Chapter 1

The Role of Biological Diversity in Agroecosystems and Organic Farming

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Additional information is available at the end of the chapter

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Abstract

Ecosystems are the basis of life and all human activities. Conservation of biological diversity is very important for the proper functioning of the ecosystem and for delivering ecosystem services. Maintaining high biodiversity in agroecosystems makes agricultural production more sustainable and economically viable. Agricultural biodiversity ensures, for example, pollination of crops, biological crop protection, maintenance of proper structure and fertility of soils, protection of soils against erosion, nutrient cycling, and control of water flow and distribution. The effects of the loss of biodiversity may not be immediately apparent, but they may increase the sensitivity of the ecosystems to various abiotic and biotic stresses. The combination of biodiversity conservation with profitable food production is one of the tasks of modern sustainable agriculture that faces the necessity of reconciling the productive, environmental, and social goals. As further intensification of production and increase in the use of chemical pesticides, fertilizers, and water to increase yields are increasingly criticized, global agriculture is looking for other biological and agrotechnical methods in order to meet the requirements of global food production.

Keywords: Biological diversity, ecosystem, agroecosystem, ecosystem services, organic agriculture

1. Introduction

In compliance with the Convention on Biological Diversity (CBD), adopted in Rio de Janeiro in 1992, biological diversity is the variability among living organisms inhabiting all environments and ecological systems [1]. Biodiversity may therefore be considered at genetic, species, and ecosystem levels. According to Clergue [2], biodiversity is a very complex issue. In agroecosystems, it serves three basic functions: genetic, agricultural, and ecological functions. The first function of biodiversity involves maintaining species gene pool, in particular, the endangered ones. The second function, connected with agricultural activity, contains increasing the resistance of agroecosystems to abiotic and biotic stresses, as well as maintaining their productive role. Biodiversity has also ecological functions, for example, creating habitats with different flora and fauna species that have specific significance in agroecosystems.

The loss of biological diversity is one of the most important problems of the world and a threat to our civilization. The destruction of primary ecosystems, intensive farming, urbanization, and also infrastructure development cause depletion and weakening of the stability of ecosystems. Agroecosystems are the most at risk of losing biological diversity [3].

During the last decades, worldwide losses of biodiversity have occurred at an unprecedented scale and agricultural intensification has been a major driver of this global change [4]. The dramatic land use changes include the conversion of complex natural ecosystems to simplified ecosystems and the intensification of resource use, including application of more agrochemicals. The evaluation of ecosystems in the UK has shown a significant loss of biodiversity during the recent 50 years. Sixty-seven percent of 333 plant and animal species on agricultural lands have been endangered, mainly due to the intensification of farming [5].

The industrialization of agriculture has caused, directly and indirectly, a dramatic impoverishment of the fauna and flora compared to the situation a century ago [6–9]. This has contributed not only to the current biodiversity crisis in Europe as whole, but also to the decline in ecosystem services such as crop pollination and biological pest control [8]. As a result, the protection of farmland biodiversity has become a key issue in the EU and national agricultural and environmental policies, and large amounts of research and funding are devoted to biodiversity conservation, such as agri-environment schemes [3, 10–11].

Despite the commitment made by the Parties to the Convention on Biological Diversity to reduce the rate of biodiversity loss by 2010, global biodiversity indicators show continued decline at steady or accelerating rates, while the pressures behind the decline are steady or intensifying [12]. The main objective of the EU Biodiversity Strategy to 2020, which was adopted in 2011, is to maintain and strengthen ecosystems and their functions, and foster sustainable development of agriculture and forestry [13]. Biological diversity should also be preserved due to economic factors. Maintaining a high level of biological diversity makes agricultural production and the related activities more sustainable, which in turn, significantly affects human activities [14–15].

Biodiversity in agriculture can be perceived on two levels: the first is related to the diversity of species and cultivars, the breeds of farm animals, so the obtained "products"; and the second is related to the biodiversity connected with agricultural production, such as the diversity of plants and wild animals that accompany the crops, as well as the diversification of the agricultural landscape.

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2. The role of traditional species, cultivars, and traditional animal breeds in maintaining biological diversity

The progress in agriculture has led to the situation that in the recent 100 years, approximately 75% of genetic resources have been lost due to the transition of farmers from growing traditional, local cultivars of lower productivity and replacing them with intensive cultivars. Although in the world there are at least 12 thousands of edible plant species, humans use only 150 to 200 of them, and 75% of food products around the world are produced from only 12 species of plants and animal species. The three main species of plants such as rice, maize, and wheat provide about 60% of the energy consumed by humanity. Such a low diversity is a major issue to food safety. From the point of view of the conservation of biodiversity and human health, we should promote traditional and local species and cultivars of plants, as well as old breeds of animals [16].

The most appropriate way of protecting genetic resources of plants is their conservation in situ in the regions strictly related to their origin. This type of protection allows us not only to preserve a given form in its place of origin, but also to continue its cultivation and selection in the traditional way. The protection of genetic resources of crops, in addition to the primary task of maintaining biodiversity, has also practical aims of delivering rich genetic material for further breeding [6].

Old and local cultivars of crops are distinguished by unusual qualitative characteristics (e.g., good taste, favorable chemical composition), low technological requirements, better adaptation ability to environmental conditions, resistance to pests and diseases, and reliable yields. The cultivation of old cultivars and forms is often connected with using environmentally friendly production systems, such as organic farming. Old varieties are usually cultivated on a limited area, at a local or regional level. In Poland, we cultivate the tradition of growing old and local cultivars of tomato, cucumber, onion, carrots, beans, pumpkin, vetch, and many other orchard fruits and vegetables. In recent years, the rapidly-developing low-input methods of farming promotes a wider use of old and local cultivars of plants, as well as old plant species, such as spelt wheat, emmer, einkor wheat, and their processing on the farm [6].

