

Ecosystem Services to Support the Diversification of Agricultural Production

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Abstract

The issue of diversification of the agricultural sector in the context of providing environmental, social and economic components is on the agenda of governments of many countries. Ecosystem services can form a powerful direction of agricultural development inculcating the sustainable development. A significant problem lies in the lack of ecosystem conservation, the lack of realization of ecosystem services, limited understanding of the nature of ecosystem services, and the lack of available statistics. Current research focuses on assessing the contribution of ecosystem services to entire cycle of a product and how it overcomes the business risks. As a result, new sources of income are foregone. That is why effective environmental management must take into account new income opportunities flowing in from various ecosystem services if conserved properly. This article is to identify possible areas for diversification of the agricultural sector in the context of ecosystem services. Some factors that determine ecosystem services are suggested. Correlation models are used to understand the relationship between ecosystem services and the agricultural productivity. Based on secondary data, the optimal directions of diversification of agricultural producers are determined. Some organizational aspects of opening new avenues in given legislation framework are identified.

Keywords

Diversification; Agricultural sector; Agricultural production; Ecosystem services

Introduction

Addressing local and global food security issues, together with balancing the negative impact on the environment, requires the introduction of a new paradigm of agricultural production based on diversification of agriculture. A recommended direction is the introduction of ecosystem services into the practice of economic activities conforming the sustainable development. This topic has paramount importance due to current environmental challenges and the challenges of socio-economic nature. For a long time, ecosystem services obtained from the natural environment were not taken into account in the economic valuation of the production processes of a final product. This has led to an irrational use and pollution of land, reduction of forest areas, reduction of honey crops¹, irrational use of water resources, significant reduction of biodiversity and other negative effects of economic activities. The issue of accounting and economic evaluation of ecosystem services leads to broad discussions on the need to determine their final value and further diversification in the context of the agricultural sector. The natural ecosystems have a decisive influence on agribusiness. Therefore, significant efforts of modern scientific research are aimed at escaping their degradation (Williams *et al.*, 2020; Zeng *et al.*, 2020). According to Hanson *et al.* (2012), enterprises often cannot link the health of the ecosystem with the final outcome of economic activities. A significant amount of research focuses on the impact of economic activities on the environment and its risks. As a consequence, corporations may lose new sources of income as part of rapid ecosystem change. Thus, the practice of environmental management should take into account not only the risks for corporate activities, but also focus on new business opportunities.

Based on the scientific findings of Hanson *et al.* (2012), the main possible areas for diversification or starting a new business respecting the ecosystem services are presented in table 1. In this tabulated data, the operational, regulatory and legal, reputational, market and financial aspects that meet certain essential characteristics of ecosystem services are highlighted.

Table 1: Opportunities for business diversification in the context of ecosystem services

<i>Direction</i>	<i>Operational</i>	<i>Regulatory and legal</i>	<i>Reputational</i>	<i>Market</i>	<i>Financial</i>
Characteristic	Improving the efficiency of water use or development of wetlands, forest protection, improving soil quality, promoting pollination of plants	Involving governments in developing policies and incentives to protect or restore ecosystems	Introduction and dissemination of sustainable methods of procurement, operations or investments in order to differentiate corporate brands	Launching new products and services that reduce customer impact on ecosystems, participating in carbon sequestration and watershed protection markets, income from natural assets, eco-labeled products, etc.	Offering more favorable lending conditions, or investment climate to companies that improve resource efficiency or restore degraded ecosystems

Bagstad *et al.* (2013) argue that most decision support tools for quantifying and evaluating ecosystem services are too resource-intensive to routinely use in decision-making. Chaplin-Kramer *et al.* (2019) developed a global modeling of ecosystem services, focusing on water quality regulation, coastal protection and crop pollination. The focus of this study is on an empirical assessment of the relationship between

¹ Honeybees usually collect nectar, pollen, or both from a large number of species of plants, which are called *honey plants*, for making honey. Examples include buckwheat, sunflower, rapeseed, etc. A comprehensive list of the families covered under this category of plants is given on the link https://en.wikipedia.org/wiki/List_of_honey_plants

factors that determine ecosystem services and the performance of the agricultural sector to find optimal ways to expand agricultural production process. This will allow the conceptualization of new areas of economic activities or diversifying existing production in order to comply with sustainable development goals. The objective of this research is to establish the links between individual ecosystem services and the output of the agricultural sector. It is to identify the possible areas for diversification of the agricultural sector keeping in consideration the ecosystem services.

