Aleksander KIRYLUK • Joanna KOSTECKA

SUSTAINABLE DEVELOPMENT IN RURAL AREAS IN THE PERSPECTIVE OF A DECADE OF ECOSYSTEM RESTORATION

Aleksander **Kiryluk** (0000-0001-7587-4851) – *Faculty of Civil Engineering and Environmental Sciences, Bialystok University of Technology*

Joanna **Kostecka** (ORCID: 0000-0003-4247-3685) – *Department of the Basis of Agriculture and Waste Management, Institute of Agricultural Sciences, Land Management and Environmental Protection, College of Natural Sciences, University of Rzeszow*

Correspondence address:
Wiejska Street 45E, 15-351 Białystok, Poland
e-mail: a.kiryluk@pb.edu.pl

ABSTRACT: Rural areas are included in the concept of sustainable development, and they are characterised by a great variety of flora, fauna, and habitats; apart from the function of food production, they can fulfil numerous functions related to the protection and shaping of the environment. The paper characterises the impact of agriculture on the natural environment. Selected parameters of agricultural plant production were described for the European Union, the Netherlands, and Poland. Factors significant in the context of the United Nations Decade of Ecosystem Restoration (2021-2030) were indicated. The features of agriculture in Hajnówka county (where over 50% of the area is under protection) were selected as a reference point for the expected results, treating it as a model of an organisation for the harmonious development of agriculture in the 21st century. The study highlights the importance of biodiversity in rural areas for building a sustainable human welfare strategy. The use of ecosystem services will be permanent when the elements of the Decade of Ecosystem Restoration are widely disseminated and rooted in the civic consciousness of the inhabitants of Poland and similar spaces in Europe. This decade must be advertised as widely as possible for this to happen, writing about it in various contexts.

KEYWORDS: Rural areas, limiting anthropopression, Decade of Ecosystem Restoration (2021-2030)

Introduction

The development of the world economy accelerated exponentially. While it took humankind 36 years to achieve two per cent growth in the twentieth century, we get ten per cent after seven years (Popkiewicz, 2013). Rockström et al. (2009) identified global processes that require slowing down and setting the limits of their safe growth for the proper functioning of people on Earth. According to these authors, the limits have now been exceeded in at least four processes: climate change threatening human security, destabilisation of the nitrogen and phosphorus cycle, high rate of biodiversity loss, and loss of a significant area of arable soil.

In April 2022, the UN Global Land Outlook 2 (UNCCD, 2022) report was released. The study was developed over five years in cooperation with 21 partner organisations. The report states that 20 to 40% of the planet's land surface has already been degraded, including farmland, wetlands, forests, and meadows. Half of humanity is experiencing the direct effects of this damage – including desertification, soil degradation, and drought.

Agriculture is an activity that significantly affects the environment: it shapes the living conditions of many species of plants and animals, and at the same time, in some cases, destroys their populations. The progress of civilisation gives excellent opportunities to shape the environment, including rural areas. Currently, agriculture can function at high unit productivity from plant and livestock production obtained from modern methods, means of production, or transgenic plant species (GMOs). However, it influences the reduction of the nutritional value of the food produced in this way and the deterioration of the condition of the environment. Therefore, many producers and consumers have become supporters of organic (ecological) farming, producing plant and animal products using environmentally friendly methods. In discussions on the future of agriculture, arguments supporting the globalisation of the agricultural market and the development of large agri-corporations continue to clash; at the same time, arguments supporting local and family management are essential for many. In some European countries, agriculture promotes the welfare and regulatory function of the state relating to this sector of the economy.

Meanwhile, large-scale livestock farming on an industrial scale emits about 14% of greenhouse gases into the atmosphere (FAOSTAT, 2022). Carbon dioxide is mainly emitted from areas undergoing agricultural change, where plants are deprived of vegetation, for example, due to deforestation or the removal of permanent meadows and pastures (Rykaczewska, 2010). In Poland, with a productivity of about 40 dt of hay per 1 ha, meadow biomass absorbs 1.5 tons of CO_2/ha. It allows about 4.7 million tons of CO_2 to be

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reduced annually in meadow biomass. The 1st Climate Agriculture Congress, organised in Germany in 2021 by two non-profit organisations: *Climate Farmers* and *Akademie Schloss Kirchberg,* pointed to the need to create a regenerative food system to reduce greenhouse gas emissions and restore soil carbon (BESH, 2022).

Therefore, contemporary agriculture is faced with many challenges that should be solved for the good of humankind. There is an overproduction of food, and at the same time, about 25% of the human population on Earth (Africa and South Asia) suffers from chronic malnutrition or starvation. According to the current estimates and forecasts of the FAO, the European Commission, and other international organisations, negative phenomena and processes occur in agriculture and its surroundings: shrinking agricultural space for field crops, the concentration of large animal farms, waste (according to WHO), about 30% of food produced, higher and higher use of chemical means of production. At the same time, agriculture intervenes in semi-natural areas by liquidating wet river valleys and deforestation. As a result of the advancing climate change, extreme phenomena occur in agricultural areas: droughts and floods and the spread of diseases, including livestock and crops.

In light of regenerative farming, the demands on the world's agricultural corporations are increasing, but that is not enough. Other system solutions are needed. Agricultural land use in the 20th century separated agricultural production from areas managed to conserve biodiversity. This principle is no longer applicable in the 21st century. The Millennium Ecosystem Assessment (2005) confirmed that agriculture had a clear impact on the environment and increased its ecological footprint. Preserving biodiversity in the agricultural landscape thus requires urgent and extensive research, policy coordination, and strategic support for farming communities. The sustainable agriculture system is an essential component of many of the 17 Sustainable Development Goals agreed upon by the UN in 2015 (United Nations, 2022). A holistic approach to modern agriculture can protect and restore rural biodiversity more effectively and thus develop ecosystem services in agricultural and semi-natural areas (Smol et al., 2020). Agriculture that considers biodiversity offers a chance for a symbiotic coexistence of a system in which food production and nature can develop favourably (Scherr & McNeely, 2008).

To diversify large-area monoculture crops dominated by cereal and fodder plants, science and practice draw attention to the need to introduce plants of minor or marginal importance to cultivation, favouring the biodiversity of villages and new crops (Kiryluk & Kostecka, 2020). The variety of values of rural areas motivates many people to introduce a new lifestyle and a new model of social development in the countryside. The comfort of living and the attractiveness of these areas largely depend on the condition of the

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natural environment and natural values. Rural areas in Poland, relating to some EU countries, are characterised by high values resulting mainly from the preserved large landscape and biological diversity. The concept of sustainable development in rural areas is an idea that is difficult to implement in the current economic and social conditions (Kozłowska-Burdziak, 2020). The positive and acceptable attitude of farmers to environmental protection issues often loses to the prevailing need to maximise profit and economic calculation. The adaptation of, for example, Polish agriculture to the standard agricultural policy of the EU and competition with agricultural producers in the food market inspire farmers to take pro-ecological activities. The increase in people's pro-environmental awareness and sensitivity toward nature and its resources may result in attempts to introduce into everyday reality the concept of violence on the natural environment and biodiversity (Butt & Kostecka, 2019; Kostecka & Butt, 2019). It can help in the faster spread of a negative attitude towards society, for example, towards such practices as:

- everyday and often unjustified use of chemical plant protection products (insecticides, herbicides, fungicides),
- mineral fertilisation, not adapted to the current fertility of the soil,
- fertilising permanent grassland with too high doses of slurry,
- simplifying the technology of tillage, eliminating crop rotation and traditional plough crops,
- accelerated introduction of genetically modified plants to cultivation.