Traditional orchards, also called backyard orchards, are of great importance for plant genetic resources. They usually satisfy only the needs of their owners and their family, unlike the commercial orchards where the production of which is destined primarily for sale. Traditional orchards became a characteristic element of the landscape of the Polish countryside. Due to the longevity of the trees, they have survived to this day. They are supported by an agri-environment scheme in Poland [17].

Native animal breeds are very important due to the role they played in the history of the development of the regions from which they originate. Due to their ecological, landscape, ethnographic, and socio-cultural functions, they must be regarded as evidence of tradition and culture of local communities, and preserved for future generations. The conservation of genetic variability guarantees a secure future of livestock production and helps maintain a healthy livestock [6].

3. The role of wild flora and fauna diversity in agroecosystem

In intensive conventional farming, special attention is paid to the negative aspects of wild flora in agrocenoses (called weeds), as they cause yield losses. Since the 1990s, however, due to the promotion of the concept of sustainable agriculture, the importance of wild plants growing on fields has been underlined. They have started to be perceived not only as competitors to arable crops, but also as an element that increases the biodiversity in agroecosystems [18–20].

Currently, the tendency in weed control is to limit the number of weeds to such a level that do not cause significant yield decreases. Such an approach is consistent with the objectives of sustainable agriculture, and particularly promoted in the system of organic farming. The harmfulness of weeds is not the same in all agrocenoses and depends on: the species and its biology, their abundance, competitive ability, the type of agricultural culture and the purpose of cultivation, as well as the soil type, weather, and agrotechnical factors [21].

The results of the research indicate a positive influence of wild flora in preserving overall biodiversity of agroecosystems [20, 22]. Elimination of wild plants from plant canopy, and thus weakening their reproductive potential interferes with the processes occurring in soil and relations between flora, fauna, and microorganisms [23]. Studies have shown that the decrease in the number of weeds as a result of the intensification of agriculture in Finland, Germany, Denmark, and the UK caused a decline of the populations of birds, pollinators, and other insects on agricultural areas [20, 22, 24]. The results of the monitoring of common breeding birds, which have been conducted in the UK since the 1990s and in Poland since 2000 indicate that the decrease in the number of the species such as tawny pipit, goldfinch, hoopoe, and lapwing, following the intensification of agriculture and the reduction in the diversity of weed flora [25]. The seeds of weeds, especially from the *Polygonaceae, Chenopodiaceae*, and *Poaceae* families, such as *Chenopodium album, Polygonum aviculare, Echinochloa crus-galli, Rumex obtusifolius,* and *Stellaria media*, are important food components for many bird species [20, 26].

Weeds constitute the source of food, as well as the habitats for animals, including useful, pollinating insects [15]. The nectar and pollen producing plants include: *Anthemis arvensis, Cirsium arvense, Centaurea cyanus, Chenopodium album, Consolida regalis, Taraxacum officinale, Papaver rhoeas,* and *Sonchus arvensis* [20–21]. Many common weed species are significant for the maintenance of the population of valuable beneficial invertebrates (pest predators and parasites), thus supporting the natural pest control [20].

Providing pest control is one of most important functions of biodiversity. There is a significant importance of predatory arthropods in agroecosystems. Many species of invertebrates are specialized in eating aphids and other pests. Others are generalist predators such as spiders or ground beetles. One of the most important natural enemies of pests are spiders. Almost all known species of spiders are predators. Many species are common in crops. The most effective in pest control are species families *Licosidae, Linephidae, Salticidae, Tetragnatidae, Clubionidae*, and *Araneidae* [27]. An important feature of spider biology is its resistance to long periods of hunger when a prey is absent. On the other hand, when prey is in abundance, they can consume a huge amount of it, often killing more prey than they can actually eat [28]. Another very

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important taxa is *Coleoptera*. There are many species of *Coleoptera*, that are generalist predators feeding on aphids and other pests. In an agroecosystem, the beetle families *Carabidae, Staphylinidae, Coccinellidae*, and *Cantharidae* are the most important invertebrates. The best known natural enemies of aphids are ladybirds *Coccinellidae* and ground beetles *Carabidae* [29]. Predatory beetles are more common in organic crops and in diverse landscapes [30]. They are also not dependent on pest population density, while specialist natural enemies are. They are also present on the field before pest population has developed. There are more generalist predators that can control the population of pests. These are insects such as bugs *Hemiptera*, robber flies *Asilidae*, wasps, and ants *Hemiptera*. More specialized in aphid control are parasitic wasps *Apocrita-Parasitica*, hoverflies *Syrphidae*, lacewings *Chrysopidae*, and *Hemerobiidae*. Both types of natural enemies are effective in controlling aphids, but they affect them in different ways. Generalist predators limit pest population, but doesn't eliminate all individuals so there is still a possibility to rebuild pest population. Specialists influence pest population slowly, preventing the increase in the population [31]. Diversity and activeness of natural enemies depends on the type of crop, diversity of landscape, and system of farming.

High plant species diversity increases the diversity of soil microflora and microfauna, including the organisms that are antagonistic against crop pathogens [32]. Certain wild flora species repel the crop pests or they act as trap plants for pests (e.g., *Chenopodium album* for black bean aphids). The allelopathic potential of many weed species has a stimulating or inhibiting effect on the development of crops and the presence of other weeds [21]. A large variety of flora and fauna is increasingly perceived as a valuable part of the agricultural landscape, especially in countries where intensification of agricultural production has led to a significant reduction of biodiversity of agroecosystems [19].

4. Biodiversity in the ecosystem services concept

Ecosystem services have become a top research issue in ecology, natural resource management, and policy [33]. Ecosystem services can be defined as the benefits that humans obtain from ecosystems [34].