Material and Methods

This study included those components for which statistics can be obtained. The information was accessed from the State Statistics Service of Ukraine for the period of 2010-2019. The list of ecosystem services was derived from a study by Landsberg *et al.* (2013). The ecosystem services considered for this study include the regulatory and control services provided by honey plants or nature reserve fund in the form of , for instance, neutralizing the wastes or CO₂ emissions. Next is the ancillary service that is obtained through the application of mineral and organic fertilizers, protection and rehabilitation of soil, groundwater and surface water, protection and reproduction of wild animals and birds, including biotechnical measures.

The method of correlation analysis, in particular, pairwise correlation, to determine the degree of density of relationships between the performance indicators (gross output of agricultural products and services and individual ecosystem services) was employed. This allowed to select those indicators that have high or medium degrees of correlation. Such selected ones can be taken into account in further research. It helps identify potential areas for diversification of the agricultural sector integrating the ecosystem services. Calculations and graphical interpretation of the results were performed in the EXEL environment, using a correlation analysis package.

Results and Discussions

Research of ecosystem services in the context of the agricultural sector

In Ukraine, as a result of transformational changes, a dual agrarian structure has emerged combining the individual farmers and corporate sectors. Undoubtedly, the individual farmer is more inclined to implement the principles of sustainable development. In contrast, the corporate farming emphasizes business scaling, the wholesale production, intensification of farming, and selling in international markets.

Low level of competitiveness of small agricultural producers in the European context and their non-compliance with the objectives set out in the Decree² of the President of Ukraine “On Sustainable Development Goals of Ukraine until 2030” No. 722/2019 of 30 September 2019 lead to new threats to the sustainable development of the agricultural sector as per the provisions of the EU’s Common Agriculture Policy³. The problem of discrediting the ecosystem services arose due to the inability of mankind to prevent the degradation of nature. Negative environmental consequences can be prevented by non-traditional methods through introducing a payment mechanism for ecosystem services). Ecosystem services can be grouped into the following main areas: provisioning services (e.g., food, water, wood, etc.); regulatory and control services (e.g., control of plant growth by pollination, flood control, carbon control, etc.); ancillary services (e.g., water cycle, photosynthesis and nutrient cycle between organisms and soil); cultural services (e.g., recreation, culture, art, etc.) (Birkhofer *et al.*, 2015; Mengist *et al.*, 2020). Sometimes these functions

² Decree of the President of Ukraine (2019) on the Goals of Sustainable Development of Ukraine until 2030. Available online at: <https://www.president.gov.ua/documents/7222019-29825> [accessed on 23 January 2022] (in Ukrainian). Also available on: <https://zakon.rada.gov.ua/laws/show/722/2019#Text>

³ https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy_en

remain invisible and run at the risk of being insufficiently provided if their contribution to the final services is not identified. A number of scientific studies conducted by Cordier *et al.* (2014), Murillo *et al.* (2014), Bennett *et al.* (2014) and Vysotska *et al.* (2021) argue that monetization of natural services can lead to better management of natural resources. Modern industrial agriculture considers only a narrow range of agroecosystem services, namely food and industrial raw materials. Contrary to this, a range of services can be expanded by supporting and enhancing other important ecosystem services, such as climate regulation, water protection and biodiversity conservation, which are essential for the maintenance of human life and social well-being.

This article defines that the ecosystem services can be measured in two forms: physical and monetary. Physical form measures the impact in terms of physical units: for example, the number of tourist visits to nature per year, number of protected areas, the amount of precipitation per year, the quantity of fertilizers and agrochemicals used, and so on. The contribution of the ecosystem to the total crop yields in the EU countries is, on average, 21%, and the remaining 79% of crop yields are attributed to the use of fossil fuels, agrochemicals, fertilizers, irrigation and other inputs (Vysna *et al.*, 2021). The monetary form of ecosystem service is determined on the basis of the value of the ecosystem service that the specific ecosystem is expected to provide. The contribution of the ecosystem in 2012 to crop production was estimated to be at 20.8 billion Euros (Vysna *et al.*, 2021). Research by Gao *et al.* (2020) focuses on the evolution of market-based instruments for ecosystem services. Emphasis is placed on an ownership of the ecosystem services. It is said that this would be useful for creating markets for carbon emission credits, storm water retention credits, and wetland mitigation loans.

However, there is a number of challenges to the concept of ecosystem services in modern times. The first challenge is the lack of a proper management of ecosystem. In order to propose optimal methods for the benefit from ecosystem services, the impact of anthropogenic interventions on ecosystems should be determined. The challenge is to assess the relationships between different indicators of ecosystem services while taking into account the uncertainty of environmental processes. The third challenge is the limited understanding of the nature of ecosystem links and the lack of a common statistical base. In order to effectively manage the assessment and delivery of ecosystem services, it is necessary to determine whether these services have common features and relationships.