The study aims to indicate selected parameters of the impact of agriculture on the environment (mainly on the example of agricultural land) against the background of changes in agricultural plant production in the European Union, the Netherlands, and Poland. Rural areas require reducing human pressure, so the activities significant in the context of the United Nations Decade of Ecosystem Restoration (2021-2030) are also listed. The agriculture features in Hajnówka county were chosen as a reference point for the expected results, where a large share of protected areas allows for preserving and restoring ecosystem services using possible solutions limiting anthropopressure.

Research methods

The article uses statistical data available in publications and electronic materials of the Central Statistical Office, Local Databases, Eurostat, Faostat, the Institute of Soil Science and Plant Cultivation, Agency for Restructuring and Modernization of Agriculture. The method of analysing structural and quantitative changes in the following areas was adopted in the study of agricultural intensification and its impact on the environment:

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- the European Union (the average of 27 member states is given) is an organisation dynamically developing conventional agriculture and a high impact of agriculture on the environment. As a result of the Common Agricultural Policy of the EU, European agriculture has been integrated, and there is a tendency to equalise its character and level of productivity in individual member states,
- the Netherlands as a country achieves the highest unit efficiency rates in plant and animal production, using the most advanced technologies and biotechnological achievements, as well as applying innovative production methods and the best pro-environmental solutions,
- Poland, as a country that, in over a quarter of a century, has significantly changed the character of agriculture to a medium-intensive one while maintaining, however, traditional cultivation methods and maintaining high-quality products of plant and animal origin,
- Hajnówka county is a research area.

The analysis of agriculture characteristics was carried out mainly for 2005, 2010, 2015, 2019, and 2020 because Poland was formally included in the Common Agricultural Policy in 2004. Hajnówka county in the province of Podlasie is presented as a rural area with slightly changed agriculture, medium and small-scale farms and a large share of protected landscape areas. This county can be considered a model for the harmonious development of so-called sustainable agriculture and activities to restore rural ecosystems. The data on Hajnówka county come mainly from the author's research and exploration.

Results of the research and discussion

Characteristics of the agricultural area in the world and Europe

In 1961-2003, world agriculture was characterised by increased crops. The slowdown of this tendency can be observed in the following years of the 21st century (Figure 1), which can be explained by the improvement of cultivation techniques, the introduction of high-yielding varieties, and the growing demand for food.

In the last decades of the 20th century and at the beginning of the 21st century, there were changes in plant production in Europe (also in Poland). Large-scale agriculture began to dominate, ensuring high food production and negatively impacting the natural environment. Soil, water environment, air, landscape, ecosystem and species biodiversity are subject to intense and negative pressure from agriculture. Agricultural production is a burden on the natural environment. In the world, agricultural areas cover about 35% of

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the area and show a slight upward trend of several percent, which may be related to the expansion of cultivated areas due to deforestation. In the European Union, agricultural areas in 1961-2020 decreased on average from 52.9% to 41.0%. In the Netherlands, there was also a decrease in the area of agricultural land in the analysed period by 14.7%. In Poland, agricultural areas decreased by 19.4%, and the most significant decrease was recorded after 2005 (Figure 1).

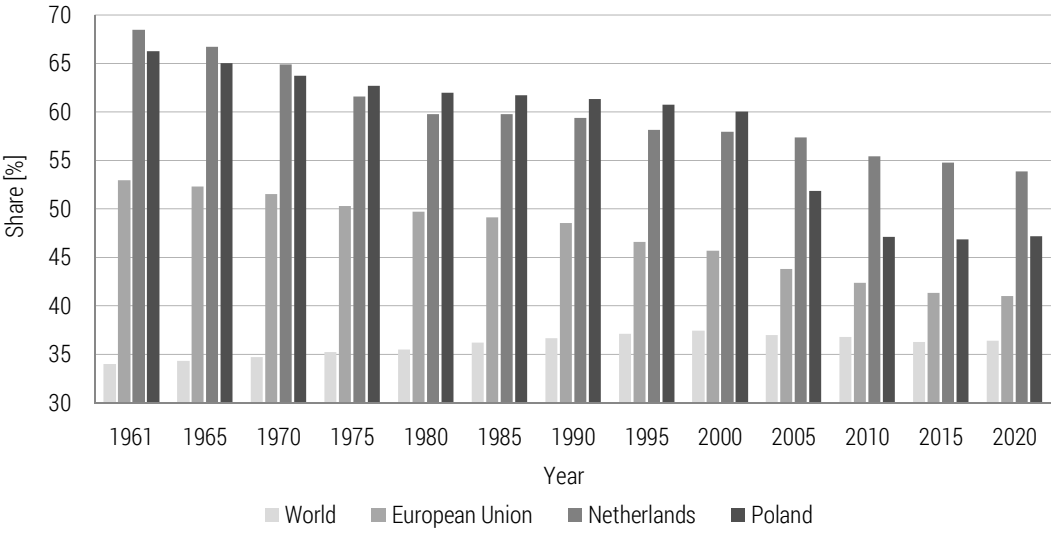

Figure 1. Changes in agricultural land (1961-2020) [%]

Source: authors' work based FAOSTAT (2022).

Despite the growing demand for food, Europe's farmland has shrunk. It was possible thanks to actions increasing the efficiency of crops, taking into account the specificity of the species of cultivated plants (and in the case of animal production – raised animals), taking into account the socio-economic and environmental conditions for sustainable and low-emission plant and animal production. Sustainable food production can provide sufficient protein and meet consumer expectations. However, this presents a challenge in the face of climate change and the need to reduce emissions (Henchion et al., 2021).

With forage grain farms currently dominating half of the crops in agriculture, there is a need to promote environmentally friendly farming systems that respect the principles of sustainable development. The statistical data in Table 1 show that the cultivation areas of rye (*Secale cereale*) and potatoes

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(*Solanum tuberosum*) have significantly decreased. It is due to, among other things, the elimination of traditional pig farming, the transition to large-farm farming, and the abandonment of feeding with traditional feed prepared on the own farm. The feeding of farm animals with fodder from industrial production dominates. As a traditional crop, e.g., in Poland, the yield and rye prices did not increase despite significant progress in cultivation, so this plant was becoming less and less profitable for farmers. Rye is still grown on light soils in less favourable climates (mountain areas), and in Poland, it is the primary raw material for bread production. Recently, however, an increase in prices for cereals has been observed. In 2005-2020, the cultivation area of triticale (*Triticale*) and maize (*Zea mays*) for fodder increased. These species are the main energy components in industrial feed production for farm livestock production. The increase in maise cultivation in Poland is caused, among others, by climate change and negative water balance. This species needs less water to produce biomass (Kiryluk, 2009) and tolerates drought better during the growing season. There is a significant increase in rapeseed (*Brassica napus*) cultivation in the EU and Poland caused by the growing demand for biofuels and the increased profitability of this production. The expansion of intensively cultivated forage cereal areas is becoming a real threat to biodiversity and agricultural landscapes in the EU, including the Netherlands and Poland.

