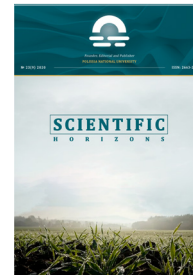


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## Integrated approach to accounting in agriculture in the context of sustainable development and circular economy

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**Abstract.** The study was conducted to analyse the possibilities of integrating the principles of sustainable development and circular economy into the accounting system of agricultural enterprises. The study employed various methods to analyse the implementation of the circular economy in agricultural enterprises. The study found that the integration of the principles of sustainable development and circular economy into the accounting of agricultural enterprises allows increasing the efficiency

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of resource management. It was also found that the introduction of environmental and social indicators into the accounting system contributes to better control over the use of natural resources, reduction of production costs, and minimisation of waste. The analysis revealed that the application of the circular model in agriculture contributes to the economic sustainability of enterprises through the reuse of materials and reduced dependence on external resources. It was also confirmed that such innovations positively affect the ecological state of land and other natural resources used in agricultural production. The study found that the use of circular approaches in accounting can increase the transparency and accuracy of financial reports, considering the environmental impact. The analysis of enterprises from different countries, such as Nibulon, The Green Shop, and the Farmers for Climate Action cooperative, revealed concrete benefits of implementing circular approaches in reducing costs, improving resource management, increasing environmental efficiency, and increasing profitability, which confirmed their significance in modern agribusiness. It was established that the assessment of environmental and social factors enables a more objective determination of the economic efficiency of agricultural enterprises. Furthermore, it was proved that the implementation of sustainable approaches reduces the risks associated with environmental regulations and increases the confidence of investors and partners. It was concluded that the integration of these approaches contributes to the long-term sustainability of agricultural enterprises. The study made a valuable contribution to science by revealing innovative approaches to the integration of environmental and social indicators into the accounting of agricultural enterprises, which contributed to their sustainable development and responsibility towards the environment

**Keywords:** resource management; environmental indicators; social indicators; economic sustainability; transparency of financial statements; cost reduction

## INTRODUCTION

Agriculture plays a key role in ensuring food security and economic stability, but modern challenges related to limited natural resources and the need to adapt to environmental changes require a rethinking of conventional management approaches. In this context, accounting is becoming not only a tool for recording financial indicators, but also a means of assessing the efficiency of resource use, environmental impact, and social responsibility of agricultural enterprises (Dubiniina *et al.*, 2022). Integration of the principles of sustainable development and circular economy into accounting practices allows enterprises to ensure the rational use of resources and increase transparency of their activities. This includes assessing the costs and benefits of using environmentally friendly technologies, such as the cost of installing solar collectors or biogas units, as well as reflecting the efficiency of closed production cycles through waste management and the reuse of bi-resources. Furthermore, the adaptation of reporting to international standards such as GRI ensures that non-financial indicators, including environmental and social indicators, are addressed, enabling businesses to meet modern transparency and responsibility requirements.

The analysis of the sources revealed a problem of insufficient integration of the principles of sustainable development and circular economy into the accounting of agricultural enterprises. Modern challenges, such as social inequality, require a rethinking of conventional approaches to management in the agricultural sector (Hrebenyk *et al.*, 2023). For instance, according to a survey conducted by the International Labour Organisation, only 15% of agricultural enterprises in developing countries regularly report on the social aspects of their

operations. R. Chopra *et al.* (2022) investigated how a sustainable approach in the agricultural sector contributes to the rational use of natural resources and the significance of including environmental indicators in financial statements. The researchers noted that environmental aspects are usually reflected in the Notes to the financial statements, which allows considering the non-financial indicators without altering the structure of the main statements. J. Lu *et al.* (2021) addressed the need to consider social factors to help assess the impact of enterprises on local communities. In their study, the researchers proved that social responsibility is significant for achieving sustainable development in the agricultural sector.

H. Salmenperä *et al.* (2021) noted that an effective accounting system could contribute to better cost control and increase the economic sustainability of enterprises. The researchers emphasised that integrating indicators such as waste disposal costs or energy-efficient technologies into accounting allows for more accurate cost analysis and improved financial performance. J. Velasco-Muñoz *et al.* (2021) noted that the implementation of circular approaches allowed agricultural enterprises to achieve economic sustainability by reducing dependence on external resources. Their findings indicated that the circular economy could increase productivity in agriculture. L. Raimi *et al.* (2021) emphasised the significance of transparency in financial reporting to increase investor and partner confidence. The researchers argued that the integration of sustainable approaches, such as accounting for environmental costs, energy efficient technologies, waste minimisation, and the use of renewable resources, into

accounting is a prerequisite for attracting finance to the agricultural sector, as it allows for a clearer reflection of the risks and opportunities associated with environmental and social factors.

M. Lim *et al.* (2022) emphasised that the circular economy helped to optimise the use of materials and resources in production. This positively affected the profitability of agricultural enterprises and their environmental responsibility. H. Han *et al.* (2023) noted that improving accounting using technologies such as blockchain and artificial intelligence helps to reduce financial risks. This allows businesses to adapt more effectively to new regulations and standards, improving cost management and financial stability. S. Hu *et al.* (2022) addressed the connection between accounting practices, such as the integration of non-financial indicators and the use of transparent costing methods, and corporate social responsibility. The researchers noted that the use of such practices contributed to the sustainable development of agricultural enterprises and allowed for effective assessment of their activities.

