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Economic efficiency of sustainable food production

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Abstract. The purpose of this study was to analyse the effects of implementing the principles of sustainable food production on aspects of agro-industrial enterprises. Using the example of the Ukrainian company Myronivsky Hliboproduct and the Uzbek company Toshkentvino Kombinati, the study found that the rational use of resources can substantially reduce the loss of raw materials, reduce waste, and increase the level of material reuse. The use of energy-efficient technologies helps to reduce energy costs, which ensures the growth of financial performance and increases

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the competitiveness of enterprises. Implementation of practices to limit the use of pesticides and chemical fertilisers positively influences the product quality and reduces the environmental impact. Social initiatives, such as supporting local farmers, developing regional communities, and creating fair labour conditions, not only strengthen the reputation of companies but also contribute to the long-term development of local economies. The study also highlighted the significance of international standards such as ISO 14001, ISO 22000, and Global Good Agricultural Practices in implementing sustainable approaches in the food industry, which ensure the unification of processes and increase trust from partners and consumers. The examples of the companies selected for the study demonstrated how the implementation of sustainable practices affects the improvement of financial performance, environmental responsibility, and social image of enterprises. The findings obtained can be employed by managers and specialists of agro-industrial companies to adapt production processes to the principles of sustainable development. Furthermore, the developed recommendations will be useful for public authorities regulating the agricultural sector, as well as for NGOs working in the field of environmental and social responsibility of business

Keywords: environmental responsibility; innovation; energy saving; international standards; organic production

INTRODUCTION

Sustainable development is becoming a key area of modern economic and environmental thinking due to the limited natural resources and growing global environmental challenges. The food industry, as one of the largest and most significant sectors of the economy, plays a crucial role in resource consumption and waste generation, which underscores the relevance of implementing sustainable practices. Growing demand for food, the need to preserve ecosystems and ensure social justice require a review of conventional approaches to production. The introduction of energy-efficient technologies, rational use of resources, and environmental innovations can not only minimise environmental impacts but also increase economic efficiency, making sustainable development an important task for the industry and society overall. The significance of investigating the economic efficiency of sustainable food production is driven by the need to find the best ways to harmonise economic and environmental interests. It is through a sound analysis and generalisation of best practices that sustainable principles can be promoted among producers, which will be a step towards building a sustainable global economy.

There are many studies in the scientific literature that highlight the cost-effectiveness of sustainable production in the food industry. P.A. Østergaard *et al.* (2020) showed that enterprises that started implementing sustainable technologies in the early stages of their operations managed to reduce energy and water costs substantially, which positively affected their competitiveness in the industry. S.M. Didukh and A.K. Korikova (2020) emphasised that the introduction of sustainable development principles in agricultural production allows not only to minimise environmental damage but also to open new business opportunities through the development of organic production and the growing demand for environmentally friendly products. K. Uktamov *et al.* (2024) found that the active use of the circular economy concept allows businesses to considerably reduce the amount of production waste and increase resource efficiency. R. Singh and G.S. Singh (2017) emphasised that a sustainable approach to food production can become a major driver of economic growth due to the increased demand for environmentally friendly products in international markets. K. Liczmańska-Kopcewicz *et al.* (2020) emphasised that investments in sustainable technologies, specifically in the implementation of energy-efficient solutions, allow enterprises to reduce energy costs substantially, which positively affects profitability.

S. Momot (2022) highlighted the role of corporate social responsibility in sustainable development, noting that companies that integrate environmental and social standards into their operations not only gain financial benefits, but also strengthen consumer confidence and build stable partnerships. A. Hamidov *et al.* (2024) showed that enterprises that actively implement measures to reduce water and energy consumption not only achieve cost savings but also improve their reputation among consumers and partners. O. Kravchenko *et al.* (2020) focused on the effects of sustainable practices in agriculture on international trade, indicating that countries that support these practices greatly increase their export potential and gain competitive advantages in trade with developed countries. R. Hashmi (2023) examined the effects of government support on promoting sustainable development in the manufacturing sector, emphasising that policies that provide subsidies and tax breaks promote the active implementation of sustainable production methods, especially among small and medium-sized enterprises. Finally, N. Arabov *et al.* (2024) demonstrated that companies that integrate sustainability strategies achieve not only economic benefits but also substantial social benefits, specifically through improved working conditions and interaction with local communities.

Research confirms that a sustainable approach to food production not only positively affects the environment, but is also economically beneficial for businesses, contributing to their long-term competitiveness and financial stability. Although there is a large body of research covering certain aspects of sustainable production in the food industry, many significant topics are still understudied. One of them is the lack of research on the economic aspects of implementing sustainable practices in small and medium-sized enterprises, which often have limited resources for large investments. There is also little research on the effects of sustainable technologies on the long-term competitiveness of enterprises in different regions.

The purpose of this study was to assess the cost-effectiveness of implementing sustainable production practices in the food industry and their effects on the competitiveness of enterprises. The objectives of the study were to assess the effects of sustainable production practices on the economic performance of food industry enterprises, as well as to investigate the influence of sustainable technologies on the competitiveness of food enterprises in a transition economy.

MATERIALS AND METHODS

The study conducted a comprehensive analysis of the principles of sustainable production, focusing on the agro-industrial sector, specifically the food industry. The analysis was conducted considering the specifics of the implementation of these principles at enterprises in Ukraine and Uzbekistan, with an emphasis on their unique economic, social, and climatic features. The study employed a qualitative analysis to assess the principles of sustainable development in the agricultural sector, particularly in the food industry. Specifically, the study examined aspects of rational use of resources, including energy efficiency, waste reduction, and the introduction of a circular economy, which involves recycling and reuse of materials in production. Special attention was paid to reducing the use of pesticides and chemical fertilisers, which is a significant part of environmentally responsible production. To assess sustainable practices in the surveyed enterprises, international standards such as ISO 14001 (2004) for environmental management and ISO 22000 (2018) for food safety management systems were considered. Furthermore, the study analysed certifications confirming the companies' compliance with sustainability standards, including Global Good Agricultural Practices (GlobalG.A.P.) (2024) for agri-food products and Roundtable on Sustainable Palm Oil (2024), which regulates the sustainable development of palm oil, and Fair Trade International (2024), which guarantees fair labour conditions.

A detailed analysis of available data was performed, including statistical reports, official documents, and annual reports of companies. For this, the study employed data from the State Statistics Service of Ukraine (Economic indicators of..., 2024), Statistics agency under the President of the Republic of Uzbekistan (2024). The financial reports of leading companies such as Myronivskyi Hliboprodukt (MHP) (2023) and Joint-Stock Company Tashkentvino Kombinati with foreign investment (2023) were also considered. The companies were selected for the study due to their role as leaders in their respective industries – food and wine. The collected data helped to assess quantitative indicators of the industry's development, including the dynamics of production volumes, the structure of resource use, economic results, and the level of implementation of environmentally friendly practices. For instance, for Myronivskyi Hliboprodukt, the study examined the use of modern energy saving technologies, specifically biogas units, and for Toshkentvino Kombinati, the study examined the introduction of environmentally friendly methods of processing production residues. The analysis methods included data systematisation, trending, and interpretation. Graphs were built, such as the volume of food production in 2014-2024 in the two countries, to illustrate changes and identify patterns in the development of the sector.

The study also included an analysis of the effectiveness of implementing sustainable practices using leading companies as examples. For example, MHP examined the use of biogas plants for organic waste disposal. The energy efficiency of technologies, such as automated climate control systems for poultry farms, was assessed. The experience of Toshkentvino Kombinati in using winery residues to produce natural fertilisers was also analysed. The social aspects of sustainable production were investigated through the lens of job creation, support for local communities, and cooperation with small farmers. This included an analysis of initiatives to improve labour conditions and access to international markets through certification of products according to organic production standards. The methodology also included a comparative analysis of the two countries' approaches to sustainable production, considering climatic, economic, and social conditions. Particular attention was paid to the assessment of innovative technologies such as drip irrigation and renewable energy sources, specifically the use of solar panels in Uzbekistan.

