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# Beyond Sustainability in Food Systems: Perspectives from Agroecology and Social Innovation

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**Abstract:** Food security faces many multifaceted challenges, with effects ranging far beyond the sectors of agriculture and food science and involving all the multiscale components of sustainability. This paper puts forward our point of view about more sustainable and responsible approaches to food production research underlying the importance of knowledge and social innovation in agroecological practices. Increased demand for food worldwide and the diversification of food choices would suggest the adoption of highly productive, but low-resilient and unsustainable food production models. However, new perspectives are possible. These include the revitalization and valorization of family-based traditional agriculture and the promotion of diversified farming systems as a social and economic basis to foster social-ecological conversion. Additionally, they encompass the forecasting of the Participatory Guarantee Systems (PGS) and the drafting of a new agenda for food sovereignty. Thanks to a desk analysis, the study describes and discusses these perspectives, their trajectories and action research implications. The results suggest the need to adopt a more inclusive and systemic approach to the described problems, as the solutions require the promotion of responsibility within decision makers, professionals and consumers. This appears essential for reading, analyzing and understanding the complex ecological-functional, social and economic relations that characterize farming systems, as well as mobilizing local communities.

**Keywords:** agroecology; DFS; social innovation; PGS; education; traditional knowledge

## 1. Introduction

In the last decades, at global level, food demand is increasing significantly, due to population and income growth and a change in people's dietary preferences [1]. In this context, the focus for many researchers and policy makers has been on the physical availability of food, facilitated by sufficient agricultural production [2], mainly based on the general concept that we need to increase global food availability by 70–100% in order to feed the world in 2050 [3]. Ironically, this statement reinforces the maintenance of the status quo, forecasting primarily the industrial-commercial (“agribusiness”) model, with the risk of forgetting the ecological basis of agriculture. Besides some positive strategies available in the literature, such as “sustainable intensification” [4,5] and extensive organic agriculture [6], large-scale agriculture generally relies on low resilient and unsustainable approaches of food production in practice. Furthermore, to comply with the substantial rise in food demand, agriculture can no longer count on the three conditions that are hardly considered by industrial agriculture paradigm and support policies: low-cost energy, abundant water and stable climate [7].

Currently, globally, most agricultural systems rely primarily on external inputs and cause a strong exploitation of natural resources: massive and no longer tolerable deforestation [8,9], water consumption and biodiversity loss [10], soil erosion and exhaustion [11,12], biogeochemical cycle alteration, high levels of climate-changing emissions [13], and a decline in the resilience of socioecological systems [14]. Moreover, despite some recent progresses, undernourishment and extreme poverty, as well as the increasing disparities, are still indubitable challenges. Contemporary food insecurity is much more than merely hunger. Meanwhile, it is not acceptable to talk just about *feeding*, it is necessary to talk about *nourishing* [15]. Considering that, at the global level, undernourishment affected more than 800 million people in 2018, and more than two billion children and adults are overweight or obese [16], it is clear that there is sufficient food for everyone, yet structural reasons for such unequal access have another origin. Globally, food systems produce enough for everybody, but not everybody has enough purchasing power to obtain sufficient food. This gives rise to an extreme form of inequality, occurring between those who have access to enough food and those who are forced to go hungry [2]. Additionally, looking at the consequences of the staggering growth in meat consumption [17], such as the transformation and destruction of many natural biomes for cattle breeding, and soybean plantation for animal feed [8,18], an issue which has been prominent for a long time [19], it is clear that the situation is getting out of hand.

We need to go beyond sustainability, fostering the responsibility of farmers, entrepreneurs, traders and consumers. Sustainability should overcome the formal concept, and an increased awareness of stakeholders about social justice and ecological compatibility is needed. New perspectives are possible and necessary to change the untenable paradigm so far adopted. This means acting in diverse dimensions of food production: maintaining soil and its interactions with plants and the environment, valorizing soil for ecosystem services [20], conserving water and energy [21], strongly reducing pesticides [22,23], forecasting new frontiers in physiology and genetics and generally in innovation [24], fostering cooperation and value creation in bottom-up approaches for food chains [25,26], and addressing climate smart farming [27]. This can be done using all possible integrated food production systems such as agroecology and permaculture [28,29], agroforestry [30,31], food forests and urban food systems [32–34], and contributing to a rural renaissance in mountains and disadvantaged inland areas [35,36], becoming more ecologically resilient and socially responsible.

To deal with such a complex and varied context, a transdisciplinary and holistic approach is needed. The matter concerns education, rural development, knowledge, innovation (social and technological) and diversification. At the same time, it embraces different challenges and dimensions: ecological (biodiversity protection and increasing resilience of agricultural systems) [37], social (farmers' recognition, the role of women and young people, local identity and labor dignity) [38], economic (promote short food supply chains, diversification in production and self-sufficiency) [26,39,40], political (stabilization of institutions and technological transfer, support to farmers' and native's knowledge and labor, subsidiarity in a decentralized government of common goods, justice, and striving against inequality) [15].

It could be necessary to promote the transition to circular and bioeconomies, using multiactor approaches and stimulating partnerships to scale up innovative methods and technologies, which should be supportive and fair. To do this, it is of paramount importance to reinstate and give value to neglected traditional knowledge, to promote agro-food system sustainability, at all levels [41,42]. Agroecological practices appear to be promising in this view, given that they are based on a set of skills and techniques developed initially from farmers and their field trial processes. In this way, local communities' capability to experiment, evaluate and expand their innovation power is emphasized, thanks to *farmer-to-farmer* research. Agroecological systems are deeply rooted in the ecological rationale of traditional agriculture, which provides examples of many successful agricultural systems characterized by a wide diversity of crops and animal species, soil maintenance and improvement, and good management of water and biodiversity—all of these practices based on traditional knowledge [43]. The agroecological approach tries to reconnect agronomical sciences with

ecology and territorial planning. It includes sociocultural needs of rural people and consumers, to reach resilience in the economic, environmental and cultural dimensions [44]. Agroecology currently holds multiple meanings, and can refer to the basic science of agronomy, an inter- or transdisciplinary science, a set of sustainable farming practices, and/or a social movement [45]. In addition, agroecology and its various approaches of Diversified Farming Systems (DFS) aim to go beyond alternative farming practices, trying to build agro-ecosystems with low dependence on external inputs, highlighting the interrelations between its components and the complex dynamics of ecological processes [44]. In other words, it is a matter of an ecological mindset focused on a holistic comprehension of the agro-food system.