C. Dasanayaka *et al.* (2021) showed that the integration of sustainability principles into accounting increases the competitiveness of enterprises. These principles were integrated through the consideration of environmental and social factors in financial statements, which reduced costs and improved resource management, which are key benefits of this approach. P. Zand and H. Mosavi (2022) noted that the use of the social accounting matrix to study the significance of the agricultural sector among the main sectors of the economy allowed assessing its impact on the country's economic situation. The researchers emphasised the role of agriculture in creating jobs, ensuring food security, and maintaining socio-economic stability. Therefore, there is a need to further explore accounting models that would combine economic, environmental, and social aspects in the accounting of agricultural enterprises. This will allow developing more comprehensive and efficient accounting models that accommodate both conventional financial indicators and non-financial aspects, such as the costs of environmental initiatives, social responsibility, and resource efficiency, which meet the current requirements of sustainable development and circular economy.

The purpose of this study was to identify ways to integrate environmental and social aspects into the financial statements of agricultural enterprises.

## MATERIALS AND METHODS

The method of axiomatisation became the basis for the development of the theoretical foundations that determine the activities of enterprises in the circular economy. This method helped to develop axioms that focus on the conservation of natural resources and waste minimisation. Clarifying the link between these axioms and accounting is essential because conserving

resources and reducing waste can affect the financial performance, particularly by reducing raw material and disposal costs.

The study analysed the practices of Unilever (UK) and Ben & Jerry's (USA), which successfully integrate environmental and social aspects into their business models. The analysis of these companies helped to identify effective approaches to accounting for environmental performance and social responsibility that can be used by other agricultural companies to improve financial outcomes and reduce adverse environmental impact. Three companies were also examined: Nibulon (Ukraine), The Green Shop (Netherlands), and Farmers for Climate Action (Australia). These companies were selected due to their active involvement in the implementation of innovative solutions in agricultural processing and the use of renewable technologies. The key evaluation criteria included the level of innovation in approaches to agricultural waste processing, use of organic materials, implementation of energy-saving technologies, as well as the effectiveness of these measures in terms of reducing environmental impact and operating costs. Innovative approaches, use of organic materials, and implementation of energy-saving technologies were considered for each company, with a focus on assessing their effectiveness in reducing adverse environmental impact and optimising costs, which can be reflected in accounting through reduced energy, raw material, and waste disposal costs.

The inductive method was employed to draw generalised conclusions based on the experience of individual enterprises. Based on the study of the enterprises, the implementation of circular principles became the basis for the development of hypotheses on the possibility of adapting these approaches in agricultural enterprises in other countries. This helped to assess how these principles can be adapted and implemented in different national contexts to improve the efficiency and sustainable development of agricultural enterprises. To confirm the hypotheses, data on financial outcomes and environmental performance of enterprises were used, as well as studies that showed a positive impact of innovative practices on business sustainability.

The deductive approach helped to derive concrete recommendations based on the general principles of the circular economy. The strategies developed, specifically, to reduce energy costs and reduce the adverse environmental impact, can be practically implemented through the introduction of the latest technologies and process optimisation. These recommendations, if implemented, can substantially improve the financial performance of enterprises, which will be reflected in accounting through cost reduction, improved resource management, and increased efficiency of business processes. This confirms the feasibility of the circular approach in agribusiness and opens new opportunities for international cooperation in the field of sustainable

development. Abstraction was employed to highlight the crucial aspects of the processes under study, such as energy optimisation and the use of organic materials. This helped to focus on the key elements of the circular economy, while discarding less significant details, which resulted in a more precise formulation of recommendations for businesses seeking sustainable development.

## RESULTS

In the face of the modern global challenges, such as climate change, depletion of natural resources, and population growth, the concept of sustainable development is becoming increasingly important for agriculture. Conventional agricultural business practices often lead to the deterioration of ecosystems, including soil degradation, water shortages, and pollution. Sustainable development offers a new paradigm that combines economic, environmental, and social aspects, ensuring the efficient use of resources without depleting them (Shebanin *et al.*, 2023).

For agricultural enterprises, this means conserving resources by implementing modern technologies that minimise the use of chemical fertilisers and pesticides and optimise water and energy consumption. For example, drip irrigation or the use of bio-fertilisers can reduce the amount of resources used considerably. Adaptation to climate change is becoming an integral part of farmers' activities, specifically through drought- and disease-resistant crop varieties and agroforestry, which helps protect soil and conserve moisture (Ismayilzادا *et al.*, 2023). Furthermore, sustainable development involves reducing adverse environmental impacts by reducing greenhouse gas emissions and implementing circular economy principles. This can include processing agricultural waste into biogas or compost, which helps reduce dependence on fossil energy sources.

An integrated approach to accounting in the agricultural sector is a key tool for achieving sustainable development goals (Yue *et al.*, 2021). The conventional accounting system focuses mainly on financial indicators, ignoring the environmental and social impacts of business operations. However, modern conditions require innovative approaches from the accounting system that would allow not only controlling the economic activity but also to addressing the environmental and social impacts. For example, the integration of environmental indicators into accounting helps to monitor the use of natural resources, assess the level of pollutant emissions, and reduce waste. Social factors, such as job creation and engagement with local communities, are also becoming important in assessing the performance of agricultural enterprises.