In the report of Millennium Ecosystem Assessment [35], ecosystem services were divided into four basic types:

- provisioning (production of food, production of other raw materials such as wood, fuel, water supply, and others);
- regulating (regulation of air composition, climate, extreme phenomena, contamination, and biological processes);
- supporting (circulation of elements, primary production, soil formation, habitat function, hydrological cycle);
- cultural (recreational, aesthetic, cultural, and educational functions).

Biodiversity plays a major role in each group of these ecosystem services. It is crucial for the functionality, stability, and productivity of every ecosystem. In dynamic, agricultural landscapes, only a diversity of insurance species may guarantee resilience (the capacity to reorganize after disturbance) [8]. The species that occur in agrocenoses differ in terms of their potential value and input into the ecosystem services [15, 36]. Thus, increasing the diversity of species richness increases the probability of the total pool containing a species that will significantly affect the functioning of the ecosystem.

Biodiversity and ecosystem services are complex issues, which is reflected in many different interpretations of the significance of biodiversity to the ecosystem. The connections between biodiversity and ecosystem services are perceived differently by different authors [37]. Some authors even treat these concepts as one, which means that if the ecosystem services are managed properly, biodiversity will be preserved and vice versa ("ecosystem services perspective"). However, others claim that biodiversity is one of the ecosystem services and the conservation of the diversity of wild species, especially the endangered ones, is one of the goods that the ecosystem should deliver ("conservation perspective").

According to Fischer and Young [38], in biodiversity, everything is connected and contained in the same environment, but with no hierarchy. Mace et al. [37] suggest that the role of biodiversity in ecosystem services should be put into some order by assuming that different relationships exist at different levels of the hierarchy of ecosystem services. Following this concept, biodiversity may be the primary regulator of the ecosystem processes, as well as the final product and ecosystem service and good itself.

Biodiversity is considered one of the provision services that can supply: genetic resources for breeding new, more useful cultivars of plants or animal breeds; new active substances for medicine and pharmacology; or new ornamental plants [37]. Biodiversity in ecosystems determines most of the basic functions of the ecosystem, such as the distribution and circulation of elements in soil or the resistance of the ecosystem to pests and environmental conditions. It is generally considered that a more diverse ecosystem is a more stable ecosystem. The results of the studies indicate that an increased biodiversity at a given trophic level positively affects the productivity of this trophic level [39].

Ecosystems with high biological diversity provide many ecosystem services that concern, among others, provision of food, maintenance of pollinators, and biological control of pests [8, 15]. Pollination is one of the ecosystem services that are of special importance for humans. Recent studies estimate that 87 of major arable crops and 35% of the world crops are pollinated by animals [40]. The diversity of pollinators is essential for maintaining the provision of the services that Costanza et al. [34] evaluated at $14/ha/year. According to other authors, it amounts to $100 billion a year around the world [41]. The loss of biodiversity of agroecosystems, caused by the intensification of agricultural production and the loss of habitats, negatively affects the service of pollinators, which causes yield decrease [42].

The studies on the influence of biodiversity on ecosystem functions are difficult due to the complexity of the relationships within the ecosystem, the impact of agricultural production systems, and landscape. It is also difficult to generalize the results obtained in the given ecosystem over other ecosystems [43].

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Meta-analysis carried out by Balvanera et al. [39] indicates that most of the published works show a positive influence of biodiversity on the functioning of ecosystem, the strongest at the level of communities. Costanza et al. [44] found a positive impact of biodiversity on the productivity of ecosystems in North America. According to these authors, 1% of the changes in biodiversity affects 0.5% of the changes in the value of ecosystem services. The research carried out in Europe provided evidence for the positive impact of biodiversity on the productivity of grasslands [45]. Lavelle et al. [46] pointed to the positive impact of diversity of soil organisms on plant productivity in agricultural ecosystems. Hillebrandt and Matthiessen [47] believe that the functioning of the ecosystem is dependent not only on biodiversity, measured by the number of species, but most of all, on species composition, and the abundance of individual species and functional groups. A recent review of the scientific literature concluded that most reported relationships between biodiversity attributes (such as species richness, diversity, and abundance) and ecosystem services were positive [48]. Despite rich evidence on the existence of the connection between biodiversity and ecosystem functioning, some authors still question this relationship [8, 49–50].

The protection of certain target species is the most socially recognized role of biodiversity, while its indirect role in processes occurring in ecosystems (such as the cycle of elements) is little known by a wider audience [37]. A higher perspective needs to deliver additional arguments for the protection of biodiversity, apart from the traditional arguments, connected with the protection of rare and charismatic species.

Authors of the report from ecosystem evaluation in the UK found that at present, we are not able to fully assess the relationship between biodiversity and ecosystem services that it provides [5]. Changes in the extent and condition of habitats may significantly affect biodiversity ecosystem services. Intensification of agriculture has caused agricultural production, along with provision services, to significantly increase, but at the same time, there was a reduction in the diversity of the landscape, the increase of soil erosion, the reduction of soil quality, and the decrease in the populations of birds and pollinators. Changes in ecosystems may have a positive or negative impact on human welfare. For example, the conversion of natural ecosystems into agricultural production areas increases farmers' income, but at the same time, decreases habitats for recreation and the threat of atmospheric phenomena. According to the authors of the report [5], these types of assessments, in addition to economic values, should also take into account human health and social values.