Table 1. Changes in the sown area of major crops in the EU, Netherlands, and Poland in 2005-2020

Feature	Year	European Union [thousand ha]	Netherlands [thousand ha]	Poland [thousand ha]
Agricultural land area	2005	192 006	1938	15 906
	2010	186 641	1872	14 449
	2015	182 406	1846	14 371
	2020	182 446	1817	14 253
Agricultural land (% of land area)	2005	43.9	57.4	51.9
	2010	42.5	55.5	47.2
	2015	41.4	54.8	46.9
	2020	40.9	54.1	47.4
Permanent grassland area	2005	51 117	795	2 592
	2010	50 742	813	2 508
	2015	48 508	766	2 628
	2020	48 231	768	2 478

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Feature	Year	European Union [thousand ha]	Netherlands [thousand ha]	Poland [thousand ha]
Grassland (% of agricultural land)	2005	26.6	41.0	16.3
	2010	27.1	43.4	17.3
	2015	26.6	41.4	18.2
	2020	26.4	42.2	17.4
Rye	2005	2 479.2	2.5	1 415.3
	2010	2 248.9	2.3	1 059.6
	2015	1 982.4	1.6	725.3
	2020	2 073.7	1.8	843.6
Wheat	2005	24 720.9	136.7	2 218.1
	2010	24 172.5	153.7	2 124.2
	2015	24 902.0	142.5	2 395.5
	2020	22 876.3	108.9	2 373.3
Triticale	2005	2 580.2	4.1	1 194.6
	2010	2 698.6	2.7	1 324.8
	2015	3 065.7	1.4	1 516.2
	2020	2 751.8	1.2	1 388.9
Maize	2005	9 310.9	20.7	339.3
	2010	8 321.9	16.7	333.4
	2015	9 249	11.2	670.3
	2020	8 965	19.4	946.1
Potatoes	2005	2 178.1	156.0	588.2
	2010	1 803.4	156.9	400.7
	2015	1 555.7	155.6	300.4
	2020	1 536.4	164.5	225.7
Oilseed rape and agrimony	2005	4 297.1	2.0	550.2
	2010	6 444.8	2.6	945.5
	2015	5 825.8	2.3	947.1
	2020	5 324.3	1.7	980.9
Barley	2005	12 936.5	50.6	1 113.1
	2010	11 315.0	33.3	970.7
	2015	11 156.6	32.8	839.3
	2020	11 025.3	38.4	675.2

Source: authors' work based on FAOSTAT [26-05-2022].

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Agriculture and the natural environment

Agricultural activities and factors influencing the environment

Mineral fertilisers can significantly disturb the natural environment if they are not carried out following pro-environmental technologies available in precision agriculture (Siebeneicher, 1997). Rockstrom et al. (2009) show that we are currently struggling with the destabilisation of biogeochemical cycles in the nitrogen and phosphorus cycle. The negative impact of fertilisation on the environment concerns mineral fertilisers (Arisha & Bardisi, 1999); therefore, organic fertilisers are gaining more and more supporters (Rahman, 2004).

Another urgent challenge for modern societies is slowing global biodiversity loss and extinction rate (Gołębiewska et al., 2016). There is overwhelming evidence that species extinction affects the functioning of ecosystems and that species provide many services; entire ecosystems have significant economic value. Much environmental research focuses on where biodiversity is lost most quickly and where biodiversity loss has the most immediate consequences. It is widely believed that converting land to monoculture and intensifying local farming practices such as using fertilisers and pesticides is the most harmful to biodiversity. The ecosystem services provided by pest control species involved in pollination and nutrient cycling benefit agricultural production and sustainable development (Gonthier et al., 2014).

The threat to the natural environment is also associated with chemical plant protection products, which, directed against specific pests, weeds, or diseases, are never indifferent to other representatives of biodiversity inhabiting the soil environment. Table 2 shows the amounts of applied mineral fertilisers and pesticides, and the amount of greenhouse gas emissions GHG (CH_4, N_2O, NH_3) converted into CO_2 equivalent in agricultural areas. The latest BP (*British Petroleum*) Statistical Review of World Energy report from 2019 shows that CO_2 emissions have been reduced by large EU countries and the USA, Russia, and Japan in the last decade. On the other hand, a significant increase in CO_2 emissions occurs in China, India, and Brazil, which creates a negative balance of emission reductions (Kacprzak, 2020).

The data in Table 2 show that Dutch agriculture uses almost three times more mineral nitrogen than Poland. It is related to introducing high-yielding wheat varieties to cultivation or increasing the number of vegetable crops requiring large doses of a strongly yield-generating factor, nitrogen. Nitrogen is a fertilising factor that threatens the quality of surface and groundwater – likewise, phosphorus is used in very high doses in Poland. The use of pesticides per hectare in the EU countries remains stable, and in Poland, it shows a slight upward trend.

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Table 2. Fertilizers indicator, pesticides, and emissions on agricultural land (changes in the years 2005-2020)

Analyzed factor	Years	European Union	Netherlands	Poland
Nitrogen N [kg × ha-1]	2005	86.6	244.3	79.6
	2010	86.6	205.8	97.2
	2015	94.1	223.5	92.5
	2020	90.1	188.5	91.8
Phosphorus P2O5 [kg × ha-1]	2005	26.7	42.5	35.3
	2010	20.1	29.0	36.4
	2015	21.7	8.4	28.9
	2020	23.2	10.2	30.4
Potassium K_2O [kg × ha-1]	2005	28.6	41.5	42.2
	2010	23.4	48.4	40.6
	2015	24.4	25.5	46.7
	2020	26.3	51.3	49.9
Pesticide [use per cropland area kg × ha-1] FAOSTAT	2005	3.1	9.4	1.3
	2010	2.8	9.1	1.7
	2015	3.1	9.2	2.1
	2019	3.1	8.9	2.1
Emissions of carbon dioxide CO_2 [kilotons = thousand tons]* * GHG emissions converted to carbon dioxide equivalent	2005	2,124,510,728	113,589,394	288,617,151
	2010	2,041,562,763	112,539,696	273,098,557
	2015	1,782,141,930	96,897,942	252,571,675
	2019	1,746,081,409	90,595,091	274,861,565
Emissions of methane CH_4 [kilotons = thousand tons]	2005	91,169,153	4,614,733	6,159,323
	2010	88,960,686	4,874,800	6,146,479
	2015	88,005,595	5,233,143	5,919,083
	2019	85,055,332	4,661,738	6,081,571
Emissions of nitrous oxide N_2O [kilotons = thousand tons]	2005	6,096,656	242,474	600,079
	2010	5,937,252	237,398	608,626
	2015	6,128,161	251,705	587,185
	2019	5,983,277	229,431	621,704
Emissions of ammonia NH3 [tons]*	2005	3,471,000	135,210	318,030
	2010	3,270,480	117,643	296,820
	2015	3,295,770	116,013	285,730
	2019	3,284,470	107,063	299,880

Source: authors' work based on FAOSTAT [26-05-2022].

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There is a need to reduce agricultural emissions from the cultivation of wheat intended for fuel (Jarosz & Faber, 2015). The amount of greenhouse gas emissions from Green House Gases (GHG) depends on crop rotation, cultivation method, the amount of mineral and natural fertilisers, plant protection products, and soil and microclimate. Increased doses of mineral fertilisers and plant protection products in intensive cultivation cause an increase in GHG emissions (Syp, 2017).