In this context, a new awareness of land value and farming resilience is needed. Farmers' knowledge is in danger of disappearance because of industrial approaches and urban expansion [46]. At the same time, the number of farmers is decreasing everywhere in the world and, generally, they have a low bargaining power, even more where economy of scale is lacking. It is necessary to recognize the dignity of farmers—they are food providers, land caretakers and landscape safeguarders, generating protection, care and custody [47].

This paper has a twofold objective. The first objective is to present and denounce environmentally and socially unsustainable agricultural practice, which cause negative effects on environment, health, and social and intergenerational equity. The second objective is to detail and discuss some further directions and perspectives to take into consideration in order to make the food production systems more sustainable and responsible. These perspectives include farming approaches, agro-food networks and practices for agro-biodiversity conservation.

The discussion around these practices and perspectives is based on the grounded theory approach, as a methodology to provide insight into complex phenomena. Furthermore, the analysis considers the issues emergency from the current debate and evaluate the literature produced in the last twenty years, analyzed through a desk analysis. Specifically, papers published and uploaded in Google Scholar since 1999 on agroecological approaches have been considered and analyzed in order to characterize the current food production systems. The choice of considering mainly the last two decades for the discussion is related to the growing, since then, of a defined conflict between agroindustrial approach and traditional ways of farming, especially due to crucial technological novelties that have not been accompanied by social growth in rural areas. Examples of representative practices for each perspective have been selected based on the correspondence with direct experience in the field. Specific attention has been made to papers dealing with the social responsibility of smallholder farmers and scientifically sound techniques and practices. Reports by international organizations drafted in the same period and about the same topic have been taken into consideration.

The Section 2 profiles crucial unsustainable agricultural practices and their determinants, according to the most recent studies. The third one discusses the currently adopted solutions to change unsustainable agricultural practices. The fourth paragraph details some possible perspectives to mitigate negative effects and to improve sustainability. Finally, some conclusions are drawn.

## 2. Current and Forthcoming Critical Issues

Environmentally and socially unsustainable agricultural practices cause serious damage to environment, health, and social and intergenerational equity. Consequences include land use change, soil fertility loss, greenhouse gas emission, biodiversity decline and destruction of natural habitats, threat to biomes and their inhabitants, modification of nitrogen and phosphorus biogeochemical cycles, groundwater contamination and increasing water consumption, frequent negation of the precautionary principle about pesticides and biotechnologies, and excess in fertilizer and pesticide use. Additionally, all these highly environmentally impactful practices provoke severe consequences on the social sphere, including the disrespect of local communities' right to their land (not always safeguarded by governments), land-grabbing practices [48–50] and the question of land tenure [51]. Often, large-scale industrial agriculture does not contemplate community values—neither the identity of indigenous

people and small-scale farmers identity, nor social and environmental value—that agroecological approaches enhance among small-scale, family-based and cooperative ways of farming [52–54]. This is true at the global level, but tropical countries, mainly located in the Global South, are the most threatened at present. Even though the European Union (EU) declares itself attentive to these concerns, it is a fact that, in countries from which the EU “imports its food security” through large quantities of commodities, high environmental impact practices are largely diffused and give rise to serious consequences [55,56]. These include tropical deforestation [8,9], which concerns primary forests constituting the major global biomass and biological diversity stocks and determines the loss of a crucial carbon pool to limit global warming and activate further negative feedbacks. Furthermore, this determines embedded deforestation for several commodities [57] and contradictions about GMOs and pesticide trade and consumption [58–60]. For example, many pesticides prohibited in the EU (but often produced in its territory) “come back” with importation of soybean for animal husbandry, meat and orange juice [61]. In the Global North, agriculture is declining in its socioeconomic relevance and self-sufficiency is decreasing in several food chains. Rural landscapes are being transformed and forests are coming back [62]. This reveals the contradiction between land uptake and rural area abandonment [63,64]. This situation confirms the displacement of social and environmental impact of primary products in other vulnerable areas of the planet, crucial indeed for biosphere health and social equity [56,65]. In these “other” areas of the planet, mostly located in the Global South, the reasons for permanent food insecurity are linked to the unbalanced use of available land: often the cropland used for export is increasing to the detriment of internal consumption [66,67].

Given the scarce availability of land in the biosphere, irresponsible consumption and unsustainable abandonment are geographically and sociologically separated, but related to a “huge loss of connection with the Earth, causing cultural and spiritual impoverishment”, as well as ecological [68]. Some aspects are similar: (i) small-scale farmers decrease, implicating lack of care, instability and abandonment; (ii) biodiversity decline, because of land homogenization in cultivated areas or natural forest destruction, and transition to industrial monocultures; (iii) vulnerable communities disappear, causing cultural and economic poverty and indiscriminate urbanization growth, which results in social discrimination and loss of identity in large metropolitan suburbs. Furthermore, since urban people are always more disconnected from ecological and rural cycles [69], food and agriculture have been split in the last decades, and their intimate relation has been broken up [46]. Additionally, city regional food systems and the need for shorter supply chains have progressively been identified as important for sustainability and improvement [39,70,71].

The situation is aggravated by the climate crisis, the current major effect of the planetary boundaries overshoot [72], that gives rise to rainfall pattern alteration, air temperature and climate unpredictability and an increase in the frequency of extreme weather events. Food production is both a victim and a driving force of the crisis, by way of land cover changes, irrigation consumption, and pollution due to nitrogen and phosphorus overuse, intensive animal husbandry, and monocultures for animal feed.

Finally, agriculture’s economic crises have been caused by the reduction of minimum farm prices over the past seven decades [73–75]. The exacerbation in price competition, especially in such fragile chains as the rural ones, could also cause slave labor [76], and depopulation of lands removing farmers from the countryside. Meanwhile, revenues and investments for marketing and large-scale distribution increase. The result is that of landscapes dominated by agribusiness, but empty [47,77].