Until now, ecosystem services were regarded as public goods, not as a market product that has a monetary value. According to some authors, the lack of valuation is the main cause of the degradation of ecosystems and loss of biodiversity [3]. If we want to maintain our environmental safety, we have to "measure" ecosystems and biodiversity. The article of Costanza et al. [34], “The value of the world’s ecosystem services and natural capital", published in Nature in 1997, was a breakthrough study in the subject of ecosystem services valuation. The authors assessed the value of 17 basic services produced by ecosystems all over the world. They evaluated them at $33 billion per year, so almost twice the amount of the gross national product of the USA ($18 billion). The concepts of ecosystem services flow and natural capital stocks are increasingly useful ways to highlight, measure, and value the degree of interdependence between humans and the rest of nature [51]. Economic assessment of the value of the services provided by the environment is difficult, time-consuming, and flawed. The valuation of each group of ecosystem services should be performed using different methods [52–53].

5. The impact of different agricultural systems on biodiversity

One of the most important factors affecting the agroecosystem biodiversity is the method of the agricultural management and land use. Agricultural systems that are used in modern agriculture may differently affect the environment, including biodiversity. Intensive agriculture is considered as the main reason of the decrease of flora and fauna species diversity and abundance in agroecosystems [14, 54]. The use of fertilizers and pesticides, removal of midfield woody vegetation and bounds leading to fragmentation and degradations of habitats are among the most important threats of agricultural ecosystems [37]. Moreover, areas with worse conditions for agricultural production are abandoned or afforested.

Decreasing populations of the birds associated with the agricultural landscape in many European countries can serve as an example of the loss of biodiversity due to the intensification of methods of agricultural production and changes in the landscape [25]. Benton et al. [55] found a relationship between the changes in the population of birds associated with agricultural areas and the number of invertebrates and agricultural practices in Scotland. Intensive agriculture was also found to have a negative effect on other groups of organisms: soil microorganisms, weed flora, earthworms, insects, spiders, and mammals [19–20, 55–59]. The analyses performed by Storkey et al. [9] for 29 European countries showed a positive correlation between the yields of wheat and the number of endangered species. The study of the list of endangered or extinct species of wild plants in Germany showed that agriculture is responsible for the decrease of populations of 513 out of 711 species [19]. The endangered taxa included 10.8% of weeds. Fifteen species were considered extinct, which constituted 25% of all the extinct species. In Poland, about 60 percent of the 165 species of archeophytes that accompany crops are endangered, mainly due to the intensification of agriculture [60].

Species' ability to tolerate human impacts: destruction, degradation and fragmentation of habitats, reductions of individual survival and fecundity through exploitation, pollution and introduction of alien species varies among taxonomic groups [61]. For instance, the proportion of species listed as threatened in the International Union for Conservation of Nature Red List is much bigger in amphibians than in birds [62].

Intensification of agricultural practices causes the loss of biodiversity, and thus influence important ecosystem services. It affects plant production, plant protection, pollination, decomposition processes, nutrient cycles, and the resistance to invasive organisms [15, 63–65]. In some cases, the intensification of agricultural production can lead to an increase in the population of some, or even rare, species. A higher productivity of agricultural areas in comparison with natural ecosystems means more feed (biomass of plants and fruit) for birds, mammals, and butterflies [8]. Söderström et al. [66] found a greater abundance of bird species on the areas used for agriculture and the reduction of the diversity in the period after the abandonment of farming, while Westphal et al. [67] found an increase in the population of bumblebees together with the increase in the area of rape cultivation. Habitat value is, therefore, often determined by food resources, which result from high productivity, which in turn may have other negative environmental consequences.

Negative impacts of conventional farming on the environment, the overproduction of food, and consumer dissatisfaction with the quality of the products obtained through such farming, caused the development of the concept of sustainable agriculture, which uses environmentally friendly methods of production [68–69]. Such assumptions are the basis of the development of alternative systems of agricultural production, such as integrated and organic farming.

An integrated production system uses technical and biological progress in the cultivation, fertilization, and plant protection in a harmonious way, which allows to obtain a stable efficiency and a proper level of agricultural income through the use of methods that do not pose a threat to the environment. It combines the most important elements of organic and conventional farming, and allows for simultaneous realization of economic, ecological, and social goals [69]. Integrated production ensures sustainable economic development of the farm, takes into account the needs of the environment, and it is also attractive for consumers due to the obtained quality of products. The results of the implementation of the integrated system in several European countries show that it managed to significantly reduce the use of chemical pesticides and synthetic nitrogen fertilizers, which led to, among others, an increase in the diversity of flora and fauna [68, 70]. The Directive on the sustainable use of pesticides (2009/128/EC) [71] has obliged all EU member states to prepare and implement integrated crop protection programs, which to some extent can protect the biodiversity of flora and fauna [72].

One of the proposed solutions for combining productive and environmental functions of agriculture is an approach called "ecological intensification" [33]. For ecological intensification, the primary interest is in managing the processes and conditions that mediate yield levels. Ecological intensification entails the environmentally friendly replacement of anthropogenic inputs and/or enhancement of crop productivity, by including regulating and supporting ecosystem services management in agricultural practices. Research efforts and investments are particularly needed to reduce existing yield gaps by integrating context-appropriate bundles of ecosystem services into crop production systems.

6. The significance of biodiversity in organic farming

The aim of organic farming is the production of high-quality food and, at the same time, the protection of the environment [73–74]. The ecological system is fundamentally different from other systems of agricultural production because it excludes the use of synthetic mineral fertilizers, growth regulators, chemical plant protection products, and synthetic feed additives. It is based on substances of natural origin, which are not technologically processed [74]. Organic farming system is based on the use of environmentally friendly production methods that include crop rotations with a large share of legumes, organic fertilizers, and non-chemical methods of plant protection. Due to the resignation from the application of synthetic mineral fertilizers and chemical plant protection products, organic farming has an even greater positive impact on the diversity of flora and fauna than the integrated system [19, 22, 56, 59, 75–77]. The results of many studies point to the positive effects of organic farming on diversity of flora and fauna on arable lands and grasslands [76–81].

