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Economic and ecological issues of agro-industrial development
Problemas económicos y ecológicos del desarrollo agroindustrial

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Resumen

El desarrollo económico moderno está relacionado con la introducción de formas intensivas de agricultura, incluida la quimificación total y la automatización. Este estudio tiene como objetivo evaluar la agricultura de los países europeos en términos de protección ambiental para garantizar el desarrollo sostenible de la agricultura basada en tecnologías orgánicas. Se encontró que los problemas ecológicos son los principales desafíos para la agricultura, a saber, la contaminación del agua, la contaminación del suelo y la introducción intensiva de cultivos genéticamente modificados. Los problemas económicos de la producción agrícola aumentan los riesgos del cultivo, la cosecha y el procesamiento. En este estudio, se aplicó un enfoque que permitió evaluar el componente económico del desarrollo de la producción agrícola orgánica en los países de la UE. Los países con un fuerte enfoque en la agricultura prestan mucha más atención a la introducción de prácticas ecológicas y orgánicas en este sector. Se ha demostrado que todos los países de la UE, en gran medida, priorizan el desarrollo ecológico en el sector agrícola moderno. La intensidad de la implementación de tales tecnologías depende del potencial ambiental del país y del nivel de desarrollo del sector agrícola dentro de la estructura de la economía nacional.

Palabras clave: temas económicos y ecológicos, producción agroindustrial, tecnologías sustentables, seguridad alimentaria, sustentabilidad ambiental, organismos estatales, consumidores.

Abstract

Modern economic development is related to introducing intensive forms of agriculture, including total schematization and automation. This study aims to assess the agriculture of European countries in terms of environmental protection in ensuring sustainable development of agriculture based on organic technologies. It was found that ecological problems are the main challenges for agriculture, namely, water pollution, soil pollution, and the intensive introduction of genetically modified crops. The economic problems of agricultural production increase the risks of cultivation, harvesting, and processing. In this study, was applied an approach that allowed assessing the economic component of the organic agricultural production development in the EU countries. Countries with a strong focus on agriculture pay much more attention to introducing ecological and organic practices in this sector. It has been demonstrated that all EU countries, to a significant extent, prioritize ecological development in the modern agricultural sector. The intensity of implementing such technologies depends on the country's environmental potential and the level of agricultural sector development within the national economy's structure.

Keywords: economic and ecological issues, agro-industrial production, sustainable technologies, food security, environmental sustainability, state bodies, consumers.

Introduction

Agricultural production, encompassing both farming and industrial food production, plays a crucial role in meeting humanity's food needs. However, along with the achievements and benefits of this sector, a range of economic and environmental problems arise that require immediate attention. In a world where the population is rapidly growing and land resources are limited, efficient agro-industrial production is necessary. However, issues such as soil fertility depletion, water resource pollution, and the use of harmful pesticides and chemical fertilizers have a negative impact on the environment and human health. Economic aspects are also of great importance. Land parceling, unequal access to resources and technologies, insufficient investment attractiveness of agriculture, low profitability, and subpar product quality present severe challenges to the development of the agro-industrial sector. Resolving the economic and ecological problems associated with agricultural production requires a comprehensive approach and joint efforts from governments, scientists, farmers, and consumers. Important tasks include:

- Increasing production efficiency.
- Implementing sustainable agriculture practices.
- Adopting advanced technologies and methods aimed at environmental conservation.

Despite numerous scientific studies on agroecological sustainable development in agriculture, it should be noted that there is no unified methodology for assessing the natural ecological component of agricultural production from an economic perspective. Therefore, this research aims to evaluate the agriculture of European countries through the lens of environmental sustainability in ensuring the sustainable development of agriculture based on organic technologies. Accordingly, several hypotheses are put forward:

1. Agriculture is significantly dependent on a complex of ecological problems.
2. The development of organic production depends on the country's economic level (the higher the economic level, the more intensively organic technologies are utilized).

Literature review

The main economic and ecological problems of agro-industrial development have been studied by many researchers (Galeano-Barrera et al., 2022; Ferronato et al., 2019; Adejumo & Adebisi, 2021; Alfalih, 2023; Debrah et al., 2021; Shapiro & Walker, 2018; Piliavskii & Mohylat, 2018). Their works have served as the foundation for theoretical and practical investigations. Scientific attention is actively focused on the issues of ecological sustainability in agro-industrial production (Cristofoli et al., 2023; Paul et al., 2019). The scientists emphasize the need to establish environmentally sustainable production systems that ensure productivity and preserve natural resources for future generations (Calicioglu et al., 2019). They highlight the following major economic and ecological issues:

1. Use of chemical fertilizers and pesticides: Abuse of chemical substances can lead to soil and water pollution, as well as impact human health and ecosystems (Vasco et al., 2021; Gul et al., 2014; Shuqin & Fang, 2018)

2. Water pollution: Irrigation of fields and the use of pesticides and fertilizers contribute to the destruction of water ecosystems, water pollution, and loss of biodiversity (Gao et al., 2023; Tudi et al., 2021).