The cultivation of energy crops to produce first-generation biofuels, i.e., cereals and oilseeds, is also associated with increased GHG emissions, especially nitrous oxide (N_2O). These crops can sometimes cause even greater GHG emissions than petrol and diesel. It is estimated that N_2O emissions from agriculture, the leading share of direct crop emissions, cause about 60% of pollution (Czyżewski & Kryszak, 2017). Therefore, according to Directive (2009), it is necessary to estimate the emissions of agricultural and process greenhouse gases (CH_4, N_2O, NH_3) and compare them with the emissions generated using conventional fuels. The estimation of emissions of N_2O, the gas with the highest potential for warming the atmosphere, is of particular importance.

Methane emissions are associated with large-scale livestock production and the breakdown of agricultural waste. Part of this emission is used in the production of biogas. Limiting methane emissions from agriculture is difficult because meat remains a significant component of the European diet. The data from Table 2 show that in the period 2005-2020, there was a reduction of this gas emission in the EU by 6.7%. It was not recorded in the Netherlands, while the reduction in its emissions was slight in Poland. The high methane emissions in the Netherlands are due to the highly developed large-scale beef production. A similar cause of methane emissions occurs in Poland, a significant milk producer in the EU. The substrates to biogas production in anaerobic digestion, except plant materials, can also be animal faeces and manure. It should be highlighted that Poland is one of the leaders in the European Union in animal breeding (Kozłowski et al., 2019).

Direct nitrous oxide N_2O arise mainly from nitrogen fertilisers, while indirect emissions are influenced by ammonia (NH_3) emissions and nitrogen leaching (Jarosz & Faber, 2015).

The research and analysed statistics show that agriculture is responsible for 98% of ammonia emissions in the EU and Poland (Witkowska-Dąbrowska, 2018). Directive (2016) imposes an obligation to reduce: sulfur dioxide, nitrogen oxides, fine dust PM 2.5 and ammonia, the primary source of which is the production of animal. Poland was obliged to reduce ammonia by 1% in 2020-2029 and 17% after 2030 compared to 2005. In Poland, the problem of ammonia emissions is regulated by the Code of Good Agricultural Practice (Ministerstwo Rolnictwa i Rozwoju Wsi, 2019). The European Environment

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Agency (EEA) compiled and published the agricultural ammonia emission factor under the Convention on Long-Range Transboundary Air Pollution (Nielsen, 2013). In 2005-2020, a decreasing trend of GHG emissions in the EU and the Netherlands was found. In Poland, however, a downward trend was recorded only from 2005-2015. Since 2015, a further increase in GHG emissions from agricultural areas in Poland has been observed. So it is a problem that should be solved as soon as possible. The ammonia emission rate from agricultural production analysis includes manure management, mineral nitrogen fertilisers, liquid manure, slurry, and droppings left by grazing animals. The emission also includes ammonia emitted from natural and mineral fertilisers at all stages of production and application to the soil. Ammonia emissions from agricultural sources cause negative changes in the environment. As a result of these emissions, there is the eutrophication of water, an increase in soil acidity, and a decrease in the absorption of nutrients by plants. Dry or wet ammonia precipitation threatens many crops and increases their susceptibility to physiological stresses. In the period up to 2005-2020, there was a slight decrease in the volume of ammonia emissions from agricultural sources in the EU and the Netherlands (Table 2). In the EU countries during this period, NH_3 emissions decreased by 9.2%, and in the Netherlands by 7.9%. The essential action of ammonia emission reduction is proper nitrogen balancing on the farm. The most significant ammonia emission occurs after applying mineral fertilisers containing nitrogen in the ammonium and amide form, which quickly transforms into ammoniacal nitrogen. Ammonia losses from nitrogen fertilisers such as ammonium phosphate, ammonium sulfate, urea, and urea solutions are estimated at 5-40%, depending on the conditions. Nitrogen losses in the form of ammonia at the stage of application of natural fertilisers on agricultural land range from about 25% to even 95%. It is crucial to cover the fertiliser with soil as soon as possible and soil application in the case of liquid fertilisers. Applying these practices and reducing emissions can improve the use of nitrogen in natural and mineral fertilisers and, thus, the farmer's environmental and financial benefits (Ministerstwo Rolnictwa i Rozwoju Wsi, 2019).

In livestock production, ammonia emissions can be reduced using appropriate feeding systems, storage, and application of manure and slurry. It is practical to use feed with a reduced total protein level, multiphase nutrition, protected protein, and feed additives, increasing protein digestibility in animal nutrition. It is also recommended to extend the grazing period, as the faeces excreted by grazing animals dry quickly, and urine is immediately absorbed into the soil. In livestock buildings, ammonia emissions mainly consist of reducing the area contaminated with faeces and their quick removal from livestock buildings. One should also pay attention to the proper storage of fertilisers; in the case of some, the loss of nitrogen compounds may even

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reach 30% (Syp, 2017). The essential document concerning emissions from agricultural areas is the Intergovernmental Panel on Climate Change (IPPC) Directive, concerning integrated pollution prevention and control. The main pillars of the Directive are:

- an integrated approach to environmental protection and the granting of an integrated permit,
- using the best available techniques (BAT – Best Available Technique),
- control of technological activities,
- public access to information (Directive, 1996).

Activities for the protection of the environment in rural areas

Environmental protection of rural areas is all activities aimed at removing the negative consequences of anthropopressure and preventive measures preventing the depletion of ecosystem functions. These are also activities aimed at the rational use of natural resources, including measures to save matter and energy. Ecosystems are recreating thanks to biodiversity (COP, 2012; Europarc Federation, 2022).

Maintaining biodiversity and ecosystem services on a global scale depends on the adequate protection of approximately 30-50% of the Earth's surface (Wilson, 2016).

Ecosystems provide humans with food, fresh water, clean air, and shelter. They help mitigate the risk of natural disasters, reduce the occurrence of pests and diseases, and contribute to climate regulation. The transformation of traditional agricultural production technologies and the transition to the conventional (industrial) system were among the greatest threats to global biodiversity in the 21st century (Komorowska, 2014; Scherr & McNeely, 2008). Significant biodiversity at the gene, species, and ecosystem levels enables a smoother transition of extreme climatic and environmental phenomena in agricultural ecosystems, making them more resistant to abiotic and biotic stresses. Maintaining biodiversity is essential to sustaining ecological functions and processes that ensure soil fertility and the excellent productivity of agricultural ecosystems (Erisman et al., 2016). By maintaining high biodiversity, the farmer can obtain higher and more stable crops of higher quality and reduce or eliminate the use of pesticides (Feledyn-Szewczyk et al., 2016). Many species favour the pollination of arable crops (Radzikowski, 2018). Proper development and yielding of about 70% of cultivated species and about 35% of food produced in farmland depend on the presence of pollinating insects. Large numbers of bees and other pollinators in the rural landscape allow for obtaining high-quality crops. The bee population, in turn, depends on the diversity of the flora of the honey-bearing species. While food security is becoming more and more focused on and linked to biodiversity,

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this is mainly true of above-ground biodiversities such as plants and animals. Far too little attention has been paid to biodiversity beneath the feet in the soil, yet it is what drives many of the processes of producing food or cleaning soil and water.