The circular economy, which is based on the principles of waste minimisation and resource reuse, plays an essential role in changing approaches to agricultural production (Toplicean & Datcu, 2024). In agriculture,

these approaches can include the efficient use of water resources, the reduction of chemical fertilisers and pesticides, and the introduction of biological pest management. Through such changes, agricultural enterprises can greatly reduce their adverse environmental impact while increasing productivity and sustainability. The circular economy also contributes to the conservation of biodiversity and the improvement of land conditions, which are critical for the long-term development of agriculture. The integration of circular economy principles into accounting can make agricultural enterprises more environmentally responsible and transparent. Such accounting provides companies with the information they need to make environmentally sound decisions and enables them to assess their impact. Another prominent aspect is to increase the trust of partners and investors, as the circular economy helps to reduce the risks associated with environmental regulations and sustainability requirements (Drobitko *et al.*, 2023).

Unilever is one of the leaders in implementing sustainable practices in business processes. The company actively integrates environmental and social indicators into its financial statements, which not only improves transparency and increases investor confidence, but also confirms its commitment to sustainable development. Specifically, the company considers all costs associated with the introduction of environmentally friendly technologies, such as energy-efficient production processes, carbon emissions reduction and the use of renewable energy sources. In 2022, Unilever invested more than EUR 1.3 billion in energy efficiency and carbon reduction. These costs are reflected in the financial statements, enabling investors to assess not only the direct costs but also the potential benefits of increased efficiency and lower operating costs in the future. The company also considers the costs of supporting social initiatives, such as healthy eating programmes, local community development and social projects aimed at reducing poverty. For example, in 2021, Unilever spent EUR 250 million on social projects. Unilever's financial reports detail the results of these initiatives, allowing stakeholders to assess their effectiveness and potential contribution to long-term development.

Ben & Jerry's is another good example of a company that demonstrates a socially responsible business approach. The company has established a special fund to support local communities and initiatives, funded through regular contributions from the company. This fund is aimed at implementing projects that improve social conditions in the regions where the company operates. In 2022, the company invested over USD 5 million in support of initiatives to develop local businesses, education, and healthcare. Ben & Jerry's financial statements detail the costs of these programmes, which confirms the company's commitment to society. Including such expenditures in the financial statements not only demonstrates the company's transparency, but also

allows shareholders and investors to assess how these expenditures contribute to long-term sustainability and social development.

Both these examples demonstrate how integrating environmental and social considerations into accounting allows companies to create a more complete picture of their operations. This approach ensures more efficient cost management, reduces risks, and increases competitiveness. Transparent reporting of environmental and social costs helps companies attract investors who are focused on sustainable development, strengthen their image, and improve relations with partners and consumers. The examples of Unilever and Ben & Jerry's confirm that integrating environmental and social aspects into accounting helps to improve business efficiency, attract investment, and demonstrate a responsible attitude towards society. An integrated approach to that considers the environmental and social aspects of

operations is a major step towards achieving long-term sustainability in the agricultural sector. The circular economy offers new opportunities to improve resource efficiency and reduce negative environmental impact. This ensures not only the survival of agricultural enterprises in the current environment, but also helps to create the foundations for a sustainable future.

Sustainable development in agriculture is not just a concept, but a necessary strategy for preserving natural resources and maintaining biodiversity in the face of increasing environmental pressure (Table 1). The key purpose of sustainable development is to create conditions under which the present needs of society can be met without compromising the needs of future generations. In agriculture, this means the rational use of natural resources, reducing the adverse environmental impact and maintaining ecosystem functions necessary for the long-term conservation of soil, water, and biodiversity.

**Table 1.** *The concept of sustainable development in agriculture*

Principle	Description	Implementation methods
Conservation of natural resources	The use of resources should be rational to ensure their restoration and maintenance of ecosystems	Crop rotation, organic farming
Supporting biodiversity	Agriculture should preserve species diversity to maintain ecosystem health	Agroforestry, creation of nature protection zones
Environmental impact reduction	Production processes should be aimed at reducing the negative impact on the environment	Use of biodegradable materials and environmentally friendly technologies
Environmental responsibility	Agricultural enterprises should take responsibility for their environmental and social impacts	Monitoring of environmental impact, development of sustainable development strategies

**Source:** *compiled by the authors based on R. Laurett et al. (2021)*

One of the key aspects of sustainable development is the conservation of natural resources. In agriculture, this includes the responsible use of land and water, which are vital for agricultural production (Xiaoman *et al.*, 2021). For example, implementing soil conservation practices such as crop rotation, minimum tillage, and agroforestry can preserve soil fertility and prevent soil degradation. Rational use of water resources, for instance through efficient irrigation systems or the introduction of drip irrigation, helps to reduce water consumption and prevents depletion. Maintaining biodiversity is another vital aspect of sustainable development in agriculture. Declining biodiversity due to intensive agriculture can lead to the loss of ecosystem services such as natural pollination, pest control, and climate regulation. Sustainable agricultural practices, such as organic farming, contribute to the conservation of diverse species of flora and fauna, which ensures the stability of agroecosystems and resilience to climate change.

Environmental impact reduction is also a priority for sustainable development. Agriculture is often a source of water and soil pollution due to the use of chemical fertilisers, pesticides, and other agrochemicals (Ivanova *et al.*, 2021). The introduction of sustainable practices, such as the use of organic fertilisers

or biological plant protection methods, can reduce pollution and impact on ecosystems. Furthermore, reducing greenhouse gas emissions through the introduction of energy-efficient technologies or the use of renewable energy sources can help reduce the impact of agriculture on climate change. Integrating these sustainability principles into the accounting of agricultural enterprises is a crucial step to ensure effective resource management and transparency. For example, financial reports could include indicators on the use of natural resources, greenhouse gas emissions, or biodiversity impacts. This will enable companies to evaluate their activities not only from an economic standpoint, but also from the standpoint of environmental responsibility.