### 3. What Can Be Done?

Certainly, it is important to consider diversities and differences around the globe. The same precarious situation of farmers and ecosystems manifests in different ways in prosperous countries and in the Global South. A “one size fits all” policy is not adequate. Joint actions are needed and everyone has the duty of working in the common interest, to maximize synergies and minimize tradeoffs, starting with government policies, and information and awareness about the unsustainability of the dominant agro-food approach. However, changes of individual behavior are necessary too, such as a more

vegetarian diet; consumption' loss and wastefulness reduction from farm to fork; technological and management improvements; diversification; and safeguarding small farmers.

With regards to the last item, in the EU and the Global North, the leading concern is related to the maintenance of an appropriate income for farms, threatened by price stagnation and an increase in costs [78]. Control policies and subsidies are not adequate and the unstable situation causes consequences such as human labor exploitation (exemplified by the case of the tomato chain in Southern Italy [76,79]). Still, cultivated and grazing spaces are disappearing, interstitial spaces (between suburbs, roads and railways) are neglected, and industrial buildings, schools, train stations and houses, after having occupied the best lands, nowadays are subjected to the same lack of care and responsibility. It is therefore important to innovate nature protection policies, extending safeguarding and conservation to the agricultural activities that offer valuable habitats to many species and coenoses coevolved with humans for centuries [80,81]. There are several interesting examples in this sense, such as the recovery of uncultivated lands entrusted to organic farmers in France [82]. However, it is extremely important to have a global outlook and not be constantly Eurocentric. With a broader vision, it is interesting to notice that the abandonment issue is not even taken into account in the Global South, where land grabbing, expulsions and expropriations are the reality [83,84]. In Latin America, Asia and Africa, agricultural areas are completely unbalanced, and the lack and/or fallacy of agrarian reforms and small farmer support results in an incessant spread of export crops, substituting food production (e.g., [85]). In this way, reasons for "abandonment" are rather different, but the result is similar.

In this context, consumers have the right and the duty of knowing at which level of sustainability food is produced or processed. Nevertheless, there is a strong lack of education and an insufficient awareness from urban citizens who, in general, are not willing to properly remunerate sustainable productions [86]. Consequently, shared choices between producers and consumers are desirable to modify current paradigms about quality, which define an "additional ecological price" that should be communicated to the consumer. At the same time, it is not negotiable the importance of social aspects in the quality matter [87]. Finally, it should be repeated that in northern and southern countries this question has quite different perspectives and consequences.

In the Global North, organic agriculture has played a crucial role in this sense. The ecological conversion of many farms, the preservation of soil fertility and the respect for "natural" or at least spontaneous processes, are moving with great beneficial influence on the entire sector [88]. Moreover, organic agriculture has proven to be the only accepted way for neoruralism and for the engagement of young people, especially in the disadvantaged inland areas that are remote, marginal, increasingly neglected by urban centers of decisional processes [89]. Otherwise, in the Global South, sustainable agricultural practices are much more related to small-scale traditional agriculture valorized by agroecological models [90]. Agroecology can contribute tremendously, since it proposes a technological approach rooted in diversity, synergy, recycling and integration, as well as in social processes based on community participation [44].

In this respect, "more knowledge per hectare" will be crucial to pursue innovation. Therefore, divulgation, technological transfer and continuous training are needed [91]. This should be done through participatory approaches, at the research, management and decision-making levels, to compliment the different knowledge and skills of every actor involved. Farmers' involvement in the entire process is of utmost importance. Different ways of sustainable agriculture can and should coexist even if, in the international scenario, it is hard to formulate a "universally valid recipe". Production techniques should give rise to efficient and resilient agricultural systems, to permit a dignified life for farmers and to support a safe and healthy diet for consumers [12,43,44]. For each crop, food chain and region, it is necessary to identify problems and solutions, conciliating environmental sustainability and farm profitability. Every choice should be based on identification of priorities and evaluations of costs and benefits, in the medium and long term, considering results at farm, district and landscape level.

Let us be realistic, and relinquish ideologies. Many solutions are available and continue to grow [92]. Let us be aware of them and integrate one to another, for better living [62]. This will be made possible focusing on environmental safety, valorizing taste and nutritional values, minimizing external inputs, reducing emissions and eliminating land and energy consumption per food unit, using systems that could provide “instruments to do the right thing, in the right place, at the right time” [93]. Agriculture will be evaluated for its long-term sustainability related to ecological effects, as well as economic and social aspects.

#### 4. Perspectives for a More Sustainable Food Production Model

It is evident that a new paradigm is needed, to promote a more grounded agriculture in terms of ecology, biodiversity, resilience and justice. Many diversified and sustainable ways of farming, equipped with ecological rationale and based on traditional knowledge, exist. They are developed by a multitude of small farmers around the globe and produce the major part of the world’s food. In this context, agroecology plays an important role in promoting the dialogue between tradition and innovation, counting on natural processes and resources.

Hereinafter, some possible and available perspectives are proposed, including farming approaches, agro-food networks and practices for agro-biodiversity conservation, in a vision of social farming, education and green care.

##### *4.1. PERSPECTIVE 1: Revitalization and Valorization of Small-Scale Family-Based Traditional Agriculture as a Social Basis for Sustainable Agriculture and Planetary Ecological Asset*

“It is commonly heard today that small farmers produce most of the world’s food. However, how many of us realize that they are doing this with less than a quarter of the world’s farmland, and that even this meagre share is shrinking fast? If small farmers continue to lose the very basis of their existence, the world will lose its capacity to feed itself” [94]. While 91% of the planet’s 1.5 billion hectares of agricultural land are increasingly being utilized for exporting commodities, feeding livestock and bioenergy [95], small family farmers are the main producers of food crops for the planet [96–98]. Precisely, small farms (less than 2 ha) operate about 12% and family farms about 75% of the world’s agricultural land [99], considering that it is a large and extremely diverse group with a variegated pattern throughout the world, according to cultures, traditions and environments by region, country and local context [96,100]. For example, in Brazil, family farmers provide on average 40% of the production of major crops with approximately 25% of the land, and, in the USA, they produce 84% with 78% of all farmland [101]. In Latin America, despite their lower number with respect to the total population, family-based traditional farms contribute between 30% and 40% of the regional gross domestic product [102]. From the point of view of food security, small increases in yields on small farms will have far more impact on food availability at the local and regional levels (Table 1), than doubtful increases predicted for large monocultures [103].