RESULTS

In a world where resources are limited and environmental challenges are becoming increasingly significant, the food industry faces two major challenges: ensuring food security and reducing adverse environmental impact. In this context, the concept of sustainable production becomes particularly relevant. It is an approach that seeks to combine economic benefit, environmental responsibility, and social justice in the process of creating foods. Sustainable production is based on the rational use of resources. In the food industry, this means reducing the loss of raw materials,

reducing waste, and reusing resources wherever possible (Garcia *et al.,* 2020). For instance, the introduction of circular models, where organic waste is converted into fertiliser or animal feed, can reduce environmental impact. Such approaches also have an economic effect, reducing the cost of disposal and procurement of new resources.

Another significant component of sustainable production is energy efficiency. The food industry consumes large amounts of energy at all stages – from growing raw materials to transporting finished products. Using energy-saving equipment, switching to renewable energy sources, and optimising logistics processes help to reduce the carbon footprint of companies. This not only reduces costs but also improves the environmental image of companies, which is an essential factor in the modern competitive environment (Salah & Mustafa, 2021). Another prominent aspect is the reduction in the use of pesticides and chemical fertilisers in the production of agricultural raw materials. Excessive use of these substances not only harms the environment but can also negatively affect consumer health. The transition to organic farming and biotechnology opens new opportunities for creating better products and new markets (Srivastav, 2020).

Sustainable production in the food industry also encompasses social aspects, such as ensuring fair labour conditions, supporting local farmers, and developing communities. By investing in sustainable practices, companies not only create environmentally friendly products, but also maintain social stability, which is significant for long-term development. While implementing sustainable practices requires significant effort and resources, their benefits are clear: they enable businesses to adapt to modern challenges, reduce dependence on limited resources, meet consumer demands, and ensure sustainable economic development. Sustainable production in the food industry is not merely a requirement of the times, but a strategy that forms the basis for a future where the economy and the environment work together (Melnikova & Gilsanz, 2023).

The sustainable development of the agricultural sector is based on a series of principles that promote a harmonious combination of economic efficiency and environmental responsibility. One of the crucial principles is the rational use of resources, which includes reducing the consumption of water, energy, and natural materials through innovative technologies. For example, precision farming allows optimising the use of water and fertilisers, reducing costs and minimising the environmental footprint. Another key principle is the transition to a circular economy, which aims to minimise waste and reuse resources (Granato *et al.*, 2022). In the agricultural sector, this can be manifested through the utilisation of production residues to create biogas or organic fertilisers. This approach reduces the environmental burden and creates additional economic benefits, especially for businesses seeking to increase their competitiveness.

The energy aspect of sustainable production is also of great significance. Shifting from fossil fuels to renewable energy sources, such as solar panels or biogas plants, can reduce operating costs and greenhouse gas emissions. This is crucial for agricultural regions, where there is exciting potential for the development of energy technologies based on biological resources (Nair *et al.,* 2022). Another significant area is reducing the use of chemicals such as pesticides and fertilisers. The transition to organic production and the use of biological products helps to preserve ecosystems and improve product quality. This meets the growing consumer demand for environmentally friendly products and enables producers to enter premium market segments (Singh *et al.*, 2021). The social component of sustainable production also plays a significant role. Ensuring fair labour conditions, supporting local farmers, and creating new jobs contribute to community development and social stability. The introduction of digital technologies, such as automation and drone monitoring, not only simplifies production processes, but also opens new opportunities to increase productivity and reduce costs.

International standards for sustainable food production underlie the implementation of environmentally responsible and socially oriented practices in the food industry. These standards define the criteria that businesses must meet to ensure the rational use of resources, environmental protection, and compliance with social norms. They serve as a guide for creating sustainable business models and open access to new markets where environmental responsibility is a crucial factor for consumers (Mak *et al.,* 2020). One of the key international standards is ISO 14001 (2004), which focuses on environmental management systems. It helps businesses to identify, assess, and minimise the environmental impact of their operations, ensuring effective management of natural resources. In the food industry, this standard is employed to optimise production processes and reduce waste. Another important standard is ISO 22000 (2018), which covers food safety management. While its focus is on ensuring product safety, it also accounts for a sustainable approach to production. This includes responsible use of raw materials, reduction of losses in the production process, and quality control at all stages of the food chain.

The Global Good Agricultural Practices (2024) principles are widely recognised standards for sustainable agriculture. They are aimed at ensuring environmental sustainability, rational water use, soil protection, and biodiversity. These principles are particularly significant for farms that supply raw materials to the food industry, as they enable the implementation of sustainable practices at the basic level of the production chain. Another important standard is the Roundtable on Sustainable Palm Oil (2024), which handles the sustainable

production of palm oil. This standard ensures the preservation of ecosystems in tropical regions and promotes socially responsible production. Although palm oil is only one component of many food products, compliance with the Roundtable on Sustainable Palm Oil can substantially affect the reputation of manufacturers using this ingredient. Furthermore, Fair Trade International (2024) focuses on supporting fair trade and labour conditions. It stimulates the development of small farms, especially in developing countries, by providing them with access to the global market at fair prices. In the food industry, the standard increases consumer confidence and supports social justice. Sustainable development of the agricultural sector is significant for Ukraine, especially in the face of challenges posed by current realities, such as military operations, infrastructure destruction, climate change, economic instability, and limited access to resources. The war resulted in the loss of major areas of agricultural land, damage to logistics networks, and reduced access to export markets, complicating food security. At the same time, climate change requires the adaptation of production technologies, including the adoption of crop varieties resistant to drought and extreme weather conditions. These challenges underscore the value of adopting sustainable production models that optimise resource use, preserve soil fertility, and increase production efficiency, even under constraints. Figure 1 shows the volume of food production.

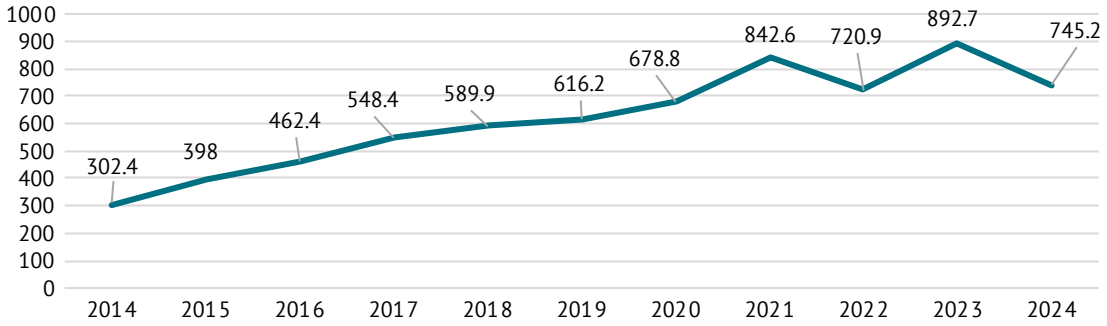

Figure 1. *Food production in Ukraine in 2014-2024, UAH billion*
Source: *developed by the authors of this study based on the Economic indicators of short-term industrial statistics (2024)*

During 2014-2018, a steady growth in production was observed, which increased by 23-30% annually. From UAH 1.429 billion in 2014, production increased to UAH 3.045 billion in 2018, which indicates a positive trend in the development of the agricultural sector. However, since 2019, the volume of production began to decline, dropping to UAH 3.019 billion in 2019, while in 2022, the volume decreased to UAH 3.854 billion, which can be explained by economic difficulties, including military aggression, the energy crisis, and other factors. At the same time, in 2023, production increased again to UAH 4.403 billion, up 14% compared to 2022, indicating a certain recovery in the agricultural sector, although the figure was still below the level of 2021 (UAH 4.679 billion). In 2024 (according to data from January to September), the figure was UAH 742.5 billion.

