical properties and are closely associated with the local culture. Research has shown how, despite the depopulation and abandonment of agricultural areas, in the area a sufficient permanence of cultural practices and social uses remain that can be a solid starting point for a sustainable development of the territory focusing on agricultural and biocultural diversity (de Pasquale and Spinelli 2021).

Similar high altitude systems are those of the *jhumscape* of the Eastern Himalayas (India) where species diversity is evident in more than thirty species representing many landraces and four non-descript breeds of livestock. The food basket was supplemented with wild edible plants collected from fringes of the forests and fallow lands that are a part of the *jhumscape*. This agrobiodiversity is still crucial for ensuring food security and nutrition to local communities and, at the same time, local farmers are the main actors for in situ preservation of local landraces (Pandey et al. 2022). In addition, it is evident how some traditional anthropogenic structures build by local farmers for territorial organization and for improving their agricultural activities, such as living fences or dry-stone walls, have a key role for local biota, creating extensive ecological networks in traditional agricultural or pastoral landscapes, as demonstrated by the study comparing the linear features of *sabana de morro* (El Salvador) with pastures with carob trees (Italy) (Venturi et al. 2021).

Isolated trees in agricultural landscapes can also have an important ecological role, even if they are currently in danger of disappearance due to agricultural intensification or inappropriate management, as is happening to the big willows in the UK farming landscape whose importance is also related to cultural values, as they once played an important role in providing firewood, charcoal, fodder, wicker, and other services and products to the local farms (Rotherham 2021). These linear or punctual features also testify the cultural value of such landscapes contributing to their identity and distinguishing them from other landscapes, and therefore, to their potential attractiveness to tourists.

## Social importance

It is also important to highlight the social role of these systems, especially in developing countries, as reported for Sinana I District (southeast Ethiopia) where local women play a crucial role in farm diversification, conservation of agrobiodiversity, and ecological sustainability. The findings revealed that there is a strong linkage between gender, agriculture and biodiversity conservation within the study area. Women are a major working force in agriculture activities and play a great role in conserving agricultural diversity. They participate in land preparation, seed selection, crop management, harvesting and storing as well as livestock management. In addition, women and men have different tasks and motivations towards what to grow and manage: women tend to grow and manage crops that are used for maintaining the nutritional dietary and food security of the family, while men are involved in the production of cash crops (Assefa et al. 2022).

## Vulnerabilities

Despite the multifunctional role of traditional agro-silvo-pastoral systems and their importance for biodiversity conservation, it is noted that most of these systems are facing various threats, including agricultural intensification, abandonment of marginal areas and of traditional features, uncontrolled introduction of chemicals without an appropriate training of local farmers. The contribution on the Kraków-Częstochowa Upland (Poland) agricultural system highlights how various threats (i.e. decline of pasturing, intensification of agriculture, afforestation, spread of alien species and secondary succession) are causing major transformations that legal regulations and top-down measures are not able to counteract; the area is almost entirely protected but despite this the agricultural system is deteriorating and vanishing (Prus et al. 2021). This confirms the necessity of applying different standards based on the interrelations between humans and nature for studying and managing territories where human impact has a long history, from the ones developed for areas where anthropogenic impact is scarce (Agnoletti 2014).

The role of local communities appears to be crucial for the preservation of local agrobiodiversity, but also for dealing with global challenges, as in the case of the Indigenous Reserve of Monochoa (Colombia), where traditional management of local resources by indigenous communities is able not only to provide multiple products and ecosystem services or to preserve a huge agrobiodiversity, but is also important to counteract deforestation of the Amazon, testifying to how traditional knowledge can have a key role in safeguarding the future of our rural areas and of the related agrobiodiversity and natural biodiversity. The same paper also reports that the Amazon region in 2018, through a decision of the Colombian Supreme Court of Justice, was recognized as an “entity subject of rights, holder of the protection, conservation, maintenance and restoration” (Hernandez Marentes et al. 2021). This recognition represents a great advance at global level regarding legislative aspects, also because it is a recognition of the role of indigenous ethnic groups living in the Amazon for the preservation of these crucial ecosystems. This is different from what happens in many other areas of the world, Europe among others, where indigenous populations and traditional knowledge are often considered a threat rather than a resource for biodiversity preservation.

## Conclusions

The challenges that the world is facing today require consideration of all the opportunities that the long coevolution and co-existence between humans and nature may offer to solve the problem of an increasing world population while maintaining a healthy environment to support life on earth. The abandonment of many traditional agricultural practices, mainly for their inability to meet the current requirements of industrial agriculture, such as repeated high yields and low costs of labor, has brought us to unsustainable agricultural systems characterized by very high external energy inputs and, in parallel, a high fragility to environmental and political shocks. Besides the failure to solve problems such as hunger, or the conservation of biodiversity, intensive agricultural systems have caused socio-economic depression in many rural areas not suited to meet the technological and productive standards of modern intensive agriculture. This situation results in an impossibility to react to

environmental and political shocks, taking advantage of practices in areas characterized by traditional agriculture. These traditional systems may be less productive, but have proved to be much more resilient and capable of adapting to changing conditions. It is also time to overcome the often proposed rhetorical opposition between conservation and innovation. There is no innovation without the reworking of values settled in the past, and there is no conservation without the creation of new values.

The study, or even simply the description of the huge variety of traditional agricultural systems scattered across the world is a necessary task to ensure that this huge cultural heritage of humanity can still play a role in sustainable development and will not disappear, both as a result of intensification or of re-naturalization. Climate change may be inevitable and adaptation may be the only solution. Among others, it is important to ensure that the wide range of existing land races, varieties and species used in agricultural heritage systems is not further reduced. It is necessary to avoid the spread of monocultures and to preserve traditional knowledge. The importance of traditional systems is not solely due to agricultural production, but also to their multifunctional role in preserving traditional knowledge, agrobiodiversity and in situ conservation of local landraces, local identity, and cultural heritage. International programmes, such as GIAHS, can play a key role in preserving traditional agricultural systems, and its related agrobiodiversity, both in developing and developed countries (Agnoletti 2012). The GIAHS programme is based on the concept of dynamic conservation, as the preservation of agricultural heritage systems must not equate to static conservation. Improvements to farmers' quality of life thanks to innovations that respect the traditional features, such as more efficient irrigation systems or better market opportunities for local products, help to maintain these systems and represent examples of resilience and adaptability towards current global challenges, such as climate change. These agricultural systems, as well as the GIAHS programme itself, should be strongly and rapidly promoted, overcoming the resistance to change that globalization, both in economic and environmental terms, always propose to innovation.

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