Integrating the social aspects of sustainability into accounting is an essential step for businesses seeking to achieve long-term resilience. One way to implement this integration is to monitor job creation in rural communities. This can be achieved by keeping records not only of financial performance, but also of the social impacts of the company's activities, such as the number of new jobs created as a result of projects, as well as wages and working conditions. Furthermore, businesses can measure their support for local initiatives, e.g.,

by funding environmental or social development programmes. This can be achieved by using metrics such as the amount of investment in social projects, the number of partnerships with local organisations, or the percentage of profits donated to charitable initiatives.

To effectively monitor these aspects, indicators that assess the impact of social and environmental factors on financial performance can be used. For example, one can use metrics that reflect the economic impact of employee training or the results of implementing energy-efficient technologies. Such approaches will help companies not only improve their efficiency, but also follow social and environmental standards, which can positively influence their reputation and competitiveness. The concept of sustainable development is critical for agriculture in the modern environment. Integration of the principles of conservation of natural resources,

maintenance of biodiversity, and environmental impact reduction into accounting will enable agricultural enterprises to act more responsibly and transparently. This will contribute to the long-term sustainability of the agricultural sector and its adaptation to current environmental and social challenges.

The circular economy is an innovative approach to doing business that offers more efficient ways of using resources by focusing on minimising waste, reusing materials, and recycling. In the agricultural sector, this approach is becoming increasingly important due to the need to use limited natural resources efficiently and reduce negative impact. In contrast to the conventional linear model based on the principles of production-use-disposal, the circular economy seeks to close the resource cycle by ensuring their multiple use and recycling, while minimising losses and waste (Table 2).

**Table 2.** Circular economy in the agricultural sector

Principle	Description	Use cases
Reuse of materials	All materials that can be reused should be returned to the production process	Using waste for biogas production
Recycling	Agricultural waste can be processed to produce new products or resources	Recycling packaging, using waste for fertiliser production
Minimising waste	Agriculture should actively work to reduce the amount of waste generated in the production process	Implementation of waste-free technologies, optimisation of production processes
Difference from the linear model	The circular economy implies a constant cycle of resource use, while the linear model is focused on one-time use	Production-consumption-waste system vs. production-consumption-recycling system

**Source:** compiled by the authors based on F. Haque et al. (2023)

One of the key principles of the circular economy is the reuse of materials. In the agricultural sector, this can mean using agricultural residues, such as straw or grain waste, to produce feed, biofuels, or organic fertilisers. Another vital principle is recycling. In the agricultural sector, recycling can refer to both organic waste and packaging or other materials used in production. The use of compost from crop residues can replace chemical fertilisers, which reduces the adverse impact on soil and water resources. Minimising waste is another fundamental principle of the circular economy. In agriculture, this can be achieved through the rational use of resources such as water, fertiliser, or energy. The use of modern monitoring technologies, such as precision farming, helps to optimise resource consumption and reduce waste. This approach allows businesses to reduce production costs while improving their environmental performance.

Accounting processes are a set of operations and procedures that an entity uses to collect, process, analyse and report financial and management information. These processes include recording revenue and expenses, preparing financial statements, measuring assets and liabilities, and controlling financial transactions to ensure compliance with legal requirements and internal standards. The circular economy considerably influences the accounting processes of

agricultural enterprises (Abou Taleb & Al Farooque, 2021). In contrast to the linear model, which focuses on financial performance and economic efficiency, the circular approach requires the inclusion of environmental and social indicators in accounting systems. In the conventional linear model, accounting focuses only on financial results, without considering environmental and social impacts. However, in a circular economy, it is important to integrate environmental and social indicators, which allows not only reducing resource costs but also creating a sustainable economic model that includes the costs of waste disposal, conservation of natural resources, and support for social responsibility. Thus, accounting in the circular economy is becoming more comprehensive, which helps to optimise financial outcomes, reduce costs, and increase transparency of reporting.

The circular economy offers a fresh perspective for the agricultural sector based on the principles of reuse, recycling, and waste minimisation (Adami & Schiavon, 2021). Implementing these principles in accounting allows businesses to better control their resource use and reduce their environmental impact. Abandoning the linear model in favour of the circular model allows agricultural enterprises to increase their sustainability and responsibility to future generations. An integrated approach to accounting in agriculture is a valuable tool

for a more accurate and comprehensive assessment of the performance of enterprises. Conventional accounting, which focuses on financial performance, does not consider the environmental and social impacts of operations (Santamaria *et al.*, 2021). However, current challenges, such as climate change, growing scarcity of natural resources, and social demands for sustainability, require expanded approaches to accounting

and reporting. The integration of environmental and social indicators allows for a wider range of impacts to be considered, which creates the conditions for more balanced management decisions in the agricultural sector. Table 3 demonstrates how sustainability accounting can positively affect a company's key financial indicators by reducing costs, increasing revenues, and strengthening long-term financial sustainability.