Dynamic development of organic farming is observed in the EU, including Poland [82]. Some authors believe that the dissemination of ecological system on agricultural areas may help reverse the negative trend of the decline of biodiversity in the cultivated fields, which was caused by the intensification of agriculture [19, 82].

The most direct way to capture the effects of human activities on biodiversity is to analyze time-series data from ecological communities or populations, relating changes in biodiversity to changes in human activities. Such long-term research (1996–2011) on weed flora diversity in different crop production systems, organic, integrated, and conventional, were conducted in the Experimental Station of the Institute of Soil Science and Plant Cultivation – State Research Institute (IUNG-PIB) in Puławy, Poland [N: 51º28′, E: 22º04′] (Table 1).

Items	Crop production systems			
	Organic	Integrated	Conventional	Monoculture
Crop rotation	Potato Spring barley/spring wheat from 2005 + undersown crop Clovers and grasses (1st year) Clovers and grasses (2nd year) Winter wheat + catch crop	Potato Spring barley/spring wheat from 2005 + catch crop Faba bean or blue lupine Winter wheat + catch crop	Winter rape Winter wheat Spring barley/ spring wheat from 2005	Winter wheat
Seed dressing	-	+	+	
Organic fertilization	compost (30 t·ha^{-1}) under potato + catch crop	compost (30 t·ha^{-1}) under potato + 2 × catch crop	rape straw, winter wheat straw	wheat straw (every 2 years)
Mineral fertilization (kg·ha^{-1})	according to the results of soil analysis, allowed P and K fertilizers in the form of natural rock	NPK (85+55+65)	NPK (140+60+80)	
Fungicide	-	2 x	2–3 x	
Retardants	-	1–2 x	2 x	
Weed control	weeder harrow 2–3 x	weeder harrow 1x herbicides 1–2 x	herbicides 2–3 x	

Table 1. Major elements of the agricultural practices of winter wheat in different farming systems (1996-2011); source [59].

The study showed that long-term management in organic system increased the diversity of weed flora accompanying crops (Figure 1). Simplifying the crop rotation from the integrated system, through the conventional system to monoculture of winter wheat, associated with the increased use of herbicides, led to the depletion of the species in weed communities. In the 16-year period, the average number of weed species in integrated and conventional systems, as well as in wheat monoculture was similar (6.1–6.8), while in the organic system by about 3.5 times higher (22 species). During the 16 years of research, the changes in weed communities in winter wheat cultivated in this farming system were found, especially involving the decreasing abundance of nitrophilous species: *Chenopodium album* and *Galium aparine* and the increasing density of more sensitive to herbicides taxa, *Stellaria media*, *Capsella bursa-pastoris*, *Fallopia convolvulus*, and species of the *Vicia* genus [59].

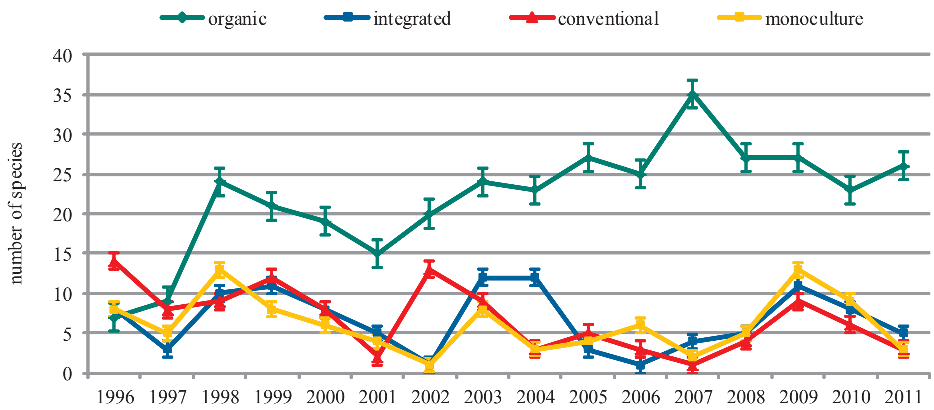

Figure 1. Weed plant diversity (± st. error) in winter wheat cultivated in different farming systems in years 1996–2011; source [59].

The agricultural practices applied in the compared farming systems (organic, integrated, conventional, and monoculture) of winter wheat differentiated the density of flora more than species composition. The largest number of weeds in the canopy of winter wheat at the dough stage was found in the organic system, 112 plants · m^{-2}, and the smallest for the integrated system, 18 plants · m^{-2}, on average (Figure 2). During the five years of the research (1997, 2001, 2002, 2007, 2008), the number of weeds in this treatment does not exceed 60 plants · m^{-2}, and only in two years (1996, 1999) was higher than 150 plants · m^{-2}, which means that it is possible to maintain weed infestation in organic cultivation of wheat at a relatively low level. Among the systems where herbicides were applied, the highest number of variability was observed in the monoculture of winter wheat.

Variability in species composition and abundance of weed flora throughout the years was influenced by the effectiveness of the applied methods of weed regulation and the weather conditions, which determined the germination of specific species of weeds and affected the density of wheat canopy and its competitiveness against weeds. In the systems where herbicides were applied, there were the highest fluctuations in the value of Shannon's and Simpson's indicators throughout the years (Figures 3 and 4). Shannon's diversity index value was the highest for weed flora in organic system and increased from 0.75 in 1996 to 2.64 in 2007 (Figure 3).