Rational use of resources is one of the key areas of sustainable production. Precision farming technologies that help optimise the use of fertiliser and water have become indispensable. For example, the use of modern soil monitoring can reduce fertiliser costs, which is vital in a context of limited access to imported materials. Even in regions that have suffered partial destruction of infrastructure, specifically as a result of the fighting in eastern and southern Ukraine (Donetsk, Luhansk, Kherson, Mykolaiv regions), where roads, bridges, water and electricity supply systems have been destroyed, these methods ensure that productivity is maintained.

An equally significant component is the introduction of renewable energy sources. An example of the introduction of renewable energy sources is the use of biogas units at Ukrainian agricultural enterprises, such as Myronivskyi Hliboprodukt (MHP launched another..., 2019). These companies convert organic waste into biogas, which reduces their dependence on conventional energy resources and helps them save on energy costs. Reducing the use of chemicals is also becoming a priority. Organic production methods enable farmers to reduce their environmental footprint while ensuring high quality products. This creates advantages for entering foreign markets where demand for organic products is growing, especially in Europe (Purnhagen *et al.*, 2021). The war has temporarily complicated logistics, but certification of products according to international standards opens new export opportunities.

Even in challenging circumstances, sustainable development helps to ensure economic resilience. For instance, businesses such as Myronivskyi Hliboprodukt, which use circular production models, reduce fertiliser and feed costs by recycling organic waste (MHP launched another..., 2019). These practices not only increase profitability but also become a valuable tool for rebuilding the agricultural sector after the war, especially in the face of widespread infrastructure damage, including damage to roads, warehouses, irrigation systems, and agricultural technical facilities.

Sustainable approaches can minimise dependence on resources that were lost or damaged, including with local resources, energy-efficient technologies, and the restoration of soil fertility through crop rotation and organic fertilisation. These practices not only contribute to the conservation of natural resources but also help to restore economic stability by increasing production efficiency even in the face of limited financial and material resources. Uzbekistan, a country with considerable agricultural potential, also faces numerous challenges in the agricultural sector. The exhaustion of water resources, soil degradation, and the growing need to ensure food security are driving the introduction of sustainable production practices in agricultural complexes. These practices not only help to preserve natural resources, but also open opportunities for economic growth and integration into global markets. Figure 2 shows the volume of food production

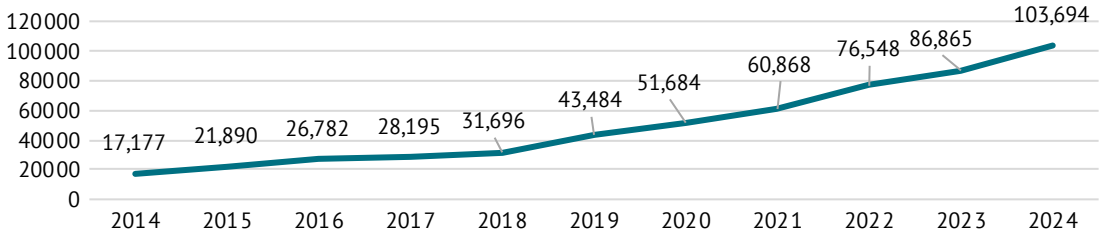

***Figure 2**. Food production in Uzbekistan in 2014-2024, UZS billion*
***Source:** developed by the authors of this study based on data from the Statistics agency under the President of the Republic of Uzbekistan (2024)*

In 2014, the volume of production was UZS 17.177 billion, and in 2023 it reached UZS 86.865 billion, which is an almost fivefold increase. The largest growth was observed in 2019-2024 – from UZS 43.484 billion in 2019 to UZS 103.693 billion in 2024, which demonstrated an almost twofold increase over this period. This growth can be attributed to the active development of agricultural production, modernisation of infrastructure, and the introduction of the latest technologies in the industry. The lowest growth rates were recorded in 2017-2018, when the annual increase was UZS 3.501 billion. However, overall, there a steady and significant increase was observed in food production in Uzbekistan throughout the period.

Uzbekistan, like Ukraine, faces serious challenges in the agricultural sector due to water scarcity and unfavourable climatic conditions. Water is a critical resource for agriculture in the country, as most agricultural land requires irrigation. In Ukraine, particularly in the southern regions such as Kherson, Mykolaiv, and Odesa, droughts are one of the most severe problems faced by farmers. Due to climate change and the lack of sufficient rainfall, irrigation is becoming critical to maintaining yields. To combat the water shortage, modern irrigation methods, including drip irrigation, are being actively introduced in these areas. For instance, in the Kharkiv region, an agricultural enterprise has applied innovative irrigation methods that have reduced water consumption by 50% and achieved onion yields of over 100 tonnes per hectare (A technology that..., 2020). Furthermore, Ukraine is testing a Japanese technology that involves the application of an organic hydrogel sorbent called EF Polymer. This product can retain moisture in the soil, gradually releasing it to plants, which reduces water use by 40%. After decomposition, the sorbent turns into fertiliser, contributing to additional savings on fertilisation (Ukraine to test Japanese..., 2024). In the Kherson region, where agriculture is the main industry, the use of drip irrigation has considerably reduced water consumption for crops such as vegetables and cereals (Karamushka *et al*., 2022).

In Ukraine, there are programmes in place to support land reclamation and efficient water management. For instance, the Government's Water Development Programme in Kherson region included the modernisation of irrigation systems, the creation of new reservoirs, and the introduction of innovative water management systems (Lower Dnipro River..., 2022). Furthermore, the Ministry of Agrarian Policy and Food of Ukraine can provide grants for enterprises that implement drip irrigation technologies and modernise water management facilities. In addition, Ukraine is actively developing practices aimed at preserving soil fertility. Specifically, precision farming methods are employed, including soil analysis, differentiated fertilisation and moisture control. Crop rotation, minimal tillage, and the use of organic fertilisers are becoming the standard for farmers seeking not only to preserve fertility but also to reduce the cost of chemical fertilisers. These methods help to maintain the ecological balance and ensure sustainable agricultural development. For instance, in Mykolaiv and Kherson regions, many farmers use crop rotation to improve soil quality. In Mykolaiv region, despite the drought, farmers harvested 2.1 million tonnes of grain in 2024, down from 2.4 million tonnes the previous year. The decline in yields is partly offset by the introduction of sustainable practices, such as crop rotation and precision farming, which help maintain soil fertility and reduce dependence on agrochemicals (Due to drought..., 2024).

These methods contribute to increased production efficiency and resilience to climate change.

Uzbekistan is actively implementing a sustainable approach to water management, especially in the face of drought conditions that characterise many regions, such as Fergana, Samarkand, and Surkhandarya. One of the key methods employed to optimise water use is drip irrigation, which reduces water consumption while increasing yields. This is significant for the country as the main crops grown on irrigated land are cotton, fruit, and vegetables. In the Fergana region of Uzbekistan, farmers are actively adopting drip irrigation for cotton and fruit growing. This method reduces water consumption by 30-50% compared to conventional irrigation methods such as sprinkling (Irisova, 2023). Furthermore, drip irrigation can increase yields by 20-50% by delivering precise and uniform moisture directly to the root system of plants. Although the initial investment in a drip irrigation system is approximately USD 1.2-1.5 thousand per hectare for the ground type, water savings and increased yields provide a quick payback of these costs (Shevchenko, 2019).