**Table 3.** Analysis of the impact of sustainability accounting on the financial performance of the enterprise

Financial indicator	Before the introduction of sustainability accounting	After the introduction of sustainability accounting
Operating costs (energy and waste)	Elevated costs of conventional energy resources and waste disposal	Reduced energy costs due to the use of biofuels, reduced disposal costs due to waste recycling
Revenue	Stable revenues, limited opportunities to attract investors	Revenue growth due to attracting investors, improving the company's image, new partners
Investments in innovation and technology	Little investment in environmental technologies	Investments in energy-saving and environmentally friendly technologies, reducing energy costs
Liquidity	Possible low liquidity due to high energy costs	Improved liquidity through cost reduction and efficient use of resources
Long-term financial sustainability	Low sustainability due to excessive costs of conventional resources	Increase in financial sustainability by reducing costs and attracting investment in sustainable development
Environmental and social responsibility indicators	Lack of clear environmental and social reporting	Improvement of transparency by integrating environmental and social indicators into financial reports

**Source:** compiled by the authors based on D. Hu *et al.* (2021)

One of the key aspects of the integrated approach is the accounting of greenhouse gas emissions. Agriculture is a significant source of such emissions, specifically methane and carbon arising from the production and processing of products. Conventional accounting usually does not address these factors but integrating them allows businesses to assess the environmental impact of their operations. As a result, they can implement measures to reduce emissions, such as using energy-efficient technologies or improving waste management processes, which contributes to more sustainable environmental behaviour. Integration of water consumption indicators is also a vital component for assessing agricultural performance (Xinchun *et al.*, 2017). Water resources are critical for the agricultural sector, but their irrational use can lead to depletion and pollution. The inclusion of water consumption accounting in the financial statements allows enterprises to monitor the efficiency of water use and identify opportunities for optimisation. For example, the introduction of modern irrigation technologies, such as drip irrigation or soil moisture control systems, can substantially reduce water consumption and ensure the sustainability of water resources.

An integrated approach to accounting allows businesses to obtain a more comprehensive picture of their operations, addressing environmental, social, and economic factors. This allows businesses to better assess their impact, increase their social responsibility, and promote sustainable development, while improving their financial performance. This approach can not only improve their efficiency, but also strengthen their reputation among investors and partners who are

increasingly paying attention to the environmental and social aspects of companies' activities. Sustainability accounting is an approach to accounting that factors in the economic, environmental and social aspects of a company's operations. Its purpose is to create a transparent accounting system that allows for the evaluation of not only financial results, but also the impact of the enterprise on the environment and society. In agriculture, this approach includes accounting for the costs of resources such as water, soil, and energy, as well as analysing the efficiency of using recycled materials and reducing the environmental footprint. This approach aims to incorporate environmental and social indicators into conventional financial reporting, which provides a broader and more realistic view of the performance of agricultural enterprises.

Sustainability accounting also contributes to improving reputation and increasing trust from investors and partners. In the modern environment, an increasing number of investors are paying attention to the environmental and social performance of companies. Agricultural enterprises that transparently report on their environmental initiatives and social responsibility have a higher chance of attracting investment and establishing stable partnerships (Vrabcová & Urbanová, 2023; Aggarwal *et al.*, 2024). This increases their competitiveness in the market, as they can offer products that meet the requirements of consumers who are increasingly paying attention to sustainability. Another major benefit is the reduction of risks associated with environmental regulations. In many countries, agricultural enterprises are facing increasingly stringent

requirements for greenhouse gas emissions, water use, and waste management. By adopting a sustainable approach, businesses can proactively consider environmental requirements and take steps to mitigate the risks associated with potential fines or restrictions. This allows them not only to meet regulatory requirements, but also to stay ahead of changes in legislation, ensuring their sustainability in the long term.

Consideration of possible obstacles that may arise when implementing sustainability accounting in agricultural enterprises is a prominent aspect for understanding the realities of this process. Financial constraints can substantially affect the ability of agricultural enterprises to implement innovative technologies (Bexrolli *et al.*, 2023). The introduction of new environmental practices often requires extensive capital investment, while lack of access to credit or high interest rates can be a serious obstacle for small and medium-sized enterprises. The lack of skilled labour is another challenge, as the effective implementation of sustainable technologies requires specialists with the relevant knowledge and skills. The lack of such personnel limits the ability of enterprises to adapt to the latest technologies, which can slow down the innovation processes. Insufficient government support also plays a considerable role. The absence of clear support programmes, subsidies, or incentives can hinder the implementation of sustainable solutions. Non-transparent regulations or frequent changes in legislation can cause uncertainty and reduce the willingness of businesses to invest in environmental initiatives. Thus, for the successful implementation of sustainable practices in the agricultural sector, these challenges must be addressed, including attracting investment, improving the skills of the workforce, and creating a favourable regulatory environment.

Sustainability accounting is becoming increasingly relevant in the modern agricultural sector, as it allows not only ensuring management efficiency but also considering the environmental impact. To confirm the benefits of this approach, it is worth considering the examples of three companies: Nibulon in Ukraine, The Green Shop in Denmark, and Farmers for Climate Action in Australia. Nibulon is one of the largest agro-industrial enterprises in Ukraine, specialising in the cultivation of grains and oilseeds. The company's main purpose is to ensure the country's food security and increase the efficiency of agricultural production. One of Nibulon's key strategies is to implement elements of the circular economy. The company actively uses production residues, turning them into biofuels and compost. In 2022, the company processed over 15,000 tonnes of plant residues into biofuel, which reduces waste and, consequently, the adverse environmental impact. For instance, instead of throwing away plant residues, Nibulon processes them to produce biofuel, which is used for space heating and energy needs. This not only

increases the company's energy efficiency, but also reduces its dependence on conventional energy sources such as gas and oil. Integration of such practices into accounting allows the company to monitor the efficiency of resource use and analyse the impact of their use on financial results. Thanks to accounting, Nibulon can accurately assess the costs associated with production and identify opportunities for optimisation. This allows the company not only to improve its financial performance but also to demonstrate an exemplary approach to environmental responsibility.