Often, mainly in the Global South, smallholder farming is associated with traditional agricultural methods. Most of the time, peasant small farms base their success on the valorization of local available resources, eliminating the dependence on systematic external inputs of energy, resources and knowledge [44] (Table 1). Traditional knowledge about food and agriculture has existed for millennia and has evolved over the last 10,000 years with the domestication of plants and animals and the development of agriculture. Family-based traditional systems are nested within the ecosystem and are based on sustainable livelihood practices, rooted in biodiversity conservation [104,105], demonstrating a successful strategy of adaptability and resiliency. Moreover, these systems permit the development of functional biodiversity with diversified production and the integration of crops, trees and livestock [106]. Traditional ecological knowledge comprises experiences, practical skills and techniques concerning the use of hundreds of plant varieties, animal breeds, landraces and wild species that can be used for food, medicine, construction and other purposes to ensure food and livelihood security [107]. Practices related to conservation, protection and enhancement of the cropland include preparation of

soil, seed conservation, crops, natural fertilizers and pesticides, and efficient use of water and other natural resources [108]. Thus, it is of paramount importance to integrate the traditional knowledge into the design of “modern” resource management systems [41,109] (Table 1), not only to provide the basis for ecologically sound but also economically viable and highly productive land use systems. In this type of agriculture, there is less or no need for external inputs, as everything can be produced on the farm itself [110], acting in a multifunctional and circular economy approach. A small improvement in a point of the circle could benefit the entire cycle, thus it is a promising tool. In addition, traditional small-scale farmers grow a wide variety of cultivars [111] (Table 1). Many of these plants are landraces grown from seed passed down from generation to generation, genetically heterogeneous, resilient and able to enhance harvest security in the midst of diseases, pests, droughts and other stresses, and to meet local needs and maintain diversity as an insurance for future environmental, social or economic changes [103,112]. For this reason, it will also be crucial to protect peasant agriculture against GMO contamination, because the common richness they represent must not be lost to individual profit. Smallholder farmers and indigenous communities should continue being creators and guardians of biological diversity [113–115].

Although the common wisdom is that small family farms are backward and unproductive, research shows that small-scale diversified farms using polycultures are more productive per unit area than large farms in monocropping systems with the same level of management [97,106,116]. Moreover, despite criticisms of this statement [117] and the importance of a complete overview [118,119], definitely we can state that small-scale agriculture can be considered as a means of improving the efficiency and conservation of resources (Table 1). In fact, traditional multiple cropping systems and polycultures, widely diffused in Africa, Asia and Latin America, permit high yields, and significantly improve total production thanks to the diversification of farming systems adapted to the local conditions [107], and they have a lower ecological impact (Table 1).

Finally, while agribusiness contributes directly or indirectly to climate and ecological crises through almost one-third of total emissions of greenhouse gases [13], small biodiverse farms have the opposite effect, since they practice low input resource-conserving farming [120]. These practices include diversification of land use [81,94], crop rotations and crop diversification [29,43,121], water management and conservation [122,123], and resilient management of organic matter (and carbon sequestration) in the soil [31,124]. Furthermore, farmers living in harsh environments, mainly in Africa, Asia, and Latin America, have developed and/or inherited complex farming systems that allowed adaptation to climate change thanks to continuously dealing with extreme weather events and climatic variability throughout the centuries [30,125] (Table 1). Smallholder contributions to climate mitigation are related to the lower use of fossil fuel, chemical fertilizers, energy and pesticides, since they utilize organic manures, crop rotations and several diversity schemes to enhance biodiversity and other ecosystem services for biological control. Even more, farmers that live in periurban communities and that are actors of short chains, avoid a lot of energy waste and emissions [103].

For all these reasons, it is of primary importance to support and foster family-based traditional agriculture, also taking into account that, in the last decades, along with biodiversity, traditional knowledge and practices are being eroded by globalization processes [104].

#### *4.2. PERSPECTIVE 2: Diversified Farming Systems (DFS) to Increase Productivity and to Foster Social-Ecological Conversion*

We can refer to a farming system as “diversified” when it “intentionally includes functional biodiversity at multiple spatial and/or temporal scales, through practices developed via traditional and/or agroecological scientific knowledge” [126]. Thus, DFS can be considered as a framework of complex farming systems in which cross-scale ecological diversification contributes to enhance the sustainability and resilience of agriculture (Table 1), and contributes significantly to food security and sovereignty. Actually, DFS dominated food production in the Global North before industrialized agriculture systems progressively displaced them, and still dominates most of smallholder farming in

the Global South. Therefore, it is not novel, but rather a reappropriation of principles that have been lost or muddled.

Focusing on local production, agroecological knowledge and adaptive methods, DFS can determine complex social-ecological systems that enable ecological diversification. Furthermore, it is widely known that “regenerative, low-input agriculture, founded on full farmer participation in all stages of development and extension (Table 1), can be highly productive” [127]. Kremen et al. [126] confirmed that it is possible to design DFS that are equally productive, compared to industrialized agriculture, and that, in addition, maintain or enhance the provisioning of ecosystem services. The DFS approach recognizes also that landscapes, and not only single farms, are important targets of land management, emphasizing how farming practices operating from plot to landscape scales maintain functional biodiversity and, consequently, ecosystem services. In addition, a land sharing approach could help in aligning land-use with climate crisis, biodiversity loss and food objectives, and gives opportunities to enhance sustainability, especially for the relatively large agricultural and forestry sector. Moreover, thanks to the importance given to social relationships among working farmers, their communities and environments, DFS can contribute to the collective managing of food production and biodiversity conservation connecting social movements, political institutions and governance processes [45].

Hence, we can say that DFS are as many as the experiences based on local community knowledge, involving different approaches, all of them with a high degree of embodied individual responsibility. Two representative examples of DFS follow.