The activity of the agricultural sector is characterized by a number of indicators. In generalized form, it is measured in terms of the gross output of products and services. But, it is important to establish links between this indicator and other factors expressed as ecosystem services. Initial statistical information for the study was obtained from the State Statistics Service of Ukraine (SSSU, 2019a; SSSU, 2019b; SSSU, 2020a; SSSU, 2020b; SSSU, 2020c; SSSU, 2021a; SSSU, 2021b) and entered in the relevant data tables 2, 3, 4, 5, 6, 7, 8, 9 and 10.

Table 2: Gross output of agricultural products and services (in million USD)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
12567.0	31696.1	32729.4	38381.8	30978.5	24736.6	24530.4	26214.5	31392.1	32414.1

Source: SSSU (2019a)

In theoretical terms, the nature reserve fund is part of the ecosystem process, which led to its inclusion in this study (Table 3). In Ukraine, creation of a nature reserve fund is an effective mechanism for maintaining the overall ecological balance, preservation of natural areas, and gene pool of fauna and flora. The area of the nature reserve fund is one of the indicators of the progress of green growth. It is believed that in order to ensure a stable state of biodiversity, it is necessary to allocate at least 15% of the country's territory to protected areas (Andrusevych *et al.*, 2014). The available statistical data (Table 3) show the positive dynamics of growth of the nature reserve fund in Ukraine. In Ukraine, there are two main trends in the

dynamics of nature reserves: 1) the network of protected areas is increasing, but 2) their quality is deteriorating. The main connects are related to the illegal use of natural resources of protected areas and non-compliance with protection regimes.

Table 3: Area of lands of the nature reserve fund (thousand hectares)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1310.5	1382.8	1565.2	1576.1	1688.5	1769.1	1997.4	1997.4	1997.4	2063.9

Source: SSSU (2020a)

The correlation coefficient of 0.26 between the gross output of agriculture and the land area of the nature reserve fund indicates that there is no significant relationship between the factors. Thus, according to the study, the change in the area of nature reserves can not be considered as an effective direction of diversification. The optimal sustainable land use in agricultural landscapes, from which the highest ecological and economic outcome can be obtained, can be established through a combination of crops, pastures and bioenergy plantations (Solovii and Kuleshnyk, 2021). Hence, the agricultural areas can be sown with honey plants, such as sunflower (*Helianthus*), buckwheat (*Fagopyrum*), clover (*Trifolium repens*), rapeseed (*Brassica napus* L.), perennial and annual grasses (Table 4).

Table 4: Areas sown with agricultural honey plants (thousand hectares)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
7525.0	7723.0	7754.0	7878.0	8730.0	7340.0	8051.0	8329.0	8529.0	8512.0

Source: SSSU (2019a)

A correlation coefficient of 0.38 was obtained when estimating the relationship between the gross output of agricultural products and services and the areas sown with honey plants. It indicates the presence of a medium degree of density between the two traits and makes it necessary to take into account the areas sown with honey crops (in a bid to further value the ecosystem services) and to identify areas for diversification (Figure 1).

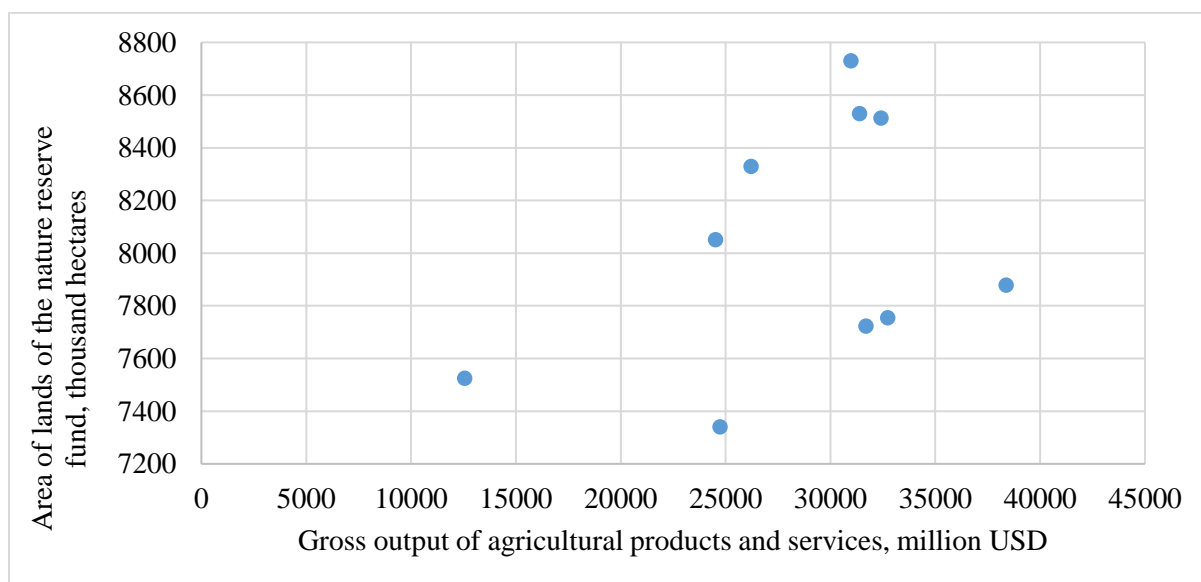


Figure 1: Correlation between gross output of agricultural products and areas of honey plants