As already mentioned, greenhouse gas emissions are also associated with agricultural production. Limiting global warming to 1.5°C requires rapid and far-reaching social and economic changes in line with the dynamic development of societies and the economy. Transformations are necessary for all areas of socio-economic life, especially changes in the philosophy of approach, development, and management, and legal changes in the areas of energy, transport, infrastructure, industrial systems, economy, business, technology, health, safety, water and environmental management and politics, communication and social participation. Transformation of economic systems should rely on actions limiting and reducing emissions in all sectors, introducing adaptation measures, and increasing pro-environmental investments. In Polish rural areas, attempts have been made for many years to use innovative system solutions (Kostecka & Kostecki, 2016a).

Agri-environment-climate activities

The solution supporting environmental protection in rural areas is currently the second pillar of the Common Agricultural Policy (CAP) of the EU, enabling the practical application of many educational programs and projects. It consists of farmers' services for the environment (Bogactwo wsi, 2022). The benefits include adjusting agricultural (field and livestock) production to environmental protection requirements. These are the so-called agri-environment-climate measures. These programs aim to protect the existing natural ecosystems in rural areas, restore the values or maintain the condition of valuable agricultural habitats and preserve biodiversity by promoting a sustainable management system, appropriate use of soils and water protection, and protection of endangered local livestock breeds and local plant varieties of arable crops (Ministerstwo Rolnictwa I Rozwoju Wsi, 2011). The solutions used in the United States were the prototype of agri-environmental programs. They were based on voluntary agreements of environmental organisations and local authorities with farmers to protect natural and landscape values. Due to the monocultural and industrial nature of the agricultural economy, the American concept of agri-environmental programs was based on the assumption of a contradiction between this economy and the preservation of environmental values. The main task of the current agri-environment-climate programs is to restore agricultural land to a state of natural homeostasis. The use of industrial production methods in agriculture should consider the latest technical solutions in this area (Samborski, 2018).

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As part of the Common Agricultural Policy, the so-called "agri-environmental packages" aim to protect biodiversity in agricultural areas (Kozłowska-Burdziak, 2020; Stalenga et al., 2016).

At the stage of declaration and implementation of the package, the farmer should cooperate with an agri-environmental advisor and, in the case of packages implemented on permanent grasslands, with a nature expert. Using a package or several packages on the farm may bring tangible financial benefits to the farmer.

Plant alternation (rotation)

The selection of the forecrop and the rotation (succession of plants) in the field plays a prominent role, among others, in the stable yielding of crops and the quality of the obtained crop. This issue was considered from the beginning of agricultural development (Chmielecki, 1956). Cultivating the same species in a given field (monoculture) for many years results in a decrease in yield, soil impoverishment, and accumulation of pathogenic factors (Feledyn-Szewczyk et al., 2016). These problems can be eliminated or minimised using crop rotation and a fixed and planned sequence of plants (Barbieri et al., 2017). The model crop rotation in agriculture is the Norfolk four-field crop. It began to be used in England in the 17th century. This cultivation system divided the farm acreage into four fields of similar size, where they have grown in the following years: root crops (potatoes), spring crops, legumes, and winter crops. As a very effective agricultural production system, the Norfolk four-field farm was quickly adopted all over Europe, where it was widely used until the second half of the 20th century. Unfortunately, at the end of the 20th century, the Norfolk crop rotation was replaced by intensive agriculture based on the achievements of the agricultural revolution (mineral fertilisers, pesticides, modern varieties). Currently, there is a belief that obtaining very high yields of the species grown in monoculture is possible. However, agricultural practice and climate change prove that modern pesticides do not destroy all plant pests and diseases. In monocultures, chemicals accumulate in the soil, and high doses of mineral fertilisers cause the depletion and depletion of organic matter in cultivated soils. These unfavourable processes begin to be minimised and eliminated in so-called sustainable agriculture, especially in organic farming. In small cultivated areas and the conditions of backyard farms, the phytosanitary effects of some plant species or the so-called positive allelopathy (secretion by one species into the environment of substances supporting the growth of the other species). Enrichment of the soil with nitrogen from atmospheric nitrogen-fixing legumes with nitrogenous bacteria (e.g., vetch, lupine, red clover, sunflower) is also included.

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Ecological agriculture in balancing the environmental burden of rural areas

Organic farming is a pro-environmental method of agricultural production. The European Commission indicated it in both the biodiversity strategy and the *From Farm to Fork* strategy, where the goal of achieving 25% of crops in the European Union in the organic farming system by 2030 was set (EC, 2022). As can be seen from Table 3, this is an ambitious goal because the total area of ecological agricultural land in the EU in 2020 has reached 9%.

In 2015, 271,349 organic farms in the EU were operating in 11,935,317 ha (Table 3). The cultivation of cereals occupied the largest area of ecological agricultural land. Permanent grasslands were in second place. In 2019, in livestock production, the production of eggs and fish increased significantly, and the number of animals, especially poultry, increased. Moreover, the number of entities preparing organic products for direct consumption has significantly increased (FAOSTAT, 2022).

Table 3. Selected features of organic farms in 2005-2020 in the EU, the Netherlands, and Poland

Specification	Year	European Union	Netherlands	Poland
Number of organic farms	2005		1 377	7 182
	2010		1 462	20 582
	2015	271 349	1 475	23 015
	2020		1 937	20 274
Area of ecological agricultural land [ha]	2005	6 362 954	48 765	166 298
	2010	9 174 505	46 233	519 068
	2015	11 935 317	49 273	580 730
	2020	14 719 036	71 607	509 291
Percentage of the total agricultural area	2005	3.8	2.5	1.0
	2010	5.1	2.5	3.3
	2015	6.6	2.7	4.0
	2020	9.0	3.9	3.5

Source: author's work based on Eurostat. Area for organic farming.

Organic agricultural production places the most significant emphasis on environmental protection and animal production on animal welfare considerations. Gives up or drastically restricts synthetic chemicals such as fertilisers, pesticides, additives, and medicinal products. The production of geneti-

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cally modified organisms (GMOs) and their use in animal feed are prohibited. It is part of a sustainable farming system and a viable alternative to more traditional approaches to agriculture. Organic farming requires regulated standards (production rules), critical control systems, and a specific labelling system, unlike other agricultural production methods.

The European Parliament and the European Commission have adopted the 2030 targets for organic farming. They assume limiting the use of the most dangerous chemical plant protection products by 50%, limiting mineral fertilisers by at least 20%, and limiting the loss of nutrients by at least 50% (Eurostat, 2022).

Organic farming is a system that positively influences the natural environment, contributing to achieving broadly understood agri-environmental benefits. It is also a response to the changing structure of market demand and growing consumer awareness. As part of the most extensive public consultation in the history of the European Union carried out to guide changes in the legislation on organic production, consumers indicated that they are ready to pay higher prices for products produced with respect for the environment and animal welfare (IJHARS, 2018).

Field plantings in the system of conventional agriculture

The farm forms a large functional whole with the possibly closed circulation of matter. Large monoculture farms in conventional agriculture impoverish the agricultural landscape and reduce the biodiversity of flora and fauna. Therefore, in shaping the value of the rural landscape, one should consider such elements as the size and distribution of fields and the surroundings: bushes, clumps or stripes of shrubs and trees, watercourses and reservoirs, the sequence of arable land and grasslands, and high woody vegetation – the so-called in the field. Trees are the allies of the farmer; their importance increases, especially in forestless spaces and areas with light soils, an insufficient amount of precipitation, and limited resources of ground and soil water. The measurable importance of tree stands is: the protection of fields against the harmful effects of winds, maintaining air humidity in the ground layer, limiting wind and water erosion on light soils, and increasing water retention in soil. They are also a habitat for many fauna species that help fight diseases and pests of crops.