Uzbekistan is actively implementing programmes to improve water management and irrigation. Specifically, the government is implementing state initiatives to modernise water management facilities, improve irrigation infrastructure, and optimise water use. The Decree of the President of the Republic of Uzbekistan (2019) is aimed at modernising the agricultural sector, increasing its competitiveness and ensuring sustainable development. The key priorities of the strategy include optimising the use of water and land resources, introducing innovative technologies, supporting farmers, and transitioning to more environmentally friendly production. Specifically, it is planned to expand the use of drip irrigation, reduce water-intensive crops, introduce digital technologies in agriculture and support the export of organic products.

Conventional intensive farming has led to soil degradation, reduced productivity and quality. To address these issues, the government is implementing land reclamation programmes, which include the construction of new reservoirs, ditches, and pipelines to ensure a more efficient and sustainable water supply for agriculture. The Food and Agriculture Organisation is implementing a project in Uzbekistan on sustainable crop irrigation to support the systematic integration of the AquaCrop programme to optimise crop irrigation. The AquaCrop software allows forecasting crop yields depending on water consumption, which is especially useful in drought-prone regions. It uses data on soil moisture and climatic conditions to accurately determine the water resources required, which can help farmers reduce costs and increase irrigation efficiency. The programme was implemented within the framework of a project on rational irrigation of crops in Uzbekistan, which contributes to sustainable agricultural development (FAO implements a project..., 2023). Furthermore, the Food and Agriculture Organisation is supporting the development and promotion of green finance mechanisms in Uzbekistan to promote climate-smart agriculture. Green finance promotes sustainable agricultural practices that can counteract climate change and reduce greenhouse gas emissions.

Growing interest in organic products in international markets is driving the adoption of sustainable production standards such as GlobalG.A.P. and ISO 22000. Producers of fruits, vegetables, and nuts that certify their products gain access to the premium segment of the European and Asian markets. For instance, in the Samarkand region of Uzbekistan, farmers are actively implementing organic farming with an eye towards international markets. Farmers in this region grow certified organic products, including apricots, grapes, cherries, almonds, and other crops that are in high demand on foreign markets. Organic products from the Samarkand region are exported to countries such as Germany, China, Turkey, and the Persian Gulf. Exports to these countries enable farmers to sell their products at premium prices that are considerably higher than the cost of conventional goods. For example, exports of dried apricots to Germany enable farmers to earn a profit that is 30-40% greater than from selling these products on the internal market (Nurbekov *et al.*, 2018).

Companies in Ukraine are actively implementing sustainable practices to stay competitive in the international market. One such example is Myronivskyi Hliboprodukt (2023). The company is one of the largest chicken producers in Ukraine, which significantly impacts the country's agricultural sector. By integrating the principles of sustainable development, the company has managed to reduce its environmental footprint considerably and achieve economic growth at the same time. The technologies implemented at MHP have not only reduced energy and water consumption costs, but also contributed to increased production efficiency, which has positively affected the company's financial results. One of the major areas of sustainable practices in the company's operations is the use of energy-efficient technologies. MHP is actively investing in reducing energy consumption and switching to renewable energy sources, which helps to reduce energy costs. This is crucial in an environment where production requires extensive energy consumption, particularly to support processing and storage technologies. The use of modern systems of energy-saving technologies reduces energy costs, which translates into lower operating expenses and higher profitability.

Furthermore, by implementing sustainable water management practices, such as installing water recycling systems and optimising irrigation, MHP can reduce its water costs. Reducing energy and water consumption costs has been instrumental in maintaining the

company's financial stability, even in times of economic crisis. Automated irrigation systems and the introduction of closed water circulation technologies enable the company to use natural resources efficiently while minimising costs. Notably, a sustainable approach to resource management has helped MHP reduce its environmental footprint and improve its reputation, which has increased demand for its products, particularly in international markets. At the same time, the use of sustainable technologies in production processes, such as biogas plants for processing organic waste, has helped the company reduce waste disposal costs and generate additional revenue. Table 1 shows the company's key financial indicators.

***Table 1**. Financial indicators of the "Myronivskyi Hliboprodukt" company for 2019-2024, USD million*

Indicators	2019	2020	2021	2022	2023	2024 (9M)
Income	2,056	1,911	2,372	2,642	3,021	2,262
Profit	215	-133	393	-231	142	141
Assets	2,509	2,108	4,014	3,809	3,886	3,965
Capital	1,596	1,254	1,794	1,446	1,567	1,635
Savings from sustainable technology	27	35	42	50	63	–

***Source:** developed by the authors of this study based on data from Myronivskyi Hliboprodukt (2023)*

MHP's financial performance demonstrates the company's ability to adapt to changing market conditions, overcome crisis periods, and maintain stable growth. Despite the fluctuations in profitability caused by the pandemic and the war, the company managed to maintain a strong level of income and capital, which demonstrates the effectiveness of its strategic approach and sustainability in development. For instance, in 2020, despite a decline in profits to USD -133 million due to the pandemic, the company managed to increase revenues to USD 1,911 million and return to profitability (USD 393 million) in 2021. This confirms that investments in sustainable development, efficient resource management, and innovative technologies are crucial factors that contribute to the company's financial stability even in adverse conditions. For 9M2024, the company's profit was USD 141 million. In 2019 to 2023, the company saved millions of dollars through the implementation of biogas plants, precision farming systems, and energy-efficient solutions. In 2023, the savings reached USD 63 million, which positively influenced the company's profitability even in the face of external challenges such as a pandemic or military action.

Energy efficiency is one of the major areas of MHP's sustainable development. The company is modernising its production facilities by introducing automated climate control systems in poultry houses. These systems help to optimise energy consumption while ensuring comfortable conditions for poultry rearing. Reducing energy costs increases production profitability and contributes to the environmental responsibility of the business. Rational use of resources is also a priority for the company. MHP uses precision farming technologies to grow grain crops that serve as feed for poultry. Thanks to modern methods of soil monitoring and fertiliser optimisation, the company reduces raw material costs, lowers its environmental footprint, and increases yields. This approach ensures stable operations even in times of economic and climate instability.

Certification according to international standards plays a significant role in the company's development and its entry into international markets. Specifically, in 2018, the European Commission's Directorate-General confirmed that MHP's facilities meet the highest quality standards, including FSSC 22000, ISO 22000 and BRC Food (The European Commission confirmed..., 2018). This allows the company to work with leading EU supermarkets and large international chains that require compliance with the most stringent safety and quality requirements. Obtaining such certificates has helped MHP not only strengthen its reputation in international markets but also expand opportunities for new partnerships. BRC Food certification ensures that the company follows the highest food safety standards, while GlobalGAP certificates confirm compliance with safety and quality requirements at all stages of production. Additionally, some of MHP's facilities are HALAL and KOSHER certified, which allows the company to expand its supply to markets where religious requirements are essential (MHP: Transformation, sustainable..., 2024). All these certifications ensure high product quality, increase trust from partners and consumers, and open new opportunities for the company in international markets.

Thanks to certification, the company gains access to premium segments of the European market, where demand for environmentally friendly and ethically produced products is growing. This is crucial for MHP, as the growing interest in sustainable production and environmental responsibility is driving demand for products certified to international standards. This enables the company not only to strengthen its competitiveness in new markets, but also to maintain high growth rates in exports, which helps to diversify sales markets and reduce dependence on domestic demand. Furthermore, certification positively influences relations with partners and customers, providing additional confidence in MHP products. This is an essential factor in expanding partnerships and entering into new deals, enabling the

company to not only maintain but also increase its market share in a competitive environment.