**Agroforestry systems**—Agroforestry is a practice of integrating cropping with trees and animals. Experiences demonstrate that agroforestry is extremely promising for provisioning and regulating services from agriculture and forestry. Thanks to sustainable land management and multiple ecological and economic interactions, it often involves stakeholders positively in the social dimension [128] (Table 1). The use of trees on farms, as well as any kind of silvo-arable and silvo-pastoral system throughout different environments, is one of the most promising approaches in maintaining high levels of biodiversity and biomass, facing the two main pillars of the global changes. Through agroforestry systems, it is possible to produce quality food (from crops and wild components), wood and fiber, providing a wide range of ecosystem services in restored landscapes, from tourism to carbon sequestration, water regulation and habitat provision for biodiversity assessment and wildlife management. At local level, agroforestry can benefit production and profitability for small farmers and landowners, and can support nature conservation efforts [129]. At a larger scale, it can help to accelerate the deployment of sustainable circular green economies. In this context, examples from tropical agroforestry and Mediterranean agro-silvo-pastoral systems are promising.

In the Global South, 80% of the future necessary production would come from increases in yields and cropping intensity and only 20% from expansion of arable land [130]. Thus, DFS, which are already diffused in the entire Global South, are all-important. Sustainable agroforestry has been practiced for thousands of years by many indigenous people in Latin America, by small farmers in Asia and Africa and by peasants all over the world. Interesting examples of the integration of traditional knowledge into scientifically based farming systems involve methods that attempt to imitate nature, such as in Brazil (Southern Bahia [131]). Most plants live in association and require other plants for optimal growth. Comparably, crop species could be planted in association with other plants similar to those with which they would normally occur in nature. Furthermore, in nature, evolution stages succeed one another in a dynamic ongoing natural succession, the understanding of which is of critical importance to designing long-term sustainable agroforestry cropping systems, as well as in restoring natural forest or degraded areas.

Traditional practices in the Mediterranean basin often include systems based on the integration of forests, orchards (especially vineyards and olive groves), and herbaceous crops, interlinked by grazing cattle, sheep and goats. Mediterranean agro-silvo-pastoral systems include a diversity of landscapes due to the presence of a broad range of tree and crop species, resulting in a high biodiversity value [132]. Unfortunately, even if the value of these traditional systems and rural landscapes is

undeniable, such practices are suffering from abandonment and we observe the disappearance, over recent decades, of shepherds, who represented the symbol of Mediterranean agro-silvo-pastoral systems [133]. A forward-looking view can be the management and development of innovative complex agro-silvo-pastoral systems, maintaining the agronomic orientation but taking into consideration also the added value of quality foods and the cultural uses of land in the complex interaction between ecosystems and society. Diversification of rural activities and strategies are necessary to achieve higher incomes and better life conditions for farmers and shepherds, otherwise further land abandonment will occur [134]. In other words, Mediterranean agro-silvo-pastoral systems could play a key role in the sustainable development of European agriculture, constituting a tool to enhance the management of rural areas for environmental conservation, landscape beauty and conservation of biological diversity.

Evolutionary plant breeding and underutilized species for agro-biodiversity conservation—Many of the issues faced in this paper, such as climate and biological diversity crisis, hunger and undernourishment, water scarcity and soil loss, are strictly connected to agro-biodiversity conservation. In fact, according to the FAO [135], an estimated 75% of the world's agro-biodiversity richness, that is the number of different plants cultivated by farmers, has already been lost in the course of the 20th century. To contain this process, it is necessary to investigate traditional species and varieties on-farm, the role played by custodian farmers and the challenges they face [111]. One option for seed genetic diversity conservation and adaptability to local contexts is evolutionary plant breeding. For a long time farmers sowed, experimented, harvested, conserved and exchanged seeds, maintaining a large amount of biodiversity. A careful observation of traditional farming system shows that farmers tend to reduce the risks associated to cropping in difficult conditions using combinations of three levels of biodiversity: different crops; different varieties of the same crop; and nonuniform varieties (such as local cultivars) [136]. In this way, thanks to diversity between and within crops, farmers disperse the risks of total crop failure due to unpredictable environmental variations [137]. Interestingly, this is in strong contrast with modern plant breeding that prefers to give the same variety or similar varieties to as many farmers as possible. Additionally, as further proof of millenary farmers' local knowledge, peasants have always mixed seeds, for the same crop but often also for different species. For example, in Ethiopia and Eritrea, a mix of wheat and barley ("hanfets" in the local language) is traditionally grown and, in Mexico, maize is traditionally planted together with beans and pumpkin ("milpa" in the local language).

Often combined with a participatory plant breeding tool, evolutionary plant breeding was developed in several world regions [136,138]. A real mixture of seeds from many different varieties of the same species on the same field evolves "by itself" to adapt to specific conditions of climate, soil and techniques [139,140]. Döring et al., [141] well explain the robustness of these practices: "in a cycle of sowing and resowing seed from the plant population year after year, those plants favored under prevailing growing conditions are expected to contribute more seed to the next generation than plants with lower fitness, following the process of natural selection". Evolving populations are able to adapt to growing conditions under which they are set. Furthermore, evolutionary plant breeding can be considered as a "living germoplasm bank" in the hands of farmers. In fact, farmers can address plant evolution as they like, and can select their varieties and reappropriate the control of seed without external assistance [139] (Table 1). Of course, this approach generates populations that are neither uniform nor "stable"; on the contrary, they are genetically highly diverse and changing in their genetic constitution over time. Transition from uniformity (characterizing modern agriculture, whose greater expression is monoculture) to diversification and mixture (based on reappropriation of ancestral peasant practices and knowledge) offers the stronger and more convincing answer to limit the increasing erosion of biodiversity, inappropriate with the current threats to agriculture.

Another strategy for on-farm agro-biodiversity conservation is to take care of "underutilized species". They help to improve people's livelihoods and contribute to food security. Their potential is still under-expressed because of their limited competitiveness with commodity crops. They are very important locally, highly adapted to marginal or complex environments and contribute to

diversification and resilience of landscapes and agroecosystems [111]. Underutilized species are rapidly disappearing because of the standardization of practices, uniformity of food habits and market demand, and monocropping systems that favor few dominating commodities. This determines, at the global level, traditional crops' genetic erosion and the consequent cultural diversity erosion intimately associated (ibid.). Finally, in general, both seed genetic diversity conservation and underutilized species promotion, can heavily contribute to valorization of farmers' knowledge, wisdom and practices.