Row, strip, or clump plantings should be introduced in a landscape with insufficient or improperly distributed woody vegetation. As their location can and should be adapted to the needs of agriculture, they should be considered the most crucial tree formation, especially in a lightly forested landscape (Ministerstwo Rolnictwa i Rozwoju Wsi, 2019).

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Assessment of the case of Hajnówka county as a model of the organisation of harmonious development of agriculture

The Hajnówka county is located on the eastern edge of the Podlaskie Voivodeship in the Republic of Poland (52.733333 = 52° 43′ 59″ φ N; 23.566667 = 23° 34′ 0″ λ). It borders Belarus from the east, Siemiatycze county to the south, Bielsko county to the west, and Białystok county to the north. Agriculture is one of the most critical sectors of the economy of the Hajnówka county (Raport, 2019).

The forest area in the Hajnówka county covers 88,000 ha, and the forest cover index (forest area relating to the total area of the unit) amounts to 53.2%. It is higher than the national average by 24%. The large forest cover of the analysed area creates favourable conditions for the use of the remaining district area sustainably due to the favourable microclimate and reduced air pollution by forest communities. The forests occur in the dense complex of the Białowieża Primeval Forest and separate complexes. The most numerous are pine forests. Scots pine is the essential forest-forming species, and Norway spruce forms groups of low boreal spruce forests. As a result of climate change and the lowering of the groundwater level, spruce is disappearing, also under the influence of the bark beetle infestation.

Protected areas are on 95 415 ha (Sawicka & Tomaszewska, 2012). In the eastern part of the county, there is the Białowieża National Park (with an area of 10,517.3 ha), classified as a UNESCO biosphere reserve. In the county, the protected landscape areas of the Narew Valley and habitat areas under Natura 2000 have been separated. Two protected landscape areas are under protection: a forest complex around the Białowieża Forest and a part of the protected landscape of the Narew Valley, with a total area of 84,490.8 ha, and 23 nature reserves covering 12,340.3 ha of land. In the Hajnówka county, 701.9 ha of ecological land was also established (Sawicka & Tomaszewska, 2012). In total, protected areas cover about 59% of the district's area, which is close to Wilson's (2016) concept, postulating that half of the Earth should be allocated to strict nature reserves, which could help save biodiversity for its own sake and human well-being.

There are about 8,000 farms in Hajnówka county, 72% of which are family farms with an area of 1-2 ha. On the other hand, over 500 farms have an area of over 15 ha; there are also several hundred hectares of farm-type farms located in the communes of Narew, Hajnówka, and Czyże (Strategia, 2014; Roszkowska-Mądra, 2014). In communes with light soils, a significant part of the arable land is used extensively or periodically fallow, contributing to biodiversity protection (Kiryluk, 2009).

The soils of Hajnówka county arose and were shaped under the influence of glaciation and, in later periods, also under anthropogenic activities. They

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are diversified, which is also a natural advantage of this county, which has podzolic, brown, fawn, rusty soils, various forms of glazed soils, and organogenic soils in river valleys and peat bogs: black earth, muck soils, and peat of transitional, low and high fens. River marshes also occupy relatively small areas. Large areas are fertile brown soils, stuck brown soils, and deer. According to IUNG data, the average index of the quality of agricultural production space in Hajnówka county is 52.6 points, with the average index for Poland being 66.6 points (Biesiacki et al., 2004). Most of the soils in this area are low in nutrients (nitrogen, phosphorus, potassium). It is estimated that the shortages of these components concern about 60% of the agricultural land, depending on the commune. Percentage share of soil valuation classes in the county: class I-0%, class II-0%, class III -9.6%, class IV-36.8%, class V-34.7%, class VI-18.9%. Nutrient deficiencies in soil are unfavourable for its fertility and the diversity of zooedaphone from the invertebrate group. These facts weaken the ecosystem services of soil ecosystems, and consequently, humans receive crops of incomplete nutritional value.

There are natural minerals in Hajnówka county: gravel, sands, as well as significant clay deposits near Lewkowo Stare, Trywieża, and Czyże, often surrounded by agricultural lands (PIG, 2022). It generates a great variety of habitats. Due to the legal status of this county in terms of nature protection, the exploitation of these minerals cannot be extended due to the threat to agricultural and valuable natural areas. Attempts were made to exploit peat for non-agricultural purposes from the Bagno Tyniewicze low peat bog; however, the project will not be implemented due to active and long-distance socio-ecological pressure.

In the last 20 years, the structure of crops on arable land has also changed in Hajnówka county (Table 4). It transforms complex companion biodiversity groups. The disappearing plants include potatoes, sugar beets, flax, and others.

Table 4. Changes in the sowing area of more essential crops in the Hajnówka county in 2005-2020 [ha]

Years	Agricultural land	Permanent grassland	Rye	Wheat	Triticale	Maize	Potatoes	Oilseed rape and agrimony	Barley
2005	67 588	27362	5587	4 227	1 049	983	200	97	862
2010	44 030	15 260					682	1433	
2015	44 493	16 690	1143	4034	2380	2476	87	1304	380
2020	46 992	16 473	2113	8408	3652	4805	163	3195	231

Source: authors' work based on GUS [19-05-2022].

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Potato cultivation area of edible and fodder varieties decreased in Hajnowski county to about 200 ha. It was a plant with a long-standing cultivation tradition and high nutritional importance in the region. The reduction in the size of the cultivation of these plants is due to the high labour consumption, low profitability, and the introduction of industrial fodder in livestock production. The decrease in legume cultivation is disturbing. The lack of these plants in field crops reduces the abundance of organic matter in soils and the assimilation of atmospheric nitrogen. There is also a downward trend in winter rye cultivation (Kiryluk, 2009). The cultivation area of oats, triticale, and barley also decreased slightly. It is due to the lower demand for these grains. Wheat cultivation is systematically increasing, resulting from the profitability and the use of new high-yielding varieties. Industrial feed producers are increasingly using wheat in their feed production. On the other hand, the cultivation of oilseeds, especially winter rape, is increasing significantly and systematically. Oilseed rape is grown on farms that produce cereals as part of the crop rotation. There is an increase in maise cultivation in the district, both silage and grain. It is often grown as the only plant on arable land. Still, negative phenomena must be considered (erosion, decrease in the content of humus and nutrients in the soil, growing weed infestation, and infestation with diseases and pests). Several hundred-hectare corn plots have recently been contracted as a long-term raw material for the existing biogas plant. The fermented manure, slurry, maise silage, and other agricultural waste make it possible to provide the biogas plant in Stary Kornin with at least 1,373,000 m^3 of methane. It is the equivalent of approximately 13,689 MWh of energy (Strategia, 2014).

Relating to the EU countries and the Netherlands, the applied mineral fertilisation for crops in Hajnówka county is low (Table 5). The pesticide application here is 1.17 kg of active substance per hectare (Łozowicka & Konecki, 2011). The most significant pesticides are used here in horticulture and rape cultivation.