Toshkentvino Kombinati, one of the leading wineries in Uzbekistan, is an example of how the integration of sustainable production principles helps the company achieve high economic efficiency and at the same time contributes to the preservation of ecological balance (Joint-Stock Company…, 2023). The plant specialises in the production of wines, cognacs, and other alcoholic beverages, gaining popularity both in the internal market and abroad due to the high quality of its products and growing export potential. Toshkentvino Kombinati's experience shows how modernisation of production processes and implementation of sustainable technologies can not only improve the company's economic performance but also reduce its environmental footprint. One of the key areas of the company's development is the introduction of energy and resource-saving technologies. For instance, the company has upgraded equipment to optimise water and energy consumption. The introduction of modern technologies in winemaking helps to reduce energy consumption, which is a significant factor in reducing operating costs. This contributes to the stability of the company's financial results and increased profitability.

Furthermore, Toshkentvino Kombinati is actively working to reduce its environmental footprint. For example, the introduction of water recycling technologies, effective waste management, and the transition to environmentally friendly packaging methods are significant components of sustainable production at the company. These measures not only reduce costs but also improve the company's reputation as an environmentally responsible producer, which positively affects the demand for its products. Adaptation to sustainable production models also includes the development and introduction of new grape varieties that are better adapted to the climatic conditions of Uzbekistan, including those resistant to drought and other adverse factors. This helps to reduce dependence on external resources and increase the stability of production in a changing climate. Table 2 shows the company's key financial indicators.

***Table 2**. Financial performance of Toshkentvino Kombinati for 2019-2024, UZS billion*

Indicators	2019	2020	2021	2022	2023	2024
Income	520	696	725	782	539	651
Profit	78	90	118	78	48	71
Assets	457	359	545	676	565	652
Capital	207	222	259	238	298	289
Savings from sustainable technology	12	18	25	20	15	19

***Source:** developed by the authors of this study based on data from the Joint-Stock Company "Tashkentvino Kombinati" with foreign investment (2023)*

Toshkentvino Kombinati's financial performance demonstrates the company's gradual adaptation to new conditions. In 2019-2024, the company demonstrated a steady increase in revenue and profit, which indicates the effectiveness of sustainable approaches in production. Specifically, in 2020, the company increased its revenue to UZS 696 billion while its profit was UZS 90 billion. In 2021, revenues reached UZS 725 billion and profits reached UZS 118 billion, indicating an effective development strategy. However, in 2023, there was a decline in revenue to UZS 539 billion, which could be the result of short-term economic challenges or changes in consumer preferences. In 2024, the company's revenue increased to UZS 651 billion, while profit amounted to UZS 71 billion, which reflects positive dynamics and resilience even in challenging conditions. Despite the difficulties, the company has a strong potential for recovery and further growth through the implementation of sustainable technologies and strategic investments. By rationalising water use, reducing chemical fertiliser costs and managing resources efficiently, the company saved around UZS 19 billion in 2024, which positively affected its financial results.

Energy efficiency is an essential element of the company's strategy. Toshkentvino Kombinati has modernised its production lines by introducing energy-saving technologies that reduce electricity consumption. The installation of modern equipment for processing wine materials and the optimisation of technological processes have helped to increase productivity and reduce production costs. The company is also actively working to reduce waste. Winery waste, including grape pomace, is used to produce natural fertilisers. This not only reduces the environmental influence but also creates additional value that can be used in the agricultural sector. The rational use of water resources is significant for winemaking in areas with limited access to water. Toshkentvino Kombinati implemented closed-cycle water supply systems, which can reduce water consumption. Furthermore, the company regularly monitors water quality, using it in an economically and environmentally responsible manner. The integration of sustainable practices has positively influenced Toshkentvino Kombinati's financial results. Reduced energy and water costs helped to reduce production costs and increase profitability. Thanks to the introduction of

modern technologies and compliance with high quality standards, the company's products have been recognised in international markets. Toshkentvino Kombinati exports wines and cognacs to countries such as China, the US, Belarus, Germany, and Tajikistan, which contributes to foreign exchange earnings for the Uzbek economy (Viticulture and winemaking, 2024). Overall, wine exports from Uzbekistan in 2022 totalled USD 4.15 million, making it the 65th largest wine exporter in the world (Wine in Uzbekistan, 2022).

Implementation of sustainable practices in the operations of food companies is the basis for ensuring long-term competitiveness, reducing environmental impact, and improving economic performance. One of the key areas is the optimisation of energy consumption, which helps to reduce costs and cut carbon dioxide emissions. This is achieved through the use of modern energy-efficient equipment, such as heat exchangers and refrigeration units, as well as the introduction of renewable energy sources, such as solar panels or biogas plants. Rational waste management is another major step. Organic residues can be transformed into fertiliser or animal feed, and packaging can be recycled or reused. Optimising water use is also crucial in this context. Modern treatment technologies such as membrane filters and biological treatment plants can greatly reduce water consumption. Some Uzbek wineries are already using collected rainwater to irrigate their vineyards, which is an excellent example of effective water management.

Reducing the use of pesticides and chemical fertilisers increases the environmental sustainability of the agricultural sector. Transitioning to organic production allows producing value-added products and reduces the adverse environmental impact. Furthermore, innovative approaches to packaging, such as the use of biodegradable materials or the transition to reusable packaging, greatly reduce plastic waste. For instance, Toshkentvino Kombinati in Uzbekistan is actively experimenting with environmentally friendly materials for wine packaging. Rationalising logistics is a key aspect of sustainable development, reducing costs and increasing efficiency. Optimisation of routes and the use of energy-efficient transport reduce fuel costs, cut CO_2 emissions, and increase profitability. Implementation of product loss monitoring systems helps to reduce waste, which reduces disposal costs. Educational trainings for employees on energy efficiency and waste management contribute to more efficient use of resources and environmental protection. Implementation of such sustainable practices also strengthens the company's image as an environmentally responsible and progressive enterprise, which attracts the attention of customers and partners who value conservation of natural resources and reduction of the ecological footprint.

All these recommendations confirm that sustainable development not only preserves resources for future generations, but also opens new economic opportunities, ensuring the long-term stability of enterprises. Prospects for sustainable production in the food industry focus on the introduction of innovative technologies, efficient use of resources, and reduction of environmental impact. The introduction of energy-efficient technologies, reduced use of chemical fertilisers and pesticides, and rational management of water and material resources can considerably improve the economic efficiency of enterprises, reducing costs and increasing their competitiveness.

DISCUSSION

The study findings confirmed that sustainable development in the food industry is a key factor that enables a harmonious combination of economic efficiency, environmental responsibility, and social justice. One of the primary benefits of sustainable production is cost reduction through optimised resource use and the introduction of innovative approaches, such as circular economy models. Examples from Ukraine and Uzbekistan demonstrated that the application of such practices can reduce the environmental footprint and at the same time increase the competitiveness of enterprises.

One of the key aspects of sustainable production is the rational use of resources (Oleksy-Gębczyk *et al.*, 2024). The study revealed that the use of precision farming technologies can greatly reduce fertiliser and water costs. This is crucial in conditions of limited access to resources, which is typical for Ukraine as a consequence of the war, as well as for Uzbekistan due to natural climatic conditions. For example, the introduction of drip irrigation methods in Uzbekistan has reduced water consumption, which confirmed the effectiveness of these approaches. L.L.D.R. Osorio *et al.* (2021) investigated the potential of the circular economy in the agricultural sector, specifically the use of waste for biogas and organic fertiliser production. The researchers' findings revealed that the transition to a circular economy not only reduces negative environmental impacts but also opens new sources of income through the sale of biogas or organic fertilisers. This enables businesses to reduce energy and fertiliser costs and contributes to sustainable development. The present findings partially coincided with these conclusions, as the use of biogas units and waste recycling were mentioned. However, the cited study focused on the economic benefits of circular processes, which the current study addressed to a lesser extent.