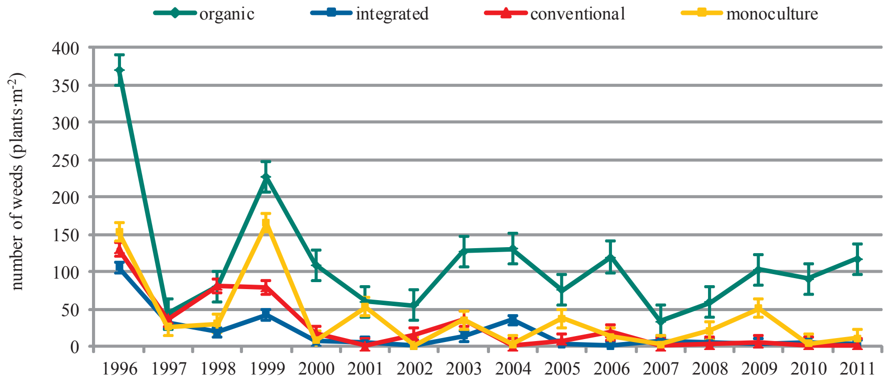

Figure 2. Weed abundance (± st. error) in winter wheat cultivated in different farming systems in years 1996–2011; source [59].

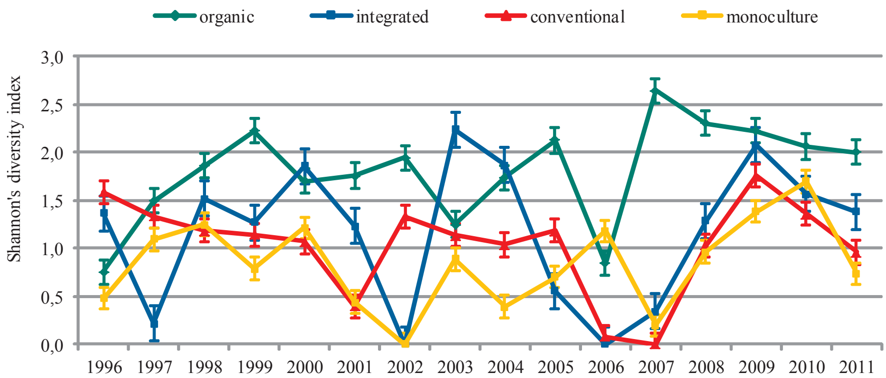

Figure 3. Shannon's diversity index values (± st. error) for weed communities in winter wheat cultivated in different farming systems in 1996–2011; source [59].

The dominance of some weed species in the community reflected in high Simpson's dominance index could affect the wheat yield more than diversified weed flora. A large diversity of weed species with low their quantity within species is less dangerous due to the yield because in multi-species weed community interspecies competition takes place. Interactions between weeds and the crop depend on the competitiveness and abundance of occurring weed species and the competitive abilities of the crop. In addition, those relationships are affected by environmental factors including soil conditions, weather, as well as agronomic practices.

It was found that weed communities in winter wheat cultivated in the organic system were characterized with a high qualitative and quantitative similarity in years, which was confirmed by the results of the ordination analysis (Figure 5).

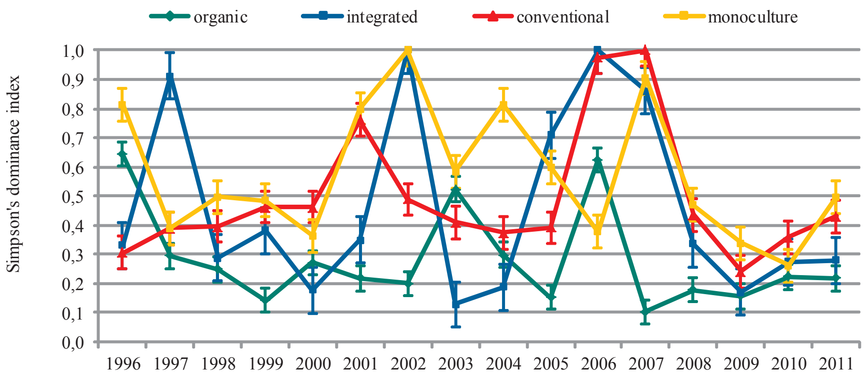

Figure 4. Simpson's dominance index values (± st. error) for weed communities in winter wheat cultivated in different farming systems in years 1996–2011; source [59].

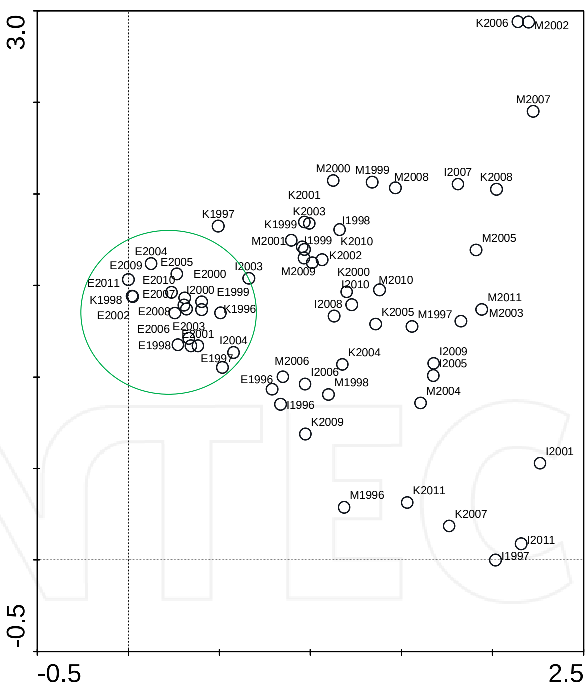

Figure 5. Ordination diagram of samples (represented weed flora communities in winter wheat cultivated in different crop production systems and years) in relation to first and second axes of Detrended Correspondence Analysis (DCA); source [59].