Table 5. Consumption of mineral fertilisers, applied pesticides and CO_2 emissions as greenhouse gas equivalent in agricultural areas of the Hajnówka county

Years	Nitrogen N [kg × ha^{-1}]	Phosphate P_2O_5 [kg × ha^{-1}]	Potassium K_2O [kg × ha^{-1}]	Pesticide – use per cropland area [kg × ha^{-1}]	Emission of CO_2 (calculated data) [kilotons]
2005	-	-		-	61
2010	63.3	23.4	29.1	1.17	89
2015	-	-		-	66
2020	63.1	27.4	33.4	-	54

Source: authors' work based on GUS [19-05-2022].

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The development of conventional agriculture leads to the natural impoverishment of the agricultural production space of the Hajnówka district. Failure to adjust the intensity and forms of agriculture to the natural conditions of agricultural production results in the activation of water and wind erosion and groundwater contamination. Pig and poultry farms (some of them require integrated permits) are also a threat to the environment. Their number decreased due to failure to meet the requirements and certification criteria.

In the Hajnówka county, there are perfect conditions for creating ecological farms producing high-quality food: vegetables, fruit, cereals, and meat (Table 6). Organic farming, run by family farms, creates local, independent, and short supply chains, enhancing food security and positively influencing public health and the environment. The total agricultural land under organic farming in Hajnówka county is only about 1%.

Among the ecological crops in the fields in Hajnówka county, there is a lot of buckwheat *Fagopyrum esculentum* and the health-promoting plantain *Plantago lanceolata* (Figure 2).

Table 6. Organic producers and the area of ecological agricultural land in 2005-2020 in the Hajnówka county

Year	Number of organic farms	Area of organic agricultural land [ha]	Percentage of the total agricultural area
2005	164	208.6	0.3
2010	339	795.2	1.8
2015	155	476.1	1.0
2020	90	532.1	1.1

Source: authors' work based on GUS [19-05-2022].

Organic cultivation of common buckwheat *Fagopyrum esculentum*

Organic cultivation of plantain *Plantago lanceolata*

Figure 2. Ecological cultivation in the fields in the Hajnówka county

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Great potential for reducing anthropopressure in rural areas is given by the production of renewable energy in livestock farms. This includes the use of manure and other waste to produce biogas. Hou et al. (2017) showed an emission reduction of around 17% by analysing 12 different technologies that have been tested in different countries of the European Union.

Anaerobic fermentation turned out to be the most advantageous technology for GHG reduction. Manure composting is also an excellent solution to reduce emissions and obtain valuable and safe organic fertiliser. The use of digestate from agricultural biogas plants for soil fertilisation can significantly reduce the use of energy-consuming synthetic fertilisers. Lyng et al. (2018) developed models for optimising manure management. They showed that biogas production in small domestic installations and centralised biogas plants is profitable and contributes significantly to reducing emissions. It also makes it possible to generate an alternative energy source in dairy farming, which can be converted into heat or electricity. This renewable energy can significantly cover the energy demand of farms.

Recently, large photovoltaic farms have been located in agricultural areas in the Hajnówka commune, e.g., in Nowoberezowo and Dubiny. They are an essential part of renewable energy sources in the pro-environmental energy balance of the district. They were located on land with low valuation classes and did not diminish the landscape values. For ecological and aesthetic reasons, large-scale cultivation of energy crops, mainly maise in monoculture on arable land of medium and reasonable valuation classes, is not desirable. Perennial cultivation of energy crops reduces landscape values and biodiversity in agroecosystems.

Organic and sustainable agriculture arising in micro-regions requires support and the removal of administrative barriers that inhibit this development today. The agri-environmental and climate packages introduced under the Rural Development Programs aim to protect the existing natural ecosystems, restore the values or maintain the condition of valuable agricultural habitats, and preserve biodiversity. As mentioned many times, a necessary action to maintain biodiversity in rural areas is popularising knowledge in a sustainable society and the multifunctional importance of these areas.

New transformation concepts are urgently needed, developed in cooperation with local government officials, scientists, and active activists for rural areas, cities, ecology, and social welfare (Dearing et al., 2010). Humanity cannot afford to expect excessive and infinitely increasing materialistic prosperity. We have long lived on credit for ecosystem services, which means we use too many resources. You need to focus on high-quality public services and satisfaction of basic social needs while approaching ecological barriers cautiously (loss of biodiversity, climate change, use of water resources, loss of the ozone layer, ocean acidification, air pollution, chemical pollution of the

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planet, unsustainable use of the surface, disruption of the nitrogen and phosphorus cycle), which humanity – if it wants to avoid catastrophes – should not exceed (Rockström et al., 2009; Nordhaus et al., 2012).

It is necessary to start with the regeneration of ecosystems and consider that the consumption of materials and energy occurs within the ecosystem cycles and their boundaries (Balmford et al., 2011). Since climate and biodiversity protection are now more important than economic growth for the survival of people, we must strive to slow down the production chain of goods and services and minimise the transformation of ecosystems (Kostecka, 2019; Hardt, 2017). It should be organised within the framework of the new European Green Deal. However, we need new and good ideas. One of them may be *The Amsterdam City Donut* (Rawortht, 2020) project/program that reconciles the interests of people and the planet, caring for development and prosperity in society while protecting natural ecosystems and resources of the Earth.

The above assumptions and actions correspond to removing the negative consequences of anthropopression and preventive actions in large areas, in line with the sustainable development of the entire planet. The chances of success here are only a logical and practical combination of local spatial development strategies built into regional strategies and, finally, a global sustainable development strategy at all the abovementioned levels. The Hajnówka county has a chance while maintaining over 50% of the area as a protected space, to develop with care for soil biodiversity and the restoration of other habitats and ecosystems. To establish a different development strategy, the decision-makers of this socio-economic area should actively update the value of their natural environment resources and social and economic needs, and then, for example, using the possibility of using an integrated index method for determining the value of environmental resources to determine the direction of development of a rural commune (Majewska et al., 2017), take long-term strategic steps that give future generations a chance to live in broadly understood well-being. When determining the conditions for the development of the county and communes, apart from determining the strengths and weaknesses of the area, one should; develop indicators of sustainable development based on data from the Local Data Bank and own research and determine the state of the natural environment of the entire area along with the level of its sustainability. The opportunity for new development directions should also be considered by defining the possible functions of these areas and activities shaping the environment. The natural and agricultural environment components should be considered, such as the current structure of land use, the quality of agricultural production space, water resources, soil, air, biodiversity, and landscape. Still, it may turn out that it will be necessary to take actions supporting the sustainable development of

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some of these areas, and this most often concerns landscape elements (Majewska et al., 2017; Kostecka & Kostecki, 2016a), the greatest strength of rural areas is usually their biodiversity. This component can be used not only for the productive function of the village but also for the ecological or recreational function. It makes it possible to diversify residents' earnings towards various forms of tourism.

It is worth organising for tourists to develop and improve sustainable tourism, broadly understood as "educational trips in rural areas". They should enable tourists to contact an interesting place, provide them with exciting experiences, and provide the knowledge that provokes them to search for new information, solutions, examples, and motivation to use positive patterns or situations in their lives. After completing a well-prepared "educational journey," a tourist is many issues while travelling can be viewed differently.