The energy component plays a crucial role in sustainable development. The use of renewable energy sources, such as biogas units and solar panels, demonstrated high efficiency in the agricultural sector in both countries (Cherven *et al.*, 2024). The practices of the Ukrainian company MHP showed that the processing of organic waste into biogas can reduce dependence on conventional energy resources and reduce greenhouse

gas emissions. Analogously, Uzbek wineries are using solar energy to reduce electricity costs. M.S. Nejad *et al.* (2023) also focused on the effects of energy-saving technologies on production costs in the agricultural sector, confirming that the use of modern renewable energy sources can reduce energy costs. Furthermore, A. Amo-Aidoo *et al.* (2021) emphasised that in the context of global warming, energy efficiency is becoming increasingly significant for the sustainable development of agricultural enterprises. Compared to the present study, these researchers focused on energy savings and concrete economic benefits of solar and biogas units, which coincided with the presented findings.

Another significant area is the reduction of chemical fertilisers and pesticides (Yaheliuk *et al.*, 2024). The study showed the value of organic farming, which reduces environmental impact and improves product quality. This is in line with current trends of growing demand for environmentally friendly products, particularly in Europe. The transition to organic technologies also opens access to premium markets, which is crucial for Ukraine and Uzbekistan. S. Das *et al.* (2023) investigated the role of biotechnology in reducing the use of chemical fertilisers and pesticides, finding that the use of genetically modified crops can greatly reduce the need for pesticides and, consequently, mitigate their adverse environmental impact. M.A. Steinwand and P.C. Ronald (2020) also noted that the use of biotechnology allows for more yields with fewer chemicals. These findings partially coincide with the present findings on the reduction of chemical use, although the researchers focused on organic farming, as opposed to biotechnology as a tool for sustainable development.

The social aspect of sustainable development also has a major influence. Ensuring fair labour conditions, supporting local farmers, and developing communities contribute to social stability (İsmayilov *et al.*, 2022). Examples of companies such as MHP in Ukraine and Toshkentvino Kombinati in Uzbekistan demonstrate how investing in local communities and creating jobs increases brand trust and stimulates economic growth. A. Wezel *et al.* (2020) also focused on the social aspects of sustainable production, including fair labour conditions and the development of local communities. The researchers found that agribusinesses that actively implement the principles of social responsibility have more stable workforces and reduce the risk of social conflict. These findings overlap with current findings on social responsibility, particularly in the case of MHP, which invests in rural community development and improves working conditions.

R. Lencucha *et al.* (2020) investigated the effects of government policies on the development of sustainable agriculture, specifically policies supporting organic farming and the application of environmental standards. The researchers found that government programmes encourage small and medium-sized farmers to adopt sustainable practices, such as organic farming and the use of renewable energy sources. This can increase environmental friendliness and economic efficiency, but it was also found that insufficient government funding limits the potential. The current study also mentioned the significance of government support and the role of certification but focused more on existing international standards and their implementation at the enterprise level. The implementation of international standards such as ISO 14001, ISO 22000, and GlobalG.A.P. provides enterprises with access to new markets and increases their reputation among environmentally conscious consumers (Gutsul *et al.*, 2023). For example, certification of Uzbek producers' products to these standards has enabled them to export organic products to Germany and China. K. Pietrzyck *et al.* (2021) studied the influence of international standards (GlobalG.A.P., ISO 22000, Fair Trade) on the sustainable development of the agri-food sector in countries. Like K.M. Siegel and M.G.B. Lima (2020), the researchers found that certification to international standards enables producers to improve the quality of their products, access new markets such as Europe and Asia, and increase competitiveness. This allows farmers and businesses to increase their income and invest in environmental technologies. The current study also covered this topic but focused more on concrete examples of the application of these standards in Ukraine and Uzbekistan, while the cited studies examined the overall impact of standards on the development of developing economies.

F. Fuentes-Peñailillo *et al.* (2024) investigated the role of digital technologies, such as satellite monitoring, soil moisture sensors, and artificial intelligence systems, in improving the efficiency of sustainable agriculture. The findings indicated that the use of these technologies enables farmers to more accurately plan fertilisation, irrigation, and pest control, which reduces resource costs and minimises environmental impact. The current study also confirmed the value of using modern technologies to increase the efficiency of sustainable production. However, the researchers focused on digital tools and their role in optimising production, while the present study mentioned this issue in less detail.

Therewith, the implementation of sustainable practices faces a series of challenges. In Ukraine, the war complicates logistics, while in Uzbekistan, limited financial resources and access to modern technology slow down the pace of change. However, support from the government and international organisations can greatly accelerate this process. Thus, the study confirmed that the principles of sustainable production not only solve current problems but also form the basis for a sustainable future. The integration of environmentally responsible, economically viable, and socially just approaches allows striking a balance between the economy and the environment, creating competitive advantages for businesses.

CONCLUSIONS

The study showed that the implementation of sustainable production principles increases the efficiency of enterprises and reduces their adverse environmental impact. A prominent aspect is the efficient use of resources such as water and energy, specifically through precision farming technologies that reduce fertiliser and water costs. Furthermore, the reduction of pesticide uses and the transition to organic farming contribute to the preservation of ecosystems and improve product quality. Sustainable development principles implemented through international standards such as ISO 14001, ISO 22000, GlobalG.A.P., and fair-trade certification are becoming an indispensable tool for companies seeking not only to protect the environment but also to increase their competitiveness in international markets.

In Ukraine and Uzbekistan, the implementation of sustainability principles in the agricultural sector contributes to economic growth and environmental sustainability. An example of this is Myronivskyi Hlibprodukt, which has reduced energy costs and increased yields by using biogas units and precision farming. According to its financial results for 2019-2024, MHP managed to increase its revenues despite the challenging environment, including the war. In Uzbekistan, Toshkentvino Kombinati is modernising its production by introducing energy-saving technologies and closed water supply cycles. These steps demonstrate how sustainable development can improve competitiveness and promote environmentally friendly economic growth. According to its financial results for 2019-2024, the company showed a steady increase in capital and assets, reflecting investments in production modernisation and the introduction of environmentally friendly technologies.

Overall, sustainable development in the food industry is a prerequisite for a future where the economy and the environment are in harmony. Integration of sustainable practices into production processes not only reduces costs and risks, but also promotes social responsibility, improves product quality, and strengthens positions in global markets. Limitations of the present study included the fact that the focus was on individual countries and companies, which limited the generalisability of the findings to other regions. Further research could include a comparison of sustainability in different industries and the impact of the latest technologies on the efficiency of sustainable production in the agricultural sector.

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CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

REFERENCES

[1] A technology that halves water consumption for irrigation has been deployed in the Kharkiv region. (2020). Retrieved from https://agronews.ua/news/178902/?utm_source=chatgpt.com.

[2] Amo-Aidoo, A., Hensel, O., Korese, J.K., Neba, F.A., & Sturm, B. (2021). A framework for optimization of energy efficiency and integration of hybridized-solar energy in agro-industrial plants: Bioethanol production from cassava in Ghana. *Energy Reports*, 7, 1501-1519. doi: 10.1016/j.egyr.2021.03.008.

[3] Arabov, N., Nasimov, D., Abduramanov, X., Utemuratova, G., & Lutfullo, I. (2024). Addressing the economic impacts of climate change in Uzbekistan: Challenges and strategies. *E3S Web of Conferences*, 542, article number 04006. doi: 10.1051/e3sconf/202454204006.

[4] Cherven, I., Banyeva, I., Ivanenko, T., Kushniruk, V., & Velychko, O. (2024). Food security strategies in the context of environmental and economic fluctuations in Ukraine. *Ekonomika APK*, 31(6), 59-68. doi: 10.32317/ekon.apk/6.2024.59.

[5] Das, S., Ray, M.K., Panday, D., & Mishra, P.K. (2023). Role of biotechnology in creating sustainable agriculture. *PLOS Sustainability and Transformation*, 2(7), article number e0000069. doi: 10.1371/journal.pstr.0000069.