The comprehensive database that collates published, in-press, and other quality-assured spatial comparisons of community composition and site-level biodiversity from terrestrial sites around the world was created under the PREDICTS project (www.predicts.org.uk) [83]. Another example of a project that aimed to study the effect of different agricultural practices on diversity of flora, invertebrates, birds, and landscape in the east-south part of Poland and to prepare a geo-spatial database is the KIK/25 project (www. agropronatura.pl).

According to many research results, organic farming fulfills the promise to protect biodiversity better than conventional farming. Supporting farmers to convert their properties to organic land and to maintain organic farming within the scope of agri-environment schemes as a part of Common Agriculture Policy can have a significant impact in biodiversity as a result of management decisions farmers apply to their agricultural land [81].

7. Trends of changes in ecosystems and ecosystem services in the European Union

A large proportion of European biodiversity today depends on habitat provided by low-intensity farming practices, yet this resource is declining as European agriculture intensifies. Within the European Union, particularly the central and eastern new member states have retained relatively large areas of species-rich farmland; but despite increased investment in nature conservation here in recent years, farmland biodiversity trends appear to be worsening [11].

In the Report of the EU [84], analysis of the trends in the spatial extent of ecosystems and in the supply and use of ecosystem services at the European scale between 2000 and 2010 were presented. In the EU, urban land and forests increased while cropland, grassland, and heathland decreased (Figure 6). Many provisioning services showed increasing trends. Food and fodder crop production increased, even when agricultural areas decreased. More organic food was produced. More timber was removed from forests with increasing timber stocks. Total number of grazing livestock decreased.

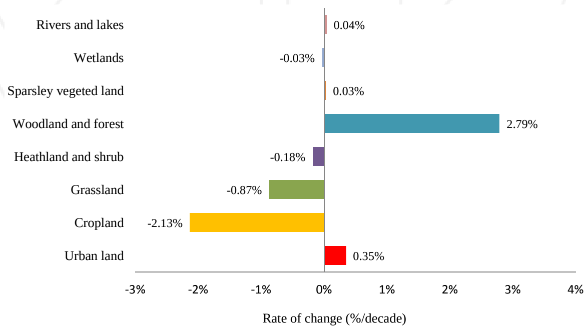

Figure 6. Change in the extent of surface area of ecosystems based on land cover data; source [84].

http://dx.doi.org/10.5772/61353

More area of natural environment was protected in 2010 than in 2000, but in contrast, the trends of two ecosystem services indicators that are directly related to biodiversity, pollination, and habitat quality were worsening (Figure 7). Crop production deficit was observed resulting from a loss of insect pollination. Habitat quality (regulation) slightly declined. There was a positive trend in the opportunity for citizens to have access to land with a high recreation potential.

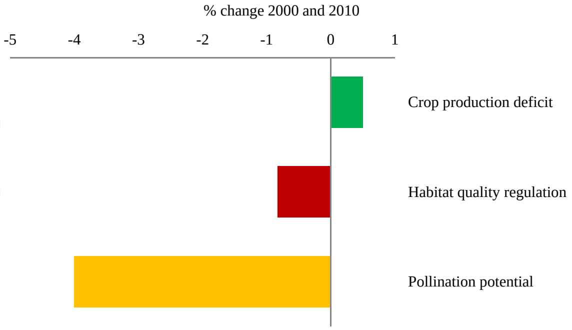

Figure 7. Main trends in ecosystem services in the EU between 2000 and 2010: Habitat maintenance and pollination; source [84].

Comparative studies show greater ecosystem quality for biodiversity as well as higher levels of rare species occurrence and species richness in lowland farmland in the central and eastern new member states than in Northern and Western Europe [11, 85]. In contrast to much of lowland EU, the main challenge and opportunity for farmland biodiversity conservation in the new member states is that a large number of species of conservation concern often still exist, e.g., in Polish field margins [11, 86]. These target species may have different requirements, creating conflicts when prescribing management measures. Simple but rigid measures applied over large areas can therefore be worse than existing management [11].

According to the EU Report, different trends in agriculture, ecosystems, and ecosystem services in EU countries were recorded (Figures 8 and 9) [84]. For example, in Poland relatively small changes were noted (increasing biomass built up and slightly negative trends in several services, including pollination potential) (Figure 8).

In France, where agriculture historically was more intensive than in Poland, slight decreases or status quo for many indicators were observed while the area under organic farming, timber stock, and forest area was rising (Figure 9).

Generally we see the following trends at the EU scale [84]:

For provisioning ecosystem services:

- More crops for food, feed, and energy are produced in the EU on less arable land. More organic food is grown. Textile crop production and the total number of grazing livestock have decreased.