Organising "educational trips for sustainable development" can function with the participation of clusters, which allows cooperation of many elements and institutions, starting from the district self-government and communes. The concept of clusters interests scientists, politicians, and entrepreneurs. It would be good if as many people as possible were persuaded to take sustainable actions for the local, regional or national economy. The functioning of the cluster economic system supports the tightening of cooperation between enterprises, increasing the productivity of production factors, implementing new technological solutions, improving the quality and directions of staff education, creating a regional brand, and using external sources of financing. The benefits for the external environment include the increase in the availability of specialised business-related services, investments in infrastructure, reduction of unemployment, increase in professional activity and income of the population, and, consequently, sustainable local and regional development. There may be entities closely related to tourism in a tourism cluster, e.g., accommodation facilities, restaurants, travel agencies, tourist carriers, and tourism-related entities: banks, insurance agencies, consulting companies – mainly small and medium-sized enterprises, highly specialised, connected with trust but competing.

In the era of exhaustion with the increasing pace of life, "educational trips" have a chance to become, for example, an exciting and attractive place to implement various forms of slow tourism embedded in nature. In this case, many places with elements of the existing traditional infrastructure may start to function as a cluster, creating an organisational structure of great economic importance (Kostecka & Kostecki, 2016b).

We must solve these and other problems significant for human survival in the ongoing and starting Decade of Ecosystem Restitution (2021-2030).

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Conclusions

In the 21st century, agriculture has evident pressure on the natural environment. It is mainly due to the marketisation of agriculture and the focus of this activity on production maximisation. Meanwhile, agroecosystems are the basis of life and many other human activities. They influence the circulation of matter and energy and fulfil many regulatory functions in terrestrial ecosystems. Excessive and uncontrolled development of agriculture, especially large-scale crop production and industrial livestock breeding, threatens biodiversity, reduces the population of many species, and, consequently, reduces ecosystem services in these areas. It is increasingly common to believe that agriculture is essential not only because it produces the most important food products for human existence but also fulfils many social, cultural, and ecological functions. In most European countries, more than half of the area is used for agriculture. The farmer protects one of society's most valuable resources: agricultural land and many natural goods. Maintaining these resources properly for present and future generations is of the utmost importance. Human functioning in 21st-century civilisation requires new patterns of behaviour. Slowing down the processes of the negative impact of agriculture on the environment is possible, among others, by introducing integrated and regenerative farming methods (recommended by the Common Agricultural Policy of the EU) and other pro-environmental activities. In the long term, reducing species biodiversity in agrocenoses and introducing monocultures in field crops will limit plant biomass production due to reducing the yielding capacity of the soil and the impact of zoocenoses on the functioning of ecosystems.

The analysed Hajnówka county is an excellent example of an attempt to combine pro-environmental farming and nature protection by covering a large fragment of space with forms of area protection. It is in line with the concept of allocating half of the Earth to strict nature reserves and the assumptions of the Decade of Ecosystem Restitution (2021-2030). Such activities can help save biodiversity and ecosystems and benefit people and their well-being.

The lack of an apparent increase in macroeconomic factors does not eliminate the chances of a good life. We only need consistent reduction of negative anthropopressure and implementation of possible solutions.

Effective measures to reduce anthropopressure in agriculture include inhibiting but also adapting to climate change, reducing biodiversity loss and restoring ecosystem services. This is a priority, although it must not come at the expense of other sustainable development goals, especially those related to efforts to reduce poverty and hunger by 2030.

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Countries that are parties to the Paris Agreement take measures to reduce greenhouse gas emissions. Priorities that directly affect, e.g. livestock include: increasing the efficiency of livestock production and resource use, intensifying recycling efforts and minimising losses for a circular bioeconomy, and reaping the benefits of the solutions based on the natural resource in order to increase the reduction of CO_2 emissions. What is also important is a comprehensive approach related to the changes in the applicable European law.

In the future of sustainable plant and animal production, the achievements of genetics, genomics, bioinformatics, statistics, automation, robotics and computer science should be of great importance. All these should also be embedded in the local natural conditions and to the satisfaction of the producers.

Recycling efforts should be stepped up and waste minimised for the circular bioeconomy. Agri-food systems rely on natural resources as the primary means of production; some natural resources are used too quickly, jeopardising their recovery. Promoting a "circular bioeconomy" instead of a linear extraction, production, use and disposal process includes recycling resources at every possible stage of agri-food systems and optimising the functioning of existing systems to minimise waste. Increased circulation in food systems, where waste from one process becomes raw material for another, is a way to increase food production efficiency.

It is estimated that about 30% of all crops are grown to feed livestock, and some animals are kept in mixed farming and breeding systems, including agroforestry and forest-pasture systems. Agriculture is a direct cause of global deforestation. Stopping such activities for forage production and grazing can be one of the most effective ways of mitigating the climate change impact on farming systems.

Extensive and semi-intensive grassland can provide much-needed carbon dioxide absorption. Well-designed grazing systems can stimulate plant growth and capture carbon in the soil, especially in areas where degradation is not yet significantly present.

The research shows that grazing farm animals are essential for sustainable development and biodiversity protection. This is gaining popularity due to the benefits it brings to valuable natural ecosystems, helping to maintain soil fertility and organic fractions, regulating water, reducing the occurrence of pests and diseases, and maintaining biodiversity.

There is also scope for wider use of land and buildings associated with livestock farms for locating solar and wind farm installations. The economics of such compensation would have to be beneficial to livestock farmers, and appropriate mechanisms for accounting for carbon dioxide emissions should be introduced so that the resulting emission savings are compensated against those generated by livestock. Conservation and ecosystem restoration is

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a global problem that requires well-integrated local, national and regional solutions.

The Hajnówka county may continue to undergo a favourable transformation and become a model of pro-environmental development with minor changes. It would be advisable to return to the traditional agricultural production methods and effectively protect the trees and vegetation that make up the ecological corridors. It is necessary to comprehensively support the development of organic farming for the local and national market and export. The existing area of organic farming should be considered minimal and not take advantage of the environmental conditions in the county.

When limiting the cultivation of maise for biogas instead of for food or fodder, a proper balance of municipal waste biofraction should also be made. Assuming that some of the best quality fractions will be composted and returned to the soil, the poorer-quality ones can be converted into energy without forgetting the necessary energy-saving strategy. One should also not forget about the aspect of social development, organising it to increase the profitability of pro-environmental farms.

We must solve these and other problems essential for human survival in the Decade of Ecosystem Restitution (2021-2030) that has just begun to build a sustainable human welfare strategy using wisely the resources of matter and energy recreated innately. It should also be emphasised with complete conviction that without a broad front of activities, including continuous education of the society, also through "educational trips", neither provisions in fundamental legal acts nor those announced by international bodies of the Decade (Decade of Education for Sustainable Development (2005-2014), The Decade of Biological Diversity (2011-2020), the International Decade of Soils (2015-2024) and the Decade of Ecosystem Restoration (2021-2030)).

The use of ecosystem services will be permanent and easier when the elements of the decade of ecosystem restitution are widely disseminated and rooted in the civic consciousness of the inhabitants of Poland and similar spaces in Europe. For this to happen, this decade of ecosystem restitution must be advertised as widely as possible, writing and talking about it in various contexts.

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The contribution of the authors

Aleksander Kiryluk – 50%
Joanna Kostecka – 50%

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