#### 4.3. PERSPECTIVE 3: Participatory Guarantee Systems (PGS)

PGS are "locally focused quality assurance systems that certify producers based on active participation of stakeholders. They are viable organic verification systems that offer an alternative to third-party certification and are built on a foundation of trust, social networks, knowledge building and exchange" (official definition, IFOAM [142]). PGS are an affordable alternative to third-party certification, particularly appropriate for small-scale farmers. In fact, PGS integrate most of the limits of the more globalized, export-oriented and market-driven organic model that increases distance between producers and consumers. According to the principles of agroecological movements, proximity relations have to be encouraged with the creation of local markets based on confidence and reciprocity, shortening as much as possible circuits between food production and consumption [44,143] (Table 1).

PGS work on a collective dimension based on active participation, shared understanding of ecological production and sustainable distribution principles, with a common agreement of responsibility and mutual trust. In general, basic elements are: (i) both participatory and decision-making approaches; (ii) social control; (iii) shared vision and responsibility concerning quality, transparency and trust building mechanisms; (iv) adaptation of regulatory systems to local conditions; and (v) a nonhierarchical relationship among stakeholders [144,145]. These connotative characteristics make PGS suitable for the social, cultural and economic reality of local peasant agriculture and family-based traditional farming, from a general point of view. In fact, they present several advantages for small-scale producers: reduction of costs, considering that the costs associated with third-party certification generally determine constraints and inaccessibility for small-scale producers from obtaining organic certification [144]; simplification of bureaucratic procedures [146]; direct linkage to alternative marketing approaches (Table 1), like CSA (Community Supported Agriculture), farmers markets, home deliveries [147]; and provision of alternative political and social spaces [148].

Concurrently, PGS can contribute to build confidence at the consumption level, since it has been demonstrated that, when individuals are networked to one another, it is possible to reach a higher level of trust [144,149]. Organic products derived from PGS certified farms appear more accessible, since direct marketing commercialization methods are diffused and encouraged [150,151]. Additionally, farmers' markets generally provide a wider variety of products, demonstrating a sustainable productive system diversification and giving even more relevance to this model. In this way, PGS (which is relatively new even if the idea was born together with the organic movement) can contribute also to the deconstruction of the organic niche market, where it becomes exclusive and inaccessible for most of the population (Table 1).

There are several success models of PGS around the world, which are inspiring and motivate many new initiatives. The PGS idea has existed since the beginning of the organic movement, and its initiatives started mainly in Latin America and other regions of the Global South. They constitute a local alternative, reacting to production and certification systems imposed by consumer centers localized abroad [148], and trying to protect small farmers' way-of-life, in contrast with agribusiness. Brazil is a pioneer in PGS, the first country to have incorporated the model in its legislation relating to organic production, thereby giving it the same rank of validity as the third party certification system [152]. In the Global North, ecological, socioeconomic and demographic conditions permit, through a vast network of small and bigger farms with strong vertical integration, to meet consumers' requests. The model is based on a virtuous twist among biodistricts and peculiarities of lands and products. Its benefits are extended to many small noncertified farms, otherwise destined for market

expulsion, which can further take advantage of integration in PGS systems, notwithstanding several incentive policy distortions which tend to favor big producers, marginalizing farmers who do not manage to directly face the market in a creative way, and valorizing quality and specialties.

#### 4.4. PERSPECTIVE 4: An Agenda for Food Sovereignty

Since countries are deemed to have the right to establish and maintain their own policies concerning food systems, as long as those policies do not hurt third countries [153], cooperation and coordination are more and more mandatory at the global level. Food sovereignty is a policy proposal, started during the World Food Summit in 1996 by the Via Campesina, an international movement bringing together millions of peasants, small and medium size farmers, landless people, rural women and youth, indigenous people, migrants and agricultural workers from around the world. Together with other organizations and movements, food sovereignty has been defined as the “*right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems*” [154] (Table 1). It is also the right of each state to maintain and develop its own capacity for food production, respecting local culture and produce diversity [110]. In these terms, food sovereignty addresses agriculture and food systems from a holistic perspective that encompasses economic, social and environmental aspects in order to identify solutions towards sustainability [155]. In this regard, a food production system is sustainable if it ensures the food security of all people, reducing the causes of undernourishment and preserving the environmental quality. Such a focus offers a strategy to resist and dismantle the current corporate and food regime, valorizing farming systems determined by local producers and users [156], as well as an alternative to produce food that is healthy, diverse, nutritious, innocuous, abundant and accessible, produced sustainably and promoting the conservation of natural resources. The concentration of power in food and farming systems locks in industrial logic and poses barriers to agroecological and social transition towards a full form of sovereignty [157]. Additionally, food sovereignty movements are proposing local approaches, mainly to food security (Table 1), spawning multiple projects to empower people to define their own culturally and ecologically appropriate food systems. Underlying the relevance of more generative ways of seeing, experiencing and getting food, these movements contribute to the transition towards sustainable food systems. The spirit of solidarity that inspires these movements has promoted the establishment of even stronger and more lasting alliances between the different actors, as well as bottom-up social innovation initiatives. However, at the same time, this creates a tension between efforts at convergence of food system innovations from below, versus co-optation of grass-roots language and practices by private and public actors who are committed not to changing the logic of industrial agriculture, but instead to reducing its harm [158,159].

**Table 1.** Tasks, actions towards sustainability, SDGs targets and indicators and major research directions, extracted from the four perspectives.

Perspective	Proposed Tasks	Actions towards Sustainability	SDG Targets	SDG Indicators	References	Major Research Directions
<b>P1—Family-based traditional agriculture (FbtA)</b>	Use of local available resources	Limiting ecosocial footprint; enhancing circular bioeconomy	2.1, 2.2.	2.1.1, 2.1.2, 2.2.2	[103,105]	Inclusion of land tenure in food chain research; foster adaptive natural resource management
	Impact on food availability at regional and local level	Providing nutritious food; encouraging local small-scale production	2.1, 3.1, 3.2, 3.4	2.1.1, 2.2.2, 3.2.1, 3.2.2, 3.4.1	[42,156,157]	Performance analysis of family-based agroforestry and agro-silvo-pastoral systems; support to expand agroecology as a tool to optimize, restore and improve productivity of small local farmers
	Resource efficiency and conservation	Preserving and regenerating local resources; optimizing performance of agroecological practices and integrated agro-silvo-pastoral systems	2.4, 12.2	2.4.1	[103,108]	Landscape functional ecology of biogeochemical and water cycles
	Resilience to environmental variability and climate change	Strengthening farming systems adaptability to environmental heterogeneity and constraints; introducing techniques controlling anthropogenic GHG emissions	2.4, 13.1, 13.2, 13.3	2.4.1, 13.1.1, 12.2.1, 13.3.1	[106,125,136]	Testing the performance and effectiveness of design and management processes in terms of production and residence times of GHGs, radiative forcing and local warming; implementing long term research and proxy analysis on the effects of FbtA on anthropogenic GHG emissions
	Production of food crops vs industrial and no-food crops	Controlling directly food quality; increasing responsibility and knowledge	1.1, 1.2, 2.1, 2.2, 12.2	1.1.1, 1.2.2, 2.1.2, 2.2.2, 12.2.1, 12.2.2	[86,101]	Modeling the effectiveness of nature based solutions for more nutritious food and better life quality; deepen agroecological methods for the progressive replacement of industrial agriculture, especially monocultures and intensive livestock systems

Table 1. Cont.