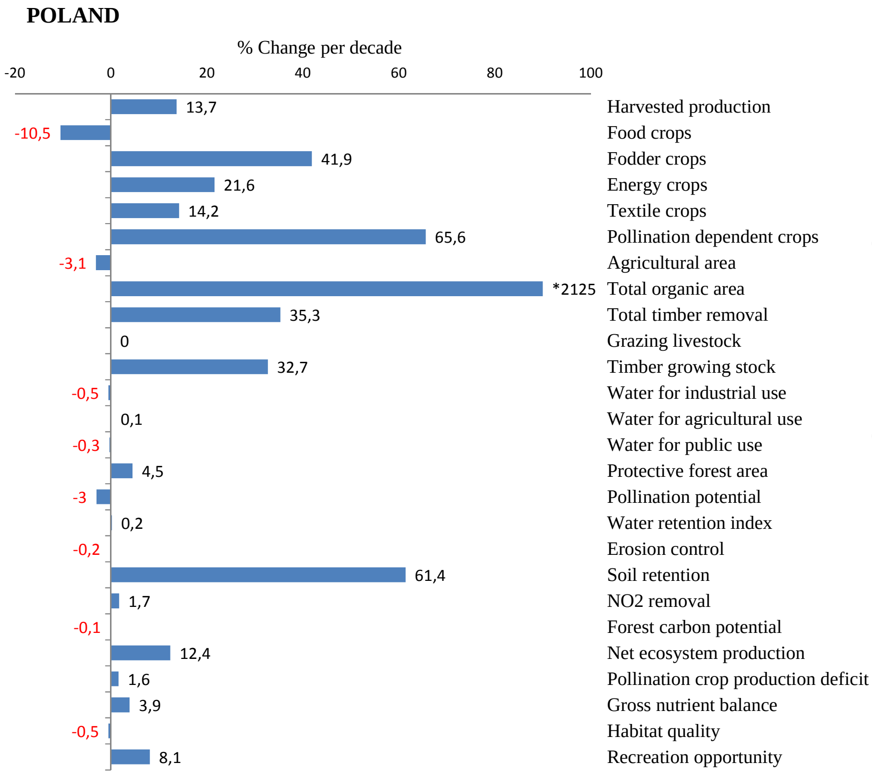

Figure 8. Trends in ecosystems and ecosystem services between 2000 and 2010 in Poland; source [84].

- The EU has used water in a slightly more resource-efficient way. Reported water abstractions decreased in both absolute and relative terms (relative to the naturally available water).
- Timber removals have increased and so, did the total timber stock.

For regulating ecosystem services:

- There is a substantial increase in net ecosystem productivity.
- Several regulating services, in particular those that are related to the presence of trees, woodland, or forests, increased slightly. This is the case for water retention, forest carbon potential, erosion control, and air quality regulation.
- Pollination potential and habitat quality show a negative trend.

For cultural ecosystem services:

- More land is protected and there is a positive trend in the opportunity for citizens to have access to land with a high recreation potential.

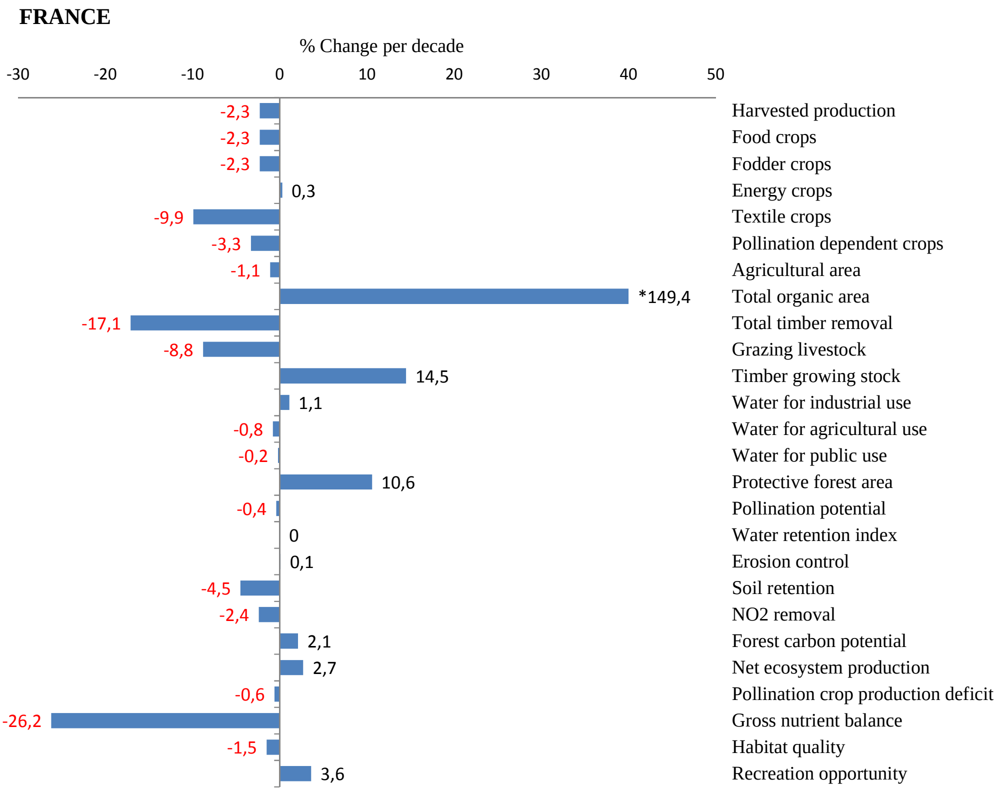

Figure 9. Trends in ecosystems and ecosystem services between 2000 and 2010 in France; source [84].

Costanza et al. [51] estimated the loss of global ecosystem services from 1997 to 2011 due to land use change at $4.3–20.2 billion/year, depending on which unit values were used. The biodiversity benefits for Europe and other countries of existing low-intensity farmland should be harnessed before they are lost. Instead of waiting for species-rich farmland to further decline, target research and monitoring to create locally appropriate conservation strategies for these habitats are needed now [11].

8. Summary

The protection of ecosystems and biodiversity is an important task and a key challenge to the world. The benefits of biodiversity conservation are difficult to notice in a short period of time or to economical evaluation. The benefits of the conservation of the species from extinction are important for future generations, because there may serve substances for medicine, genes useful in breeding, and others. At present, we do not know which plants may prove to be valuable in the future, which is why it is important to preserve as much gene pool as possible. Agriculture can contribute to the conservation of high-biodiversity systems, which may provide important ecosystem services such as pollination and biological control. Interdependencies between different groups of organisms, as well as the interaction between human activities and biodiversity require, however, further research. These studies should be conducted by experts from different disciplines in order to properly assess the value of biodiversity and ecosystem services, and create a strategy for the development of environmentally friendly agriculture and sustainable development of rural areas.

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