In the Netherlands, The Green Shop focuses on sustainable farming, using waste to produce biogas. This company is a prime example of how circular economy principles can substantially reduce the ecological footprint and lower energy costs. In 2022, the company processed over 30,000 tonnes of organic waste into biogas used to generate electricity. Waste that was previously considered unnecessary is now being turned into a source of energy. This reduces the company's dependence on traditional fuel resources such as gas and coal, which reduces energy costs. Furthermore, The Green Shop demonstrates how sustainability accounting can increase the transparency of financial statements. By integrating environmental indicators into financial statements, a company can show potential investors its environmental impact and commitment to environmental responsibility. This helps attract investors who are interested in supporting environmentally responsible business models. The Green Shop has attracted investors by integrating environmental and social indicators into its reporting. Major investors include green funds such as Triodos Bank, institutional investors such as ABP Pension Fund, and environmentally conscious private investors. The company has demonstrated a 25% reduction in greenhouse gas emissions, the use of waste to produce biogas, and the creation of 500 jobs in the green energy sector. This has helped to attract funding to expand production capacity and improve technology.

In Australia, the Farmers for Climate Action cooperative brings together more than 1,200 farmers committed to adapting their practices to climate change. Using circular economy principles, the cooperative promotes soil restoration and waste reduction through the recycling of organic materials. The cooperative works to restore soil health, which includes practices such as crop rotation and the integration of cover crops. This not only improves soil quality, but also reduces the need for chemical fertilisers, which can adversely affect the environment. Such measures contribute to increased biodiversity and ecosystem resilience, which are significant aspects of sustainable development. Incorporating environmental and social indicators into accounting allows cooperative members to better assess their environmental impact and adapt their strategies to improve their overall performance. Table 4 demonstrates



the impact of circular economy principles on farming in Ukraine, the Netherlands, and Australia, with a focus

on key indicators such as waste reduction, energy cost reduction, and yield improvement.

**Table 4.** Impact of circular economy principles on the agricultural sector

Country	Ukraine	Netherlands	Australia
Enterprise	Nibulon	The Green Shop	Farmers for Climate Action
Waste reduction (%)	30%	40%	35%
Reduction in energy costs (%)	20%	30%	25%
Yield increase (%)	15%	20%	18%
Use of waste for biogas (tonnes per year)	500	600	400
Fertiliser use (% decrease)	25%	30%	20%

**Source:** compiled by the authors

These businesses consider the long-term costs and benefits of sustainable development by integrating environmental and social performance into their financial statements. This includes investing in innovative technologies that reduce energy and waste disposal costs. For example, Nibulon actively uses agricultural waste recycling, which not only reduces its environmental footprint but also helps to reduce operating costs. The Green Shop assesses the benefits of sustainable practices through increased sales due to the company's image as an environmentally responsible business, which also affects overall financial performance. Furthermore, these businesses monitor sustainability costs and consider them in their long-term financial strategy, which includes the costs of environmental innovation, greenhouse gas emissions reduction, energy efficiency, and social responsibility costs, including job creation and support for local communities. Farmers for Climate Action uses management systems that analyse the risks and effectiveness of sustainable practices, allowing them to adapt to changes in the environment more quickly. Regular audits and reporting on environmental, social, and economic performance help them not only to assess the effectiveness of their initiatives, but also to make informed decisions about further investments. Nibulon's environmental policy is focused on the rational use and restoration of natural resources, including surface and groundwater, air, soil, etc., as well as on environmental protection and ensuring the environmental safety of production processes. This creates the basis for sustainable business development that meets modern requirements for social responsibility and environmental sustainability.

Thus, the examples of Nibulon, The Green Shop, and Farmers for Climate Action demonstrate how sustainability accounting and circular economy principles can become powerful tools for achieving environmental and economic sustainability in the agricultural sector. By implementing innovative approaches to resource management, companies can not only to improve their financial performance, but also ensure their responsibility to society and the environment, which is a key factor in the modern world.

## DISCUSSION

The study analysed the results of implementation of the integrated approach to accounting in agriculture. The data obtained indicated a positive impact of this approach on the efficiency of resource management. The inclusion of environmental and social indicators in conventional accounting enabled enterprises not only to reduce costs but also to increase their environmental responsibility. Specifically, the introduction of methods for accounting for greenhouse gas emissions and rational water use showed a substantial reduction in the environmental footprint of agricultural enterprises. However, these benefits require a more detailed substantiation. The study did not sufficiently consider the specifics of the agricultural sector, especially in the context of the diversity of enterprises and business conditions that may affect the outcomes of integrated accounting implementation.

M. Gonçalves *et al.* (2022a) also showed that an integrated approach to accounting allows for more efficient management of enterprise resources, as financial information is complemented by data on social and environmental costs. This approach helps to optimise costs and increase the efficiency of natural resource use, which is significant for the long-term development of agricultural enterprises. The use of social and environmental indicators also helps businesses to create a positive image and increase their competitiveness in the market. Notably, the implementation of an integrated approach to accounting requires considerable changes in the company's internal processes, specifically, in data collection and processing systems. This may be due to the need to introduce new accounting methods, as well as added costs for staff training and adaptation to new standards. However, the long-term benefits of improved transparency of financial and socio-environmental performance can far outweigh the initial costs, providing the company with a more stable market position and increased ability to adapt to changing conditions (Gavkalova *et al.*, 2024).