The agricultural sector accounts for up to 15% of global greenhouse gas emissions and almost half of global nitrogen and methane emissions. The United Nations Economic Commission for Europe has recognized manure management systems as the main source of ammonia (NH₃) emissions in agriculture (Drebot, 2021). At the same time, agriculture can help reduce the negative impact of economic activity. Reducing greenhouse gas emissions can be done through rehabilitation of depleted arable lands and pastures; improving the fodder base for livestock; improving ruminant genetics; improvement of compost harvesting and storage technologies; biogas production from the agricultural waste.

Correlation analysis of the relationship between gross agricultural output and total gas emission (correlation coefficient 0.04) indicates a lack of links between them. Hence, this factor should not be taken into account in further studies related to the valuation of ecosystem services (Table 5).

Table 5: Total gases emissions (thousand tons)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
6678.0	6877.3	6821.1	6719.8	5346.2	4521.3	4686.6	4230.6	4121.2	4108.3

Source: SSSU (2021a)

According to the International Monetary Fund, by 2030 the world needs to impose a carbon tax of \$75 per ton of carbon dioxide equivalent in order to reduce the emissions to a level that it meets the target of reducing 2 degrees Celsius. Many countries have begun already to introduce carbon pricing (Gulati and Singh, 2022). Sweden leads with a carbon price of up to \$137 per ton of carbon dioxide equivalent, while the EU leads with \$50 per ton of carbon dioxide equivalent (Gulati and Singh, 2022). Changes in the agricultural sector are also needed to combat global warming. It should reach zero emissions. In this context, reforestation and increased humus in the soil are promising measures.

The correlation coefficient of 0.19 found between the gross output of agricultural products and services and the volume of CO₂ emissions indicates a weak correlation between the factors (Table 6). Thus, this does not provide grounds for further consideration in the context of this study.

Table 6: CO₂ emissions (thousand tons)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
198.2	236.0	232.0	230.7	194.7	162.0	150.6	124.2	126.4	121.3

Source: SSSU (2021b)

Much attention in agricultural activities is given to the adequacy and efficiency of fertilizer use. This applies to the dynamics of nutrients in the scheme "soil-water-nutrients-root". Plant nutrition can be improved by returning nutrients to circulation or by adding additives (mineral chemicals) or organic fertilizers. Application of mineral fertilizers is an important component of ecosystem services. In the research of Khabatiuk and Andrusyevych (2021) on "fertilizers", it is proposed to include nitric and sulfonic nitric acid, ammonia, potassium nitrates, nitrogen fertilizers, complex fertilizers with the content of two or three nutrients from nitrogen, phosphorus and potassium (NPK), and other fertilizers. The initial data for correlation analysis of fertilizer as a factor are shown in table 7.

Table 7: Mineral fertilizers (thousand tons)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1064.2	1266.9	1346.6	1493.8	1471.7	1415.0	1728.9	2028.1	2346.3	2338.3

Source: SSSU (2019b)

The calculated correlation coefficient of 0.32 indicates the average degree of correlation between the gross output of agricultural products and services and the quantity of mineral fertilizers applied in the farms (Figure 2). This indicator can be included in further studies on the valuation of ecosystem services and identifying areas for diversification.