Perspective	Proposed Tasks	Actions towards Sustainability	SDG Targets	SDG Indicators	References	Major Research Directions
<b>P1—Family-based traditional agriculture (FbtA)</b>	Dignity of farmers as food providers who generate protection, care and custody	Preserving the natural and cultural capital; enhancing the fundamental role of the primary sector in communities	2.3	2.3.1, 2.3.2	[111,115,125]	Qualitative research on socioanthropological processes; performance analysis of family-based agroforestry and agro-silvo-pastoral systems
	Valorization of traditional knowledge and practices	Preserving the natural and cultural capital	8.9, 12.8	8.9.2, 12.8.1	[41,103,108,109,139]	Integration of traditional knowledge into science-based farming systems to create contemporary agroecosystems adapted to local circumstances
	Worldwide validity (Global North and South)	Promoting and supporting global equality in food access; reducing inequality between countries	10.5, 16.8	16.8.1	[56,61,96,160]	Linkages between food production, import-export and access all over the globe
<b>P2—Diversified Farming Systems (DFS)</b>	Cross-scale ecological diversification	Preserving biodiversity; introducing a landscape approach to planning, design and management of land and farms	11.4, 15.9	11.4.1, 15.9.1	[126]	Action research on design and management of farms in a landscape ecological framework
	High productivity + provision of ecosystem services	Emphasizing the role of multiple ecosystem services in agroecological and agro-silvo-pastoral approaches	1.4, 2.2, 12.2, 15.9	1.4.2, 2.2.1, 2.2.2, 12.2.1, 15.9.1	[102,106,107,126]	Mapping and modeling ecosystem services dynamics; experimental testing of tools towards the enhancement of ecosystem services; creation of specific agroecological indicators
	Landscape design, management, and maintenance as important targets of land planning	Balancing nature protection for the sustainable use of resources in multiscalar land management	15.1, 15.3, 15.5	15.1.2, 15.3.1, 15.5.1	[126]	Multiscalar functional ecology of biogeochemical and water cycles
	Reduced risk associated to cropping in difficult conditions	Improving climate-change resilience; reducing the cogeneration risk	2.4	2.4.1	[125,136]	Risk cycle assessment; life-cycle assessment on crop production; creation of specific agroecological indicators
	Reduced (or eliminated) pesticides use through agroecological practices	Improving zero pollutants cultivation techniques and lowering of the pollution footprint of agro-pastoral land use	3.9, 3.d, 6.1	3.9.1, 3.9.3, 6.1.1	[103,107,108]	Multiscalar functional ecology of biogeochemical and water cycles; creation of specific agroecological indicators

Table 1. Cont.

Perspective	Proposed Tasks	Actions towards Sustainability	SDG Targets	SDG Indicators	References	Major Research Directions
<b>P2—Diversified Farming Systems (DFS)</b>	Integration of crops, trees and livestock	Increasing functional biodiversity; lowering use of external-inputs	11.4, 12.2, 15.9	11.4.1	[106,128,129]	Development of natural resource management strategies emphasizing crop diversification; experimental testing of tools towards the enhancement of ecosystem services
	On-farm conservation	Preserving genetic diversity	2.5, 15.6	2.5.1, 2.5.2	[106,111,137]	Promote alternative technologies through social learning and participatory approaches; innovative mapping and modeling of multiscale genetic diversity
	Re-appropriation of control of seeds	Fostering farmers empowerment while preserving biodiversity	10.4, 15.6	15.6.1	[136]	Quality research on participatory processes and community involvement tools; governance and enabling environmental action research
	Full farmers participation in all stages of development	Increasing farmers responsibility and enhancing the fundamental role of the primary sector in the communities	10.2, 16.7	16.7.1, 16.7.2	[44]	Application of farmer-to-farmer method; quality research on participatory processes and community involvement tools
<b>P3—Participatory Guarantee Systems (PGS)</b>	Active participation, common agreement of responsibility and mutual trust	Supporting social cooperation; Fostering socioeconomic support to farming activities	12.8	12.8.1	[44,144,145,148]	Qualitative research on socioanthropological and participatory processes; Testing governance tools (contracts, norms, incentives, etc.)
	Shorter circuits between food production and consumption	Activating and supporting circular bioeconomy	11.a		[143,145]	Research on flows of components and dynamics of circular bioeconomy
	Alternative marketing approaches	Activating and supporting circular bioeconomy	2.3, 11.a	2.3.1, 2.3.2	[26,147]	Research on flows of components and dynamics of circular bioeconomy; creation of equal local and regional market opportunities, standing on solidarity economy
	Deconstruction of the organic niche market	Providing equal access to quality food	10.4		[150,151]	Perception and preferences analysis of food products

Table 1. Cont.