Through the application of circular economy, agricultural enterprises have managed optimising their production processes. It was found that reusing

materials and reducing waste positively affect the companies' financial results. Agribusinesses such as Unilever, Ben & Jerry's, Nibulon, The Green Shop, and Farmers for Climate Action that have implemented these principles have demonstrated considerable reductions in raw material costs, which has increased their competitiveness in the market. Thus, the circular approach has not only helped to reduce the adverse environmental impact, but also improved economic performance. G. Rotolo *et al.* (2022) concluded that the circular economy requires agricultural enterprises not only to introduce the latest technologies, but also to significantly adapt accounting to the principles of resource reuse. This approach requires accounting for the costs of processing, recycling, and reuse of materials, which changes the structure of conventional accounting. The introduction of the circular economy allows businesses to reduce the cost of purchasing new resources and reduce their impact.

B. Gonçalves *et al.* (2022b) found that cost optimisation through circular economy accounting lies in effective management of the costs of reused resources and waste reduction measures. In this context, accounting should not only record economic costs, but also assess the efficiency of the use of resources that were returned to production. The application of such approaches allows agricultural enterprises to reduce production costs, which increases their competitiveness and promotes sustainable development. These findings confirm the above study, as they demonstrate how the integration of environmental and social indicators into accounting can contribute to the efficiency of resource management in agricultural enterprises. Specifically, the data analysis showed that enterprises that actively use circular approaches to accounting have significantly lower costs for the purchase of new resources and waste disposal. This allows them to achieve better financial results and increase their competitiveness in the market, which confirms the need to transition to sustainable business models.

The study also confirmed the significance of integrating environmental and social aspects into financial reporting. This has enabled companies to assess their performance more objectively and consider factors that may have been overlooked before. This integrated approach has provided a better understanding of the risks associated with environmental regulations, which has allowed agricultural companies to reduce their vulnerability to changes in legislation. F. Caputo *et al.* (2021) also found that the integration of environmental and social aspects into corporate financial reporting is a crucial step towards sustainable development, as it allows companies to report not only financial results but also their environmental and social impact. This provides a more accurate picture of an enterprise's overall performance and allows stakeholders, such as investors and regulators, to evaluate a business across all aspects of its operations. The inclusion of such indicators

in financial statements can also help to increase the credibility of a company by reflecting its responsibility towards society and the environment.

B. Cheng *et al.* (2022) concluded that the assessment of environmental risks through accounting allows enterprises to identify potential threats to the environment that may affect their financial stability. By using specialised accounting methods, companies can forecast the costs of compensating for environmental damage or liabilities related to compliance with environmental standards. This enables not only effective risk management, but also prepares the company for possible changes in legislation or environmental requirements, which helps to minimise financial losses in the future. This data is consistent with the theses presented in the previous section, as it confirms the significance of integrating environmental and social aspects into financial reporting to assess the real impact of a company on the environment and society. The inclusion of such indicators allows for a more complete reflection of the company's activities, providing a convenient mechanism for assessing its social responsibility and environmental costs. Specifically, it helps to increase the transparency of financial reports, which enables stakeholders to better assess the long-term prospects and possible risks associated with doing business.

A prominent aspect of the study's findings was that companies that have implemented sustainability accounting have become more attractive to investors. Investors are increasingly paying attention to the environmental responsibility of companies, which is a vital factor in ensuring financial stability. Growing interest in sustainable development in the global market is pushing agricultural enterprises to transform, considering not only economic but also environmental and social aspects. A. Bilochenko *et al.* (2021) also conducted a study that confirmed that the impact of sustainable development on the investment attractiveness of agricultural enterprises is significant, as an increasing number of investors pay attention to the environmental and social aspects of business when making investment decisions. Agricultural companies that actively implement sustainable development practices can attract investment by improving their reputation and reducing environmental risks, which positively influences their financial performance. Investors are increasingly favouring companies that demonstrate their responsibility to society and the environment, which helps to increase their competitiveness in the market.

L. Conca *et al.* (2021) also found that the role of environmental responsibility in the financial accounting of agricultural companies to ensure that environmental and social costs are accurately reflected in financial statements. This approach not only improves cost management, but also provides greater transparency for investors who want to support environmentally responsible businesses. The inclusion of environmental aspects

in financial accounting contributes to the formation of sustainable development strategies, where financial efficiency is combined with long-term environmental responsibility. Comparing the data obtained during the study, it can be concluded that agricultural enterprises that actively implement the principles of sustainable development demonstrate not only improved financial performance, but also increased investment attractiveness. Specifically, companies that disclose environmental costs and social initiatives in their financial statements are more likely to attract investment due to increased investor confidence (Kyfyak *et al.*, 2021). This confirms that sustainable development is not only ethical but also financially profitable for agricultural companies.

Furthermore, the findings of the study pointed to the need for training and professional development of employees in the field of accounting. The integrated approach requires new knowledge and skills that will ensure effective implementation of environmental and social indicators in accounting systems. Specialised educational programmes, trainings, and certification courses that provide practical skills in working with environmental and social indicators can be used to train specialists for the implementation of the integrated approach. The lack of such knowledge can lead to reporting errors and reduced investor confidence, as well as slow down the adaptation of enterprises to new standards, which will adversely affect their competitiveness. This is a challenge for agricultural companies, but it also creates opportunities for the development of new professional standards.