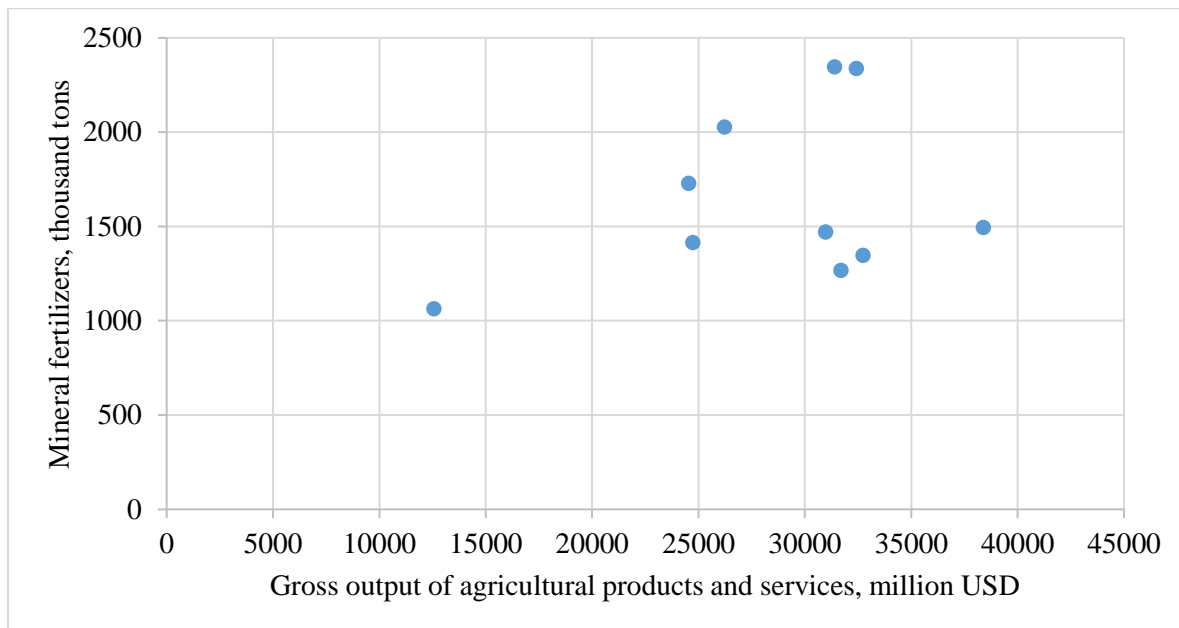


Figure 2: Correlation between the volume of agricultural products and the volume of mineral fertilizers

The presence of sufficient amounts of organic matter in the soil helps preserve its functions and prevents degradation. Irrational methods of crop production lead to lower quality and deterioration of soil structure and increased erosion. As a result, carbon emissions increase. Therefore, the world's reserves of organic matter must be stabilized or increased. This can be achieved by using crop rotations with legumes, application of green manure, plowing of plant mass of crops in combination with the minimum mechanical cultivation, reducing the number of herbicides, and adopting the agroforestry. The best results in providing the soil with nutrients can be obtained in integrated systems that combine crop, livestock and forestry (FAO and NSC ISSAR, 2019). In this study (Table 8), the correlation between the gross output of agricultural products and services and the amount of applied organic fertilizers (coefficient 0.22) has a weak density. This does not form grounds for defining this indicator as a direction of possible diversification.

Table 8: Organic fertilizers (thousand tons)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
9963.6	9954.2	9685.2	9652.9	9898.4	9662.7	9162.9	9273.9	11648.9	11382.5

Source: SSSU (2019b)

The capital investment in the protection and rehabilitation of soil, and in groundwater and surface water is important (Table 9). In general, in Ukraine, "green" investment is carried out at the expense of public funds and funds from other sources, including the private sector and international financial institutions. Significant political and economic instability creates obstacles to the development of "green" investment in Ukraine. The analysis of statistical information shows the dynamics of sharp fluctuations in this indicator during the period covered by this study. It indicates the instability of capital investment and the lack of strategic vision and consistent government policy in this area.

Table 9: Capital investments in protection and rehabilitation of soil, and in the groundwater and surface water (million USD)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
40.0	79.9	67.6	40.6	30.0	17.6	16.1	47.6	53.5	66.2

Source: SSSU (2020b)

The obtained correlation coefficient of 0.38 indicates the existing average degree of correlation between the gross output of products and services and investments in the protection and rehabilitation of soil, groundwater and surface water (Figure 3). This factor is recommended for further consideration in the context of this study. The formation of an appropriate investment climate in the "green" economy will make financial instruments of "green" investment more effective.