3. Soil pollution: Improper land management, erosion, water, and wind erosion contribute to soil loss, decreased fertility, and threatened agricultural productivity (Pimentel & Burgess, 2013; Günal et al., 2015; Wassie, 2020).

4. Loss of biodiversity: Destruction of natural habitats to create new agricultural lands leads to the loss of biodiversity, species extinction, and disruption of ecological balance (Armenteras et al., 2019; Gordon, 2020; Chandellier & Malacain, 2020).

Thus, the analysis of scientific literature allows us to conclude that the problems of economic and ecological development problems of the agricultural sector are relevant worldwide. Solving these problems requires an integrated approach that considers the needs of modern production and the preservation of natural resources for future generations.

Materials and Methods

Statistical analysis based on Eurostat data allowed for assessing the economic and ecological aspects of modern agricultural crop production through the volumes of organic plant output. In this regard, indicators such as agricultural GDP and the volumes of organic crop production were utilized. Consequently, an indicator of economic expenditure per unit of organic crop production, as measured by GDP per ton, was determined, enabling the ranking of European countries.

The methods such as systemic analysis, literature research, statistical analysis, legislative analysis, and interviews with agricultural sector experts and ecologists were used to achieve the set goal. Statistical analysis using national statistical agencies' data facilitated the evaluation of the state of agro-industrial production in European countries. The research process also incorporated systemic analysis methodology to assess the effectiveness of implementing various political and economic instruments in agro-industrial output and their impact on the environmental situation within a country. Overall, the research methodology aimed to obtain comprehensive information about the state of agro-industrial production, its economic and ecological issues, and formulate recommendations for overcoming them.

Result and discussion

Agricultural production is an important sector of the economy that provides the population with food and creates job opportunities. However, the development of this industry is associated with a range of economic and environmental problems that require attention and resolution.

One of the critical issues is the low level of productivity, which affects the production and competitiveness of Ukrainian agricultural products in global markets. In addition, it is vital to consider the environmental aspect of production, as the use of pesticides, herbicides, and other chemicals can have a negative impact on the environment and human health.

A significant economic problem is the low level of technical equipment and the adoption of modern technologies in the agricultural sector, which somewhat limits the potential for increasing productivity and product quality.

According to analysis, there is a problem of uneven regional development and insufficient infrastructure in the agricultural sector, which also affects competitiveness and productivity. Therefore, comprehensive measures are needed to increase productivity and product quality, ensure environmental safety and environmental protection, as well as infrastructure development and the use of modern technologies to address these issues.

An important step in addressing the economic and environmental problems of the agricultural sector is the implementation of innovative technologies and practices. For example, using biological methods of plant protection can reduce the use of chemical pesticides and herbicides, which helps reduce environmental pollution and improve product quality.

Developing environmentally friendly production and processing technologies will reduce emissions of harmful substances and contribute to the conservation of natural resources. For instance, using renewable energy sources such as solar and wind can reduce dependence on fossil fuels and decrease greenhouse gas emissions.

In addition to technology, an important element in addressing the economic and environmental problems of the agricultural sector is raising environmental awareness in society. It can be achieved through information campaigns, organizing educational events, and promoting ecological culture. Furthermore, it will engage the public at large in

environmental conservation issues and create a favorable environment for developing environmentally friendly agricultural production.

Assessing research analysis, let us highlight urgent issues of contemporary agro-industrial development in European countries.

The first problem is soil pollution, which is a significant economic and environmental issue that negatively impacts the development of agro-industrial production. Although chemical fertilizers, pesticides, and other agrochemicals may increase crop yields and protect against pests, they can have long-term consequences for soil resources.

One of the problems lies in the contamination of soils with chemical substances extensively used in agriculture. After applying chemical fertilizers and pesticides, residues of these substances can persist in the soil and accumulate over time. As a result, it can lead to a decline in soil quality and fertility. Soil pollution can also affect ecosystems that depend on it, including microorganisms, plant root systems, and biodiversity.