[6] Decree of the President of the Republic of Uzbekistan "On Approval of the Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020-2030". (2019, October). Retrieved from https://faolex.fao.org/docs/pdf/uzb197241.pdf.

[7] Didukh, S.M., & Korikova, A.K. (2020). Sustainable development of agro-industrial holdings of Ukraine: Features and directions of improvement. *Agrosvit*, 3, 90-99. doi: 10.32702/2306-6792.2020.3.90.

[8] Due to drought, the Mykolaiv region received a smaller grain harvest – 2.1 million tons. (2024). Retrieved from https://inshe.tv/economics/2024-12-10/890609/?utm_source=chatgpt.com.

[9] Economic indicators of short-term industrial statistics. (2024). Retrieved from https://stat.gov.ua/uk/explorer?urn=SSSU:DF_IND_SHORT_STAT_INDUSTR_STAT(13.0.0).

[10] Fair Trade International. (2024). *Fairtrade certification: Reliable and trustworthy*. Retrieved from https://www.fairtrade.net/en/why-fairtrade/how-we-do-it/how-does-the-label-work/how-fairtrade-certification-works.html.

[11] FAO implements a project on rational irrigation of agricultural crops in Uzbekistan. (2023). Retrieved from https://east-fruit.com/uk/novyny/fao-realizuye-v-uzbekystani-proyekt-iz-ratsionalnoho-zroshennya-ahrokultur/?utm_source=chatgpt.com.

[12] Fuentes-Peñailillo, F., Gutter, K., Vega, R., & Silva, G.C. (2024). Transformative technologies in digital agriculture: Leveraging Internet of Things, remote sensing, and artificial intelligence for smart crop management. *Journal of Sensor and Actuator Networks*, 13(4), article number 39. doi: 10.3390/jsan13040039.
[13] Garcia, S.N., Osburn, B.I., & Jay-Russell, M.T. (2020). One health for food safety, food security, and sustainable food production. *Frontiers in Sustainable Food Systems*, 4, article number 1. doi: 10.3389/fsufs.2020.00001.
[14] Global Good Agricultural Practices. (2024). *Harmonized produce safety standard*. Retrieved from https://www.globalgap.org/what-we-offer/solutions/harmonized-produce-safety-standard/.
[15] Granato, D., Carocho, M., Barros, L., Zabetakis, I., Mocan, A., Tsoupras, A., Cruz, A.G., & Pimentel, T.C. (2022). Implementation of Sustainable Development Goals in the dairy sector: Perspectives on the use of agro-industrial side-streams to design functional foods. *Trends in Food Science & Technology*, 124, 128-139. doi: 10.1016/j.tifs.2022.04.009.
[16] Gutsul, T., Sulima, N., & Kuderskyi, B. (2023). Analysis of the state and prospects of milk production and dairy products in Ukraine in the post-war period. *Animal Science and Food Technology*, 14(3), 35-46. doi: 10.31548/animal.3.2023.35.
[17] Hamidov, A., Kasymov, U., Allahverdiyeva, N., & Schleyer, C. (2024). Governance of technological innovations in water and energy use in Uzbekistan. *International Journal of Water Resources Development*, 40(1), 123-139. doi: 10.1080/07900627.2022.2062706.
[18] Hashmi, R. (2023). Business performance through government policies, green purchasing, and reverse logistics: Business performance and green supply chain practices. *South Asian Journal of Operations and Logistics*, 2(1), 1-10. doi: 10.57044/SAJOL.2023.2.1.2301.
[19] Irisova, S. (2023). Protection of plants sown after cereals in the Fergana valley. *Science and Innovation*, 2(11), 158-166. doi: 10.5281/zenodo.10124008.
[20] İsmayilov, V., Shalbuzov, N., Karimova, V., Safarov, A., & Cabbarli, L. (2022). Government agencies in the field of sustainable agricultural development in various countries. *Rivista di Studi sulla Sostenibilita*, 2022(2), 165-183. doi: 10.3280/RISS2022-002011.
[21] ISO 14001. (2004). *Environmental management systems – requirements with guidance for use*. Retrieved from https://ocw.un-ihe.org/pluginfile.php/3158/mod_resource/content/1/ISO_14001.pdf.
[22] ISO 22000. (2018). *Food safety management systems – requirements for any organization in the food chain*. Retrieved from https://www.bizna.ir/upload/emn/1593363136.pdf.
[23] Joint-Stock Company "Tashkentvino Kombinati" with foreign investment. (2023). *Report on the results of the first quarter of 2023*. Retrieved from http://www.toshkentvino.uz/wp-content/uploads/2024/02/2023_pdf.
[24] Karamushka, V., Boychenko, S., Kuchma, T., & Zabarna, O. (2022). Trends in the Environmental conditions, climate change and human health in the southern region of Ukraine. *Sustainability*, 14(9), article number 5664. doi: 10.3390/su14095664.
[25] Kravchenko, O., Kucher, A., Hełdak, M., Kucher, L., & Wysmułek, J. (2020). Socio-economic transformations in Ukraine towards the sustainable development of agriculture. *Sustainability*, 12(13), article number 5441. doi: 10.3390/su12135441.
[26] Lencucha, R., Pal, N.E., Appau, A., Thow, A.M., & Drope, J. (2020). Government policy and agricultural production: A scoping review to inform research and policy on healthy agricultural commodities. *Globalization and Health*, 16, article number 11. doi: 10.1186/s12992-020-0542-2.
[27] Liczmańska-Kopcewicz, K., Pypłacz, P., & Wiśniewska, A. (2020). Resonance of investments in renewable energy sources in industrial enterprises in the food industry. *Energies*, 13(17), article number 4285. doi: 10.3390/en13174285.
[28] Lower Dnipro River basin water resources management. (2022). *Water management development program in Kherson Region*. Retrieved from https://buvrnd.gov.ua/files/DDDDDDDNDD_DNDDNDDD.pdf.
[29] Mak, T.M.W., Xiong, X., Tsang, D.C., Iris, K.M., & Poon, C.S. (2020). Sustainable food waste management towards circular bioeconomy: Policy review, limitations and opportunities. *Bioresource Technology*, 297, article number 122497. doi: 10.1016/j.biortech.2019.122497.
[30] Melnikova, L., & Gilsanz, A. (2023). Applying polysaccharides regulatory complex as a frugal innovation in dairy farms. *Polish Journal of Environmental Studies*, 32(5), 4177-4189. doi: 10.15244/pjoes/166344.
[31] MHP launched another eco-project for biofuel production. (2019). Retrieved from https://www.rbc.ua/ukr/news/mhp-zapustil-eshche-odin-ekoproekt-proizvodstvu-1565187417.html.
[32] MHP: Transformation, sustainable development, best international practices. (2024). Retrieved from https://esg-rating-2021-mhp.korrespondent.net/ukr.html?utm_source=chatgpt.com.
[33] Momot, S. (2022). The impact of business social responsibility on the implementation of sustainable development principles in the region. *Collection of Scientific Papers of Cherkasy State Technological University. Series: Economic Sciences*, 64, 27-36. doi: 10.24025/2306-4420.64.2022.255775.