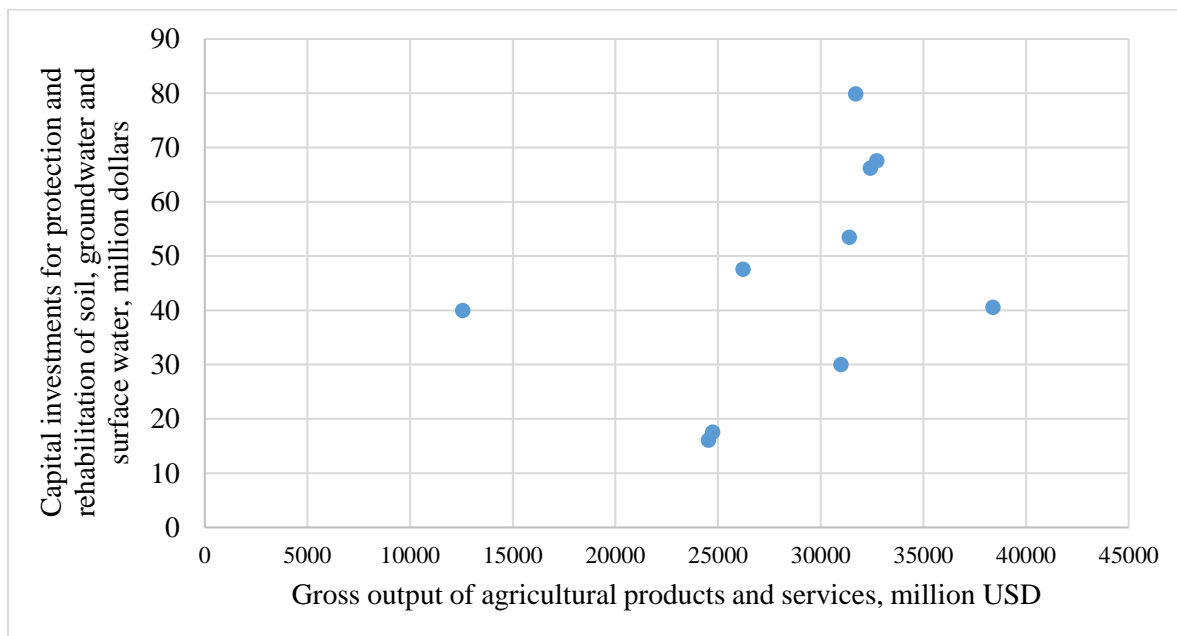


Figure 3: Correlation between gross output and investments in protection, rehabilitation of soil, groundwater and surface water

When forming the directions of ecosystem services, it is important to take into account the costs of protection and reproduction of wild animals and birds, including biotechnical measures (Table 10). The problem is that much of Ukraine's agricultural land is important for the conservation of birds of prey, as it forms a powerful forage base for the rodent population. Modern economic practice actively uses a significant number of plant protection chemical products. This poses a threat to biodiversity. However, the owners or tenants of these lands are not obliged to protect or finance biodiversity.

Table 10: Expenditures on protection and reproduction of wild animals and birds, including biotechnical measures (million USD)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
8.4	10.3	10.3	10.1	7.2	4.8	4.8	5.3	10.9	13.1

Source: SSSU (2020c)

The study has found a relationship between the medium density (correlation coefficient 0.48) between gross output of products and services and the cost of protection and reproduction of wild animals and birds, including biotechnical measures (Figure 4). These measures are possible ways to diversify the activities of

agricultural producers. With the appropriate legislative regulation, the direction identified in the study can be continued in practical economic activities in the context of ecosystem services.

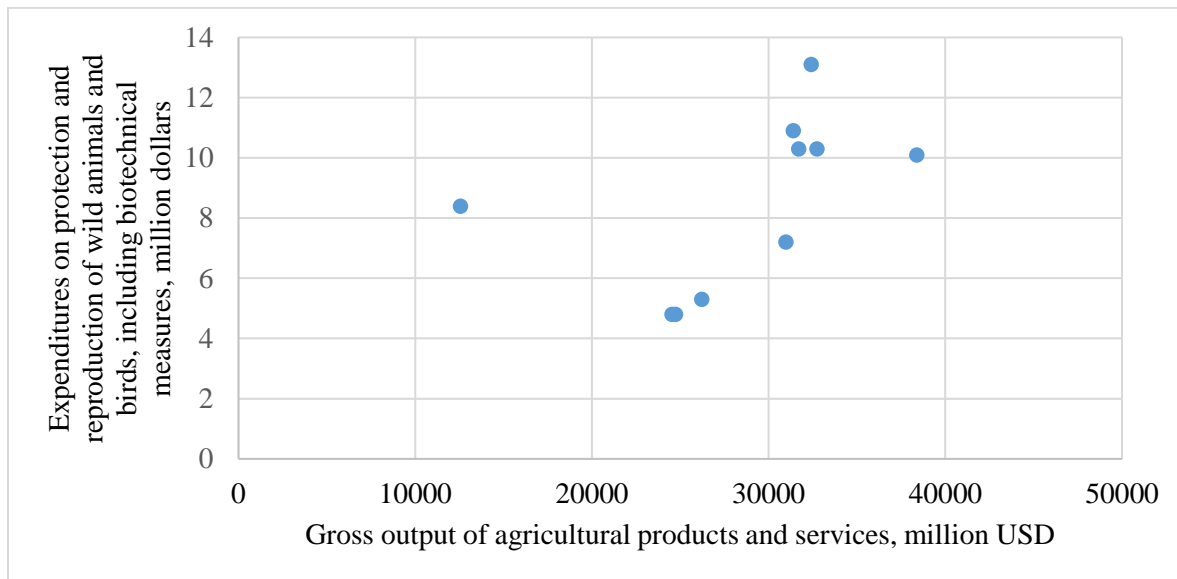


Figure 4: Correlation between gross output and costs for the protection of animals and birds (biotechnical measures) (million USD)

The analysis of pair correlations allowed to identify the degree of correlations between random factor and performance traits, to identify dependencies with the highest degree of impact and, on this basis, to identify areas for diversification of the agrarian sector in the context of ecosystem services.