The consistent use of chemical substances can also result in the accumulation of toxic substances in plants, animals, and food products. It can have a negative impact on the health of people who consume these products. Some chemical substances can be carcinogenic or have other harmful effects on the human body.

The following aspects should be considered to solve the problem of soil pollution and ensure environmentally sustainable agricultural production:

1. Transition to sustainable agriculture: Utilizing organic farming methods such as composting, green manure, nutrient cycling, and biological pest control can help reduce dependence on chemical substances and promote healthy soil.
2. Efficient management of fertilizer and pesticide use: Establishing precise usage standards for fertilizers and pesticides, adhering to application recommendations, and implementing monitoring and control systems, can reduce their negative impact on the soil.
3. Adoption of alternative pest control methods: Developing and implementing biological pest control, using plant barriers, biological agents, and other environmentally friendly practices, can reduce the reliance on chemical pesticides.
4. Encouraging soil conservation: Land management programs, erosion prevention measures, mulching, and green seeding can help preserve soil by reducing erosion,

improving moisture content and soil structure, minimizing water evaporation, and preserving fertility.

5. Mulching involves covering the soil surface with materials such as straw, hay, black soil, or cover crops. It creates a barrier that protects the soil from direct sunlight, the impact of rain, and wind, thereby promoting moisture retention and enhancing soil structure.

6. Crop rotation and diversification: Implementing crop rotation and diversification systems helps mitigate negative impacts on the soil. Different crops have varying nutrient requirements, so alternating them helps prevent soil depletion and preserve its fertility.

7. Application of natural soil enrichment methods: Utilizing natural sources of nutrients such as compost, organic waste recycling, and the use of green manure promotes soil fertility improvement without negative environmental impacts.

The second issue is water pollution. Water resources are used for the irrigation of fields and livestock watering, as well as becoming a recipient of waste from industry, transportation, and other sources. Firstly, excessive water use for irrigation can lead to the depletion of water sources. Water scarcity and improper management of its use can result in reduced water levels in rivers, lakes, and groundwater. These can lead to declining groundwater levels, drying up of water bodies, and negatively impacting ecosystems dependent on these water resources.

Additionally, using chemical fertilizers and pesticides in agriculture can contribute to water pollution. During field irrigation, the chemicals can seep into groundwater and find their way into rivers, lakes, and underground water sources. It can result in contamination of water bodies with chemicals that can be harmful to aquatic life and human health.

Water pollution also occurs through emissions from industrial facilities, transportation waste, and illegal discharge of sewage. These discharges contain toxic substances, heavy metals, petroleum products, and other pollutants that harm the aquatic ecosystem and can accumulate in the organisms of aquatic life.

The following aspects should be given attention to reduce water pollution and ensure environmentally sustainable agricultural production:

1. Use of efficient irrigation systems: Implementing modern irrigation systems such as drip irrigation or micro-irrigation helps reduce water use and prevents excessive water runoff, which can lead to chemicals leaching into water reservoirs.
2. Utilization of natural wastewater treatment methods: Developing and implementing wastewater treatment systems based on biological processes, such as constructed wetlands, fiber filtration, green filters, and wetlands, helps reduce water body pollution and preserve water quality.
3. Fertilizer management systems: Efficient fertilizer use and management systems help reduce the risk of water pollution from chemical substances. Developing and utilizing precise fertilizer application methods, controlling their dosage, and considering soil cover characteristics can help avoid excessive use and contamination of water resources.
4. Implementation of green technologies in agriculture: Applying environmentally sustainable practices such as agroforestry, cover cropping, and mixed cropping contributes to reducing water body pollution. Incorporating diverse plant species into crop cultivation helps minimize soil erosion risks, improve soil structure, and conserve moisture. Cover cropping and mixed cropping also promote biological pest and disease control, reducing the need for pesticides and other chemical plant protection measures.
5. Establishment of water storage systems: Creating water storage facilities such as ponds or reservoirs allows for water conservation and redistribution. These promote efficient water use in agriculture, reduce dependence on natural water sources, and alleviate pressure on aquatic ecosystems.
6. Organic farming: Implementing organic farming practices reduces the use of chemical fertilizers and pesticides, thereby avoiding water body pollution. Organic cultivation methods support biological diversity, soil fertility, and water resource conservation, fostering more environmentally sustainable agricultural production.

The third problem is the loss of biodiversity, which affects ecosystems and the sustainability of agricultural production. The main aspects related to biodiversity loss include:

–Loss of natural habitats: Expansion of agricultural land and reduction of forest cover result in the destruction of natural habitats, which serve as the home for many plant and animal species. It leads to a decrease in diversity and the extinction of certain species.