Perspective	Proposed Tasks	Actions towards Sustainability	SDG Targets	SDG Indicators	References	Major Research Directions
<b>P4—Food sovereignty</b>	Healthy and culturally appropriate food for people	Providing equal access to quality food	2.1, 2.2		[44,154]	Perception and preferences analysis of food products; grounded research on food culture based on agroecology principles
	Localist approach to food security	Minimizing the foodprint; improving education and knowledge on food production	12.8	12.8.1	[108,157]	Promote alternative technologies through social learning and participatory approaches; Innovation in education to food and water with a regional and local focus
	Contrast to the unsustainable agro-food logic and supremacy	Localizing food markets; facilitating local producers	12.1		[148,156]	Qualitative research on socioanthropological processes; deepen agroecological ways for the progressive replacement of industrial agriculture, especially monocultures and intensive livestock systems

## 5. Conclusions

All over the world, agriculture has been called to answer planetary challenges and to feed a growing population, but the real point is about how to do it in a sustainable and diversified way according to ecological and social conditions. As the FAO has reiterated recently, all sustainable approaches should coexist, in a complementary way, to be able to meet the great challenge of agriculture for the next decades, that of feeding a planet of almost 10 billion people in 2050, producing safe and healthy food and maintaining an adequate social and environmental balance. We will have to produce much more food using the same arable land, stopping deforestation and cutting emissions due to food production. For that, there are no simple solutions. Some suggestions, however, emerge from the previous discussion.

The revitalization and the valorization of family-based traditional agriculture should be addressed to transform agriculture into a more sustainable activity. All over the world, family-based traditional agriculture contributes to gross domestic product and has a relevant impact on food availability locally. This form of production at the small scale improves the efficiency and the conservation of natural resources, much more than large-scale monocultures, and uses less external inputs. This happens above all because it encompasses traditional ecological knowledge, practical skills and techniques concerning the use of hundreds of plant and animal varieties, which are more ecologically-oriented and respectful of local biodiversity.

The promotion of diversified farming systems is another proposed solution to increase productivity and at the same time to foster social-ecological conversion. This is confirmed by several recent studies, which demonstrate that, being based on local production, these schemes are regenerative and promote low-input agriculture. Additionally, research confirms that they are equally productive, compared to industrialized agriculture, in addition to maintaining or enhancing the provisioning of ecosystem services.

PGS adoption is suggested as it works on a collective dimension based on active participation, shared understanding of ecological production and sustainable distribution principles, with a common agreement of responsibility and mutual trust. The social component of the production and the importance of networking among all stakeholders involved in agricultural practices are therefore evidenced.

Finally, the draft of a common agenda is equally considered important as it promotes the convergence of more generative ways of seeing, experiencing and getting food, solidarity and alliance among several actors, development of social innovation initiatives towards the transition to sustainable food systems and the achievement of a concrete food sovereignty.

How to turn these suggestions into action?

First of all, this can be done through the production and exchange of good practice in the areas of social innovation, education and agroecological knowledge transfer. In these activities, the involvement of policy-makers, associations, farmers and the collaboration among them is essential. This will be possible sharing indicators and variables that could permit the analysis of conflicts, tradeoffs and opportunities [161]. In this sense, land sharing approaches are often more responsible and agroecological than land sparing policies, giving opportunities to a respectful economy in order to save nature and human dignity with an integral ecological reconversion.

The second point is the acceptance that farming systems are complex and multifunctional, so agricultural techniques cannot be limited to a succession of single practices (even if virtuous) along the food chain, but should meet an integrated vision of processes, going beyond single cultures and field boundaries and involving the entire chain from production to consumption. In this context, the consumer's role is essential, because when they realize that *to eat is a political and ecological act*, they can support local farmers instead of the corporate food chain, creating socioecological sustainability and resilience.

The third point concerns the impacts of dominant conventional food systems, strongly based on intensive farming monocultures with a prevailing use of pesticides and synthetic fertilizers, and

intensive animal husbandry with antibiotic abuse. These unsustainable ways of farming often cause natural habitat loss, fragmentation, or degradation and indirectly influence the increase of ecological vulnerability. The risk factor due to the above mentioned dramatic trend, evidently emerges in cases of extremely perturbative, long lasting and unexpected events, e.g., the pandemic syndromes MERS, SARS-CoV, and above all the current 2020 SARS-CoV-2. In fact, 70% of emerging infectious diseases originate from wildlife: the loss and fragmentation of their habitats force wildlife sheltering in precarious niches into proximity with human activities [160]. Rapid development of industrial agriculture and animal husbandry takes place across regions with high biodiversity, and the greater the number of species, the higher the risk of transmission of infectious diseases [162]. At the same time, conventional agriculture could be seriously affected by lockdown effects crashing food products at large scale, while agroecology and small-scale food production are demonstrating resilience even in this dramatic context. These evidences add further motivations in favor of supporting and promoting agroecological perspectives of sustainability in food systems. To go in this direction, many other important issues for ensuring a sustainable human food supply and a healthy life for all have to be considered such as reducing food wastage, changing consumption patterns towards a vegetarian diet, reducing biofuel production, and regulating commodity speculation [163,164]. For the safety of the planet and humankind we should look at food and ecosystems as commons more than as commodities.

The last, but not least, point concerns the essential importance of maintaining a broad point of view, considering that our planet is highly variegated and that a local-global vision is challenging but necessary. In fact, Global North and South, as a first possible distinction, are very different and peculiar. As we tried to report in the paper, some questions are generalizable, others need to be observed and analyzed from different perspectives.

To go beyond sustainability it is necessary, on one side, to promote responsibility of all actors involved in agricultural practices, from decision makers, to professionals and consumers and, on the other side, to valorize a “super-disciplinarity” approach, which is the aptitude towards research that creates new knowledge at the boundaries of different research fields. Moreover, a big challenge is redirecting research to be more problem-solving and participatory, to provide locally available and appropriate technologies relevant to a large number of farmers, who are applying them. To achieve a real sustainability, as proposed in Table 1, major research directions go from inclusion of land tenure in food chain research to in-depth analysis of multiscale functional ecology of biogeochemical and water cycles, as well as the mapping and modeling of ecosystem services dynamics. They also include performance analysis of family-based agroforestry and agro-silvo-pastoral systems, translation of principles coming from traditional knowledge into practical strategies to enhance production and resilience, and innovation in education around food and water with a regional and local focus. It will be important also to foster qualitative research on socioanthropological processes, research on flows of components and dynamics of circular bioeconomies and linkages between food production, import-export and access all over the globe. In other words, it is necessary to valorize complex bioecological, functional, social and economic relations that characterize farming systems; to mobilize civil society and institutions to enhance the good use of innovations, growing in responsibility at least as much as in technological power; and to foster the defense of rural communities and their land rights. Today, more than ever, we have to protect rural people, strengthening farmers through social recognition and involvement in all stages, and cultivate new sustainable cultural approaches.

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