Diversification and its implications for the agricultural sector

The theme of diversification is reflected in the scientific works of many authors. For example, Bilousko and Bilousko (2018) considers diversification as a direction of strengthening competitive advantages. In this context, the transition to the production of environmentally friendly products is considered optimal. Research by Kiani *et al.* (2021) in 3 areas located in different agri-environmental zones of Punjab (Pakistan) show that the losses of farmers who have adopted agricultural diversification to mitigate the effects of climate change have been lower. An average of \$635 per year was lost by those who adopted diversification, while the farmers who did not adopt had lost their farm income by an average of \$772 (Kiani *et al.*, 2021). Bellon *et al.* (2020) explore the relationship between crop diversity and consumption in northern Ghana. The authors conclude that increasing crop diversity opens up market opportunities for households, and diversifying agricultural production seems more beneficial to the farmers than specialization of agriculture. Research by Giller *et al.* (2015) shows the pragmatic introduction of conservation agriculture on large, mechanized farms and limited use on small farms in developing countries. In addition, the authors present evidence that denies the direct impact of conservation agriculture on increasing crop yields and carbon sequestration in the soil. Studies described by Tamburini *et al.* (2020) indicate that the impact of agricultural diversification on biodiversity and ecosystem services was mostly positive (67% positive effect, 23% neutral effect and 10% negative effect). At the same time, soil fertility and nutrient cycle had the most positive effects. The positive impact of the diversification strategy is also confirmed by the studies of Beillouin *et al.* (2020). Beillouin *et al.* (2021) determine that diversification increases not only the production of crops and biodiversity of uncultivated plants and animals, but also the support and regulation of ecosystem services (e.g., water quality by +51%; pest and disease control by +63%; and soil quality by +11%).

In general, based on table 11, the benefits of diversification can be grouped by achievement goals. These include economic goals, social goals and environmental goals. Each of them corresponds to a number of characteristic features (Fraier, 2018; Pecheniuk and Pecheniuk, 2019). The economic component is manifested by a reduction in production costs and minimization of risks, reducing dependence on the resource base; social component determines new jobs and mitigation of the negative impact of seasonality of agricultural production; ecological goal is manifested in the reduction of dependence on climatic conditions, improving soil fertility, reducing pollution, conservation of natural resources.

Table 11: Advantages of diversification for agricultural producers

Goals to achieve	Content
Economic goals	<ul style="list-style-type: none"> • Increased profits due to the lack of those production costs that are unnecessarily incurred in the cultivation of conventional crops; • Expanding the range of crops minimizes market risks and creates resistance to market fluctuations; • Providing fodder base with minimal costs; • Cost optimization over time, which is associated with different periods of growth and maturation of crops; • Reducing dependence on the external inputs (fertilizers, pesticides, etc.).
Social goals	<ul style="list-style-type: none"> • Creating additional jobs; • Balancing the seasonality of production.
Environmental goals	<ul style="list-style-type: none"> • Reducing dependence on climatic conditions and harvesting in extreme weather conditions; • Increasing soil fertility: legumes enrich the soil with nitrogen, cereals provide access to oxygen due to the developed root system, biomass after harvesting helps to fertilize the soil. Conservation of natural resources; • Reducing the level of pollution of natural resources; • Reducing pests and weeds and increasing the plant resistance to diseases.

The introduction of new activities related to ecosystem services can be linked to the innovative component of the agricultural enterprise. This requires a clear organizational algorithm. Research conducted by Andrushko *et al.* (2021) determines the main stages of diversification and implementation of new activities for agricultural enterprises. Shvets and Shara (2021) determine the current legal framework of Ukraine on this particular issue (Table 12).