–Use of pesticides and eradication of pests: Using chemical pesticides to control pests can negatively impact biodiversity. They can harm beneficial insects, birds, and other organisms that perform essential ecological functions. It can disrupt natural balance and reduce biodiversity.

–Monocultures and loss of genetic diversity: Cultivating a single species of plants or animals in large areas, known as monoculture, can reduce genetic diversity. It creates a vulnerability to diseases, pests, and climate change. Loss of genetic diversity in crop plants can also limit access to essential resources for future agricultural development.

–Loss of aquatic ecosystems: Pollution of water bodies and depletion of water levels result in decreased biodiversity in aquatic ecosystems.

The following approaches can be used to reduce biodiversity loss due to agricultural production:

1. Conservation of natural habitats: Preserving forests, wetlands, and other natural habitats helps maintain species diversity and preserve their habitats. Reserving territories and establishing national parks can contribute to conserving rare and endangered species.
2. Application of agroecological methods: Using agroecological practices such as green manure, crop rotation, intercropping, and mixed cropping creates favorable conditions for biodiversity. These methods help reduce dependency on chemical fertilizers and pesticides, preserve plant diversity, and promote biological pest control.
3. Ecosystem restoration: Restoring degraded ecosystems, such as swamps and wetlands, can help bring back diverse plant and animal species. It can be achieved through restoration measures like tree planting, reclamation of abandoned lands, restoration of natural water resources, and creating conditions for natural biodiversity regeneration.
4. Creation of protected areas: Establishing protected areas around water resources, forests, and other natural habitats helps preserve them and ensure proper conservation and management. It may involve establishing reserves, regulating land and water resource use, and developing management strategies for biodiversity conservation.
5. Ecological certifications and standards: Implementing ecological certifications and standards in agricultural production helps reduce negative impacts on biodiversity. It may

include requirements for biodiversity conservation, the use of environmentally safe production methods, and adherence to natural resource conservation standards.

It is essential to understand that biodiversity conservation is a complex task that requires a combination of scientific research, political support, and cooperation among all stakeholders, including agricultural enterprises, government bodies, scientific institutions, and NGOs. Only through a comprehensive approach sustainable development of agricultural production can be achieved while preserving natural resources and increasing biodiversity.

The fourth issue is the economic instability of the industry. Agricultural production highly depends on market price fluctuations, weather conditions, and economic factors. Despite being an important sector for many countries, the risks are high, and deviations from predicted outcomes can have serious consequences.

The final problem is the use of illegal cultivation methods. Some farmers employ illegal cultivation methods that can be hazardous to health. For example, the use of pesticides without legal authorization can pose a risk to people consuming these food products.

Let us evaluate the economic factor in the development of environmentally friendly cultivation of agricultural crops. For this purpose, it is necessary to calculate the indicator of the GDP share per ton of organic crops grown and rank European countries based on this indicator (Table 1).

Table 1

Economic contribution to organic agricultural production in European countries

EU countries	Organic crops production, tons	GDP, millions of USD	Agricultural share in GDP, %	Agricultural GDP in millions of USD	GDP per 1 ton of organic crops, millions of USD
Cyprus	566,00	39714,60	1,90	754,58	1,33
Netherlands	19887,00	1111230,90	1,70	18890,93	0,95
Ireland	9501,00	541319,10	1,10	5954,51	0,63
Serbia	22132,00	146961,00	7,60	11169,04	0,50
Bulgaria	30458,00	192069,60	5,00	9603,48	0,32
Slovenia	5795,00	92250,20	1,90	1752,75	0,30
Spain	336485,00	1932617,00	2,90	56045,89	0,17
Hungary	99523,00	356852,80	4,10	14630,96	0,15
Poland	296367,00	1432234,90	2,60	37238,11	0,13
Greece	165320,00	331638,00	4,40	14592,07	0,09
Romania	403904,00	689004,30	5,00	34450,22	0,09
Czech Republic	112347,00	472821,50	2,00	9456,43	0,08
Belgium	65415,00	676595,60	0,70	4736,17	0,07
Finland	116200,00	302011,40	2,70	8154,31	0,07
France	1068579,00	3447954,00	1,90	65511,13	0,06
Slovakia	60687,00	185743,00	2,00	3714,86	0,06
Luxembourg	2952,00	84921,10	0,20	169,84	0,06
Latvia	90665,00	66391,20	4,80	3186,78	0,04
Sweden	310100,00	627182,70	1,50	9407,74	0,03
Lithuania	186430,00	120921,40	3,70	4474,09	0,02
Estonia	70984,00	57518,70	2,30	1322,93	0,02
Croatia	63441,00	17768,30	3,50	621,89	0,01

Source: calculated by authors based on UNECE (2021); Eurostat (2023).