[34] Myronivskyi Hliboprodukt. (2023). *Group annual report and accounts 2023: A leading international food and agrotech company*. Retrieved from https://api.next.mhp.com.ua/images/51d31/2ef40/69ea3acbd9a.pdf.
[35] Nair, L.G., Agrawal, K., & Verma, P. (2022). An overview of sustainable approaches for bioenergy production from agro-industrial wastes. *Energy Nexus*, 6, article number 100086. doi: 10.1016/j.nexus.2022.100086.
[36] Nejad, M.S., Almassi, M., & Ghahderijani, M. (2023). Life cycle energy and environmental impacts in sugarcane production: A case study of Amirkabir Sugarcane Agro-Industrial Company in Khuzestan province. *Results in Engineering*, 20, article number 101545. doi: 10.1016/j.rineng.2023.101545.
[37] Nurbekov, A., Aksoy, U., Muminjanov, H., & Shukurov, A. (2018). *Organic agriculture in Uzbekistan: Status, practices and prospects*. Tashkent: Food and Agriculture Organization of the United Nations.
[38] Oleksy-Gębczyk, A., Szeląg-Sikora, A., Kowalska-Jarnot, K., Lis, A., Sikora, J., & Cupiał, M. (2024). Influence of worldview factors on food consumers' purchasing decisions. *Lecture Notes in Civil Engineering*, 609 LNCE, 323-332. doi: 10.1007/978-3-031-70955-5_36.
[39] Osorio, L.L.D.R., Flórez-López, E., & Grande-Tovar, C.D. (2021). The potential of selected agri-food loss and waste to contribute to a circular economy: Applications in the food, cosmetic and pharmaceutical industries. *Molecules*, 26(2), article number 515. doi: 10.3390/molecules26020515.
[40] Østergaard, P.A., Duic, N., Noorollahi, Y., Mikulcic, H., & Kalogirou, S. (2020). Sustainable development using renewable energy technology. *Renewable Energy*, 146, 2430-2437. doi: 10.1016/j.renene.2019.08.094.
[41] Pietrzyck, K., Jarzębowski, S., & Petersen, B. (2021). Exploring sustainable aspects regarding the food supply chain, agri-food quality standards, and global trade: An empirical study among experts from the European Union and the United States. *Energies*, 14(18), article number 5987. doi: 10.3390/en14185987.
[42] Purnhagen, K.P., Clemens, S., Eriksson, D., Fresco, L.O., Tosun, J., Qaim, M., Visser, R.G., Weber, A.P., Wesseler, J.H., & Zilberman, D. (2021). Europe's farm to fork strategy and its commitment to biotechnology and organic farming: Conflicting or complementary goals? *Trends in Plant Science*, 26(6), 600-606. doi: 10.1016/j.tplants.2021.03.012.
[43] Roundtable on Sustainable Palm Oil. (2024). *Our standards*. Retrieved from https://rspo.org/as-an-organisation/our-standards/.
[44] Salah, S.A., & Mustafa, A. (2021). Integration of energy saving with Lean production in a food processing company. *Journal of Machine Engineering*, 21(4), 118-133. doi: 10.36897/jme/142394.
[45] Shevchenko, K. (2019). *Rain or drip: What to choose for agriculture and how much does irrigation cost*. Retrieved from https://agravery.com/uk/posts/show/dos-ci-krapla-so-obrati-agrariu-ta-skilki-kostue-zrosenna?utm_source=chatgpt.com.
[46] Siegel, K.M., & Lima, M.G.B. (2020). When international sustainability frameworks encounter domestic politics: The sustainable development goals and agri-food governance in South America. *World Development*, 135, article number 105053. doi: 10.1016/j.worlddev.2020.105053.
[47] Singh, R., & Singh, G.S. (2017). Traditional agriculture: A climate-smart approach for sustainable food production. *Energy, Ecology and Environment*, 2, 296-316. doi: 10.1007/s40974-017-0074-7.
[48] Singh, R., Das, R., Sangwan, S., Rohatgi, B., Khanam, R., Peera, S.K.P.G., Das, S., Lyngdoh, Y.A., Langyan, S., Shukla, A., Shrivastava, M., & Misra, S. (2021). Utilisation of agro-industrial waste for sustainable green production: A review. *Environmental Sustainability*, 4, 619-636. doi: 10.1007/s42398-021-00200-x.
[49] Srivastav, A.L. (2020). Chemical fertilizers and pesticides: role in groundwater contamination. In M.N.V. Prasad (Ed.), *Agrochemicals detection, treatment and remediation: Pesticides and chemical fertilizers* (pp. 143-159). Kidlington: Elsevier. doi: 10.1016/B978-0-08-103017-2.00006-4.
[50] Statistics agency under the President of the Republic of Uzbekistan. (2024). *Volume of industrial production (annual)*. Retrieved from https://api.siat.stat.uz/media/uploads/sdmx/sdmx_data_552.pdf.
[51] Steinwand, M.A., & Ronald, P.C. (2020). Crop biotechnology and the future of food. *Nature Food*, 1, 273-283. doi: 10.1038/s43016-020-0072-3.
[52] The European Commission confirmed that MHP meets the highest international standards. (2018). Retrieved from https://surl.li/bfnfll.
[53] Ukraine to test Japanese technology that reduces water use by 40%. (2024). Retrieved from https://surl.li/pqgbbe.
[54] Uktamov, K., Akhmedov, S., Khashimova, D., Fayziyeva, K., Narmanov, U., Sobirova, D., Kuryozov, O., & Komilov, A. (2024). Improving the country's food security in the conditions of developing a circular economy. *BIO Web of Conferences*, 116, article number 07010. doi: 10.1051/bioconf/202411607010.
[55] Viticulture and winemaking: Toshkentvino Kombinati. (2024). Retrieved from https://madeinuzbekistan.ru/toshkentvino.
[56] Wezel, A., Herren, B.G., Kerr, R.B., Barrios, E., Gonçalves, A.L.R., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy for Sustainable Development*, 40, article number 40. doi: 10.1007/s13593-020-00646-z.

[57] Wine in Uzbekistan. (2022). Retrieved from https://oec.world/en/profile/bilateral-product/wine/reporter/uzb.
[58] Yaheliuk, S., Fomych, M., & Rechun, O. (2024). Global market trends of grain and industrial crops. *Commodity Bulletin*, 17(1), 134-145. doi: 10.62763/ef/1.2024.134.

Економічна ефективність сталого виробництва харчових продуктів

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Анотація. Метою дослідження було проаналізувати вплив впровадження принципів сталого виробництва харчових продуктів на аспекти діяльності агропромислових підприємств. На прикладі української компаній «Миронівський хлібопродукт» та узбецької Toshkentvino Kombinati встановлено, що раціональне використання ресурсів дозволяє суттєво знизити втрати сировини, скоротити обсяг відходів і підвищити рівень повторного використання матеріалів. Використання енергоефективних технологій сприяє зниженню витрат на енергоресурси, що забезпечує зростання фінансових показників і підвищує конкурентоспроможність підприємств. Впровадження практик обмеження застосування пестицидів і хімічних добрив позитивно впливає на якість продукції та зменшує екологічне навантаження на довкілля. Соціальні ініціативи, такі як підтримка місцевих фермерів, розвиток регіональних громад і створення справедливих умов праці, не лише зміцнюють репутацію компаній, але й сприяють довготривалому розвитку місцевих економік. У дослідженні також висвітлено значення міжнародних стандартів ISO 14001, ISO 22000 та Global Good Agricultural Practices у впровадженні сталих підходів у харчовій промисловості, що забезпечують уніфікацію процесів і підвищують довіру з боку партнерів та споживачів. На прикладах діяльності обраних для дослідження компаній продемонстровано, як впровадження сталих практик впливає на покращення фінансових показників, екологічної відповідальності та соціального іміджу підприємств. Отримані результати можуть бути використані керівниками та фахівцями агропромислових компаній для адаптації виробничих процесів до принципів сталого розвитку. Крім того, напрацьовані рекомендації стануть корисними для органів державного управління, які регулюють агропромисловий сектор, а також для громадських організацій, що працюють у сфері екологічної та соціальної відповідальності бізнесу

Ключові слова: екологічна відповідальність; інновації; енергозбереження; міжнародні стандарти; органічне виробництво