Table 12: Organizational stages of implementation of new activities

<i>The name of the stage</i>	<i>The name of the legal act</i>	<i>Description of actions</i>
1. Obtaining a license	Article 7 of the Law of Ukraine ⁴ "On Licensing of Economic Activities" of 02.03.2015 № 222-VIII; Part 2 of Article 2 of this same law (list of economic activities)	Determining the need for a license
2. Obtaining a permit on emission of pollutants into the atmosphere	Law of Ukraine ⁵ "On Protection of Atmospheric Air" of 16.10.1992 № 2707-XII.	The need for a permit is due to the operation of stationary facilities that pollute the air

⁴ <https://zakon.rada.gov.ua/laws/show/222-19>

⁵ <https://documents1.worldbank.org/curated/es/289901537161303609/pdf/P132741-ESMP-Kharkiv-Disclosure-Version-English.pdf>

<i>The name of the stage</i>	<i>The name of the legal act</i>	<i>Description of actions</i>
2.1. Emission inventory, assessment of the impact of emissions on air, etc.	The procedure for conducting and paying for work related to the issuance of permits for emissions of pollutants into the atmosphere by stationary sources, and accounting of the enterprises, institutions, organizations and citizens. The entrepreneurs who receive such permits are approved by the Cabinet of Ministers under Resolution № 302 of 13.03.2002.	
2.2. Permit for special use of water resources	Article 49 of the Water Code of Ukraine ⁶ ; The permits for special water use are approved by the Cabinet of Ministers under Resolution № 321 of March 13, 2002.	
2.3. Subsoil use permit	Art. 19 of the Subsoil Code ⁷ ; Art. 21 of the Subsoil Code ⁸ ; Article 16 of the Subsoil Code ⁹ ; Special permits for subsoil use are approved under the Resolution № 615 of the Cabinet of Ministers of 30.05.2011.	If the economic activity is related to the use of subsoil, a permit is required for groundwater extraction.
2.4. Permit to carry out operations in the field of waste management	Art. 17 of the Law of Ukraine ¹⁰ "On Waste" of 05.03.1998 № 187/98-VR; Under Clause 8 of the Procedure for Maintaining the Register of Waste Generation, Treatment and Utilization Facilities, permits are approved under the Resolution № 1360 of the Cabinet of Ministers of Ukraine of August 31, 1998	Permit is obtained when the total waste generation exceeds 1000 tons.
3. Compliance of the Classification of Economic Activities with the new type of activity	Art. 19, 43, 44 of the Commercial Code of Ukraine ¹¹ ; paragraph 298.2 of the Tax Code of Ukraine ¹²	To avoid misunderstandings, it is necessary to register Classification of Economic Activities codes for all types of activities that the agricultural enterprise carries out or plans to carry out.

These organizational stages characterize the general aspects. When carrying out a new type of activity, the agricultural producer must take into account the peculiarities of the future business and determine the feasibility of the stages presented in the study.

⁶ <https://www.ecolex.org/details/legislation/water-code-no21395-vr-of-1995-lex-faoc043460/>

⁷ <https://www.ecolex.org/details/legislation/subsoil-code-no13294-vr-of-1994-lex-faoc043462/>

⁸ <https://www.resourcedata.org/dataset/rgi-subsoil-code-of-ukraine/resource/66ed20cb-e226-4ca3-83e9-8f445be36767>

⁹ <https://leap.unep.org/countries/ua/national-legislation/subsoil-code-no13294-vr-1994>

¹⁰ <https://cis-legislation.com/document.fwx?rgn=16883>

¹¹ <https://wipo.lex.wipo.int/en/legislation/details/19453>

¹² https://www.wto.org/english/thewto_e/acc_e/ukr_e/wtaccukr88_leg_3.pdf

Conclusions

The analysis of correlations allowed to identify promising areas for diversification of the agricultural sector in relation to ecosystem services. The study covered 8 factors related to ecosystem services. The most suitable for further research and for diversification of the agricultural sector of Ukraine in relation to ecosystem services are: 1) expanding the area under honey crops; 2) increasing the mineral fertilizer application; 3) ensuring the protection and rehabilitation of soil, groundwater and surface water; and 4) the protection and reproduction of wild animals and birds, including biotechnical measures. Diversification of the agricultural sector in relation to ecosystem services will have positive consequences in the context of solving economic, social and environmental challenges. It should be noted that the opening of new activities under Ukrainian law requires certain organizational stages. Their expediency will be determined directly by the direction in which future economic activity is expected. Therefore, it is a subjective to the activities chosen and the existing legal environment in the country.

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with the ICMJE criteria for authorship)

Contribution	Author 1	Author 2	Author 3	Author 4
Conceived and designed the research or analysis	Yes	No	No	No
Collected the data	No	Yes	No	No
Contributed to data analysis & interpretation	No	No	Yes	No
Wrote the article/paper	No	No	No	Yes
Critical revision of the article/paper	Yes	No	No	No
Editing of the article/paper	No	Yes	No	No
Supervision	No	No	Yes	No
Project Administration	No	No	No	Yes
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Overall Contribution Proportion (%)	25	25	25	25

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The research did not involve plant species.

Research on Indigenous Peoples and/or Traditional Knowledge

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