We have identified 6 groups of European countries in terms of their contribution to developing organic farming. The leaders in this regard are Cyprus and the Netherlands. While the Netherlands is traditionally a global exporter of agricultural crops, Cyprus has taken a leading position by cultivating olives and fruits, which involve fewer chemical processes and a more straightforward transition to organic technology. The average expenditure in terms of GDP per ton is approximately 1 million dollars.

The second group includes countries with expenditure in terms of GDP per ton ranging from 0,3 to 0,6 million dollars. This group consists of relatively small countries such as Ireland, Serbia, Bulgaria, and Slovenia. Finally, the third group includes medium-sized countries (Spain, Poland, Hungary) with an average indicator of 0,15 million dollars. In other countries, this indicator is below 0,1 million dollars.

There is a trend that more developed and larger countries (France, Sweden, Finland) pay less attention to organic cultivation of agricultural crops. This pattern can be explained by the fact that larger territories have less emphasis on applying organic technologies since land is abundant. On the other hand, smaller countries are forced to pay more attention to innovative organic cultivation technologies due to limited agricultural land resources. Therefore, this indicator is mainly dominated by small European countries.

Thus, economic and ecological problems related to agro-industrial production are serious issues that require attention and the adoption of effective measures for their resolution. It is necessary to seek more environmentally friendly production methods and use plant protection means and fertilizers, reduce emissions of pollutants into water bodies, and ensure the sustainable development of the agro-industrial sector.

Additionally, it is important to consider the possibility of implementing modern technologies that allow for greater productivity and reduce the negative impact on the environment. Such technologies may include integrated pest management, the use of microbiological preparations, organic farming, and others.

To ensure the sustainable development of the agro-industrial sector, it is also necessary to support farmers and small agricultural enterprises. It may include financial support, improving the quality of scientific and technical assistance, and access to markets.

It is also vital to increase awareness and education among farmers and consumers about the impact of agro-industrial production on the environment and human health. In addition, it is necessary to disseminate information about environmentally friendly cultivation methods and support the development of the organic product market.

In general, it is necessary to introduce innovations and maintain production stability to solve agro-industrial production's economic and ecological problems. Only in this way can the development of the industry be ensured, natural resources preserved, and the quality of life improved.

The literature review shows that agricultural production faces significant economic and environmental challenges (Cristofoli et al., 2023). The intensive farming methods adopted by many countries have led to various ecological issues, including soil degradation, water pollution, and deforestation.

The economic challenges agro-industrial production faces remain open questions: price fluctuations, market competition, and inadequate investments. The global market is highly competitive, which is reflected in agricultural product prices. These price fluctuations can lead to instability in the agricultural sector and cause significant financial problems for farmers. Additionally, the high cost of production, including resources such as seeds, fertilizers, and equipment, can make agriculture inaccessible for small farmers.

Conclusion

The authors analyze agro-industrial production development's economic and ecological problems in this article. This research indicates that the development of the agro-industrial sector is vital for the country's economy, but its impact on the environment is significant. In addition, the issues related to the use of chemical fertilizers and pesticides, soil, water, and air pollution, as well as problems associated with the decline in biodiversity and soil productivity, are considered.

Various methods and approaches to solving these problems are analyzed, including the use of biological plant protection methods, the use of biofuels, and renewable energy, as well as increasing resource efficiency and reducing energy costs.

Overall, addressing the economic and environmental problems in the agro-industrial sector requires a comprehensive approach and cooperation between government agencies, the public, and businesses.

The analysis showed that country, where agriculture is a priority for economic development (in particular, the Netherlands and Cyprus), pay increased attention to introducing organic technologies and allocate significant financial resources for their implementation. At the same time, countries with important agricultural resources receive substantial volumes of organic production without considerable capital investments. However, environmental preservation and economic development should occur in synergy. Therefore, modern agribusiness is actively implementing appropriate green technologies. However, this is one of the directions for implementing the sustainable development program. Another direction depends on environmental measures in industrial production and transportation. It can only be achieved through clever and environmentally responsible use of resources. Therefore, sustainable development should focus on technologies that allow industrial production without polluting the environment. Furthermore, it requires expanding fundamental research and transitioning to new industrial technologies based on applying natural biophysical processes.

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