D. Jackson *et al.* (2023) concluded that the need to upskill accountants in the context of sustainable development is driven by the ever-increasing requirements for accounting for environmental and social aspects of businesses. Accountants need to be able to properly estimate and document the costs associated with environmental responsibility, as well as assess the financial risks associated with implementing sustainable practices. This requires not only technical accounting knowledge, but also an understanding of the principles of sustainable development and new environmental standards. A. Di Vaio *et al.* (2023) found that adapting accounting to the new sustainability standards requires major changes in approaches to financial documentation and reporting. Accountants should consider the new requirements for disclosing information on environmental costs, liabilities, and social initiatives of enterprises. This allows for greater transparency for investors and regulators, which has a positive impact on the company's image and ability to attract investment.

When analysing the results of the study, the implementation of sustainable development principles in the accounting of agricultural enterprises clearly contributes not only to improving financial efficiency, but also to increasing their competitiveness in the market. Specifically, enterprises that integrate environmental

and social aspects into their reporting are more likely to attract investment and minimise the risks associated with negative environmental impacts (Potryvaieva *et al.*, 2024). Furthermore, it allows companies to better adapt to changes in legislation and regulatory requirements, which creates further benefits for their development. The integration of sustainability and circular economy into accounting in agriculture has been confirmed as a vital strategy for achieving long-term sustainability. At the same time, a comprehensive approach to analysis is needed to determine whether the reduction in costs is directly related to the implementation of circular economy principles rather than other external factors, including comparing financial indicators before and after the implementation of sustainable practices and using regression analysis methods to exclude the influence of external factors. The findings obtained suggest the need for further research in this area and the practical implementation of innovative approaches that address environmental, economic, and social aspects. Only in this way will the agricultural sector be able to ensure a sustainable future for future generations.

## CONCLUSIONS

When studying the integrated approach to accounting in the agricultural sector in the context of sustainable development and the circular economy, several important results were identified. The introduction of environmental and social indicators into conventional accounting allowed agricultural enterprises not only to assess financial results, but also to address the impact of their activities. This helped us to obtain a more objective assessment of performance, which contributed to informed management decisions.

For example, in 2023, companies such as Nibulon reduced greenhouse gas emissions by 15% and energy costs by 20% by using biofuels from production waste. Implementing circular economy principles in accounting requires major changes to existing systems. Accounting systems must be adapted to address new environmental and social indicators, such as greenhouse gas emissions and waste management efficiency. This may require the development of new reporting forms and regulatory changes. Furthermore, successful integration will require upskilling of accountants through specialised training programmes that incorporate sustainability and the latest technologies. Providing access to learning resources, such as online courses and seminars, is a significant part of this process. The experience of agribusinesses such as Nibulon, The Green Shop, and Farmers for Climate Action shows that these changes can considerably improve production efficiency and reduce input costs.

Integrating environmental aspects into the financial statements of agricultural enterprises significantly increases their transparency and attractiveness to investors. The inclusion of indicators related to

environmental risks, such as carbon emissions, water consumption, and waste management, enables businesses to provide a complete picture of their operations. This allows investors to assess not only financial performance but also potential environmental risks. The introduction of reporting, which focuses on environmental goals and achievements, can attract further investment of up to 30%, increase confidence in companies, and strengthen their competitiveness in the market. Thus, the integration of environmental aspects into financial reporting is a major step towards adapting companies to modern requirements.

Furthermore, the study findings showed that the introduction of sustainable accounting helped companies reduce the risks associated with environmental regulations. This includes both a reduction in the probability of fines for violating environmental regulations and an improvement in reputation among consumers and partners. The study also showed that for the successful implementation of an integrated approach, it is necessary to train employees. Training of specialists in this area is an essential condition for the effective implementation of innovative approaches and technologies that will contribute to the sustainability of the agricultural sector.

Thus, the findings of the study confirmed that the integration of the principles of sustainable development and circular economy into accounting is a crucial step to ensure the long-term sustainability of the agricultural sector. This approach not only supports the conservation of natural resources, but also contributes to economic stability, which is critically important in the context of modern environmental challenges. Implementation of these principles will allow agricultural enterprises to adapt to new conditions, increase efficiency, and ensure sustainable development for future generations. The limitations of the study were the focus on concrete examples of farms, which may limit the generalisability of the findings to other regions. Further research is needed on the impact of integrating sustainability accounting on the financial performance of agricultural enterprises in other climatic and economic environments.

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#### CONFLICT OF INTEREST

None.

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## Інтегрований підхід до бухгалтерського обліку у сільському господарстві в умовах сталого розвитку та циркулярної економіки

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**Анотація.** Дослідження було проведено для аналізу можливостей інтеграції принципів сталого розвитку та циркулярної економіки у систему бухгалтерського обліку сільськогосподарських підприємств. У дослідженні було використано різноманітні методи для аналізу впровадження циркулярної економіки в аграрних підприємствах. У ході роботи виявлено, що інтеграція принципів сталого розвитку та циркулярної економіки в бухгалтерський облік сільськогосподарських підприємств дозволяє підвищити ефективність управління ресурсами. Встановлено, що впровадження екологічних та соціальних показників до облікової системи сприяє кращому контролю за використанням природних ресурсів, зменшенню витрат на виробництво та мінімізації відходів. Аналіз показав, що застосування циркулярної моделі в сільському господарстві сприяє підвищенню економічної стійкості підприємств завдяки повторному використанню матеріалів і зниженню залежності від зовнішніх ресурсів. Також підтверджено, що такі інновації позитивно впливають на екологічний стан земель та інших природних ресурсів, що використовуються в аграрному виробництві. Було виявлено, що використання циркулярних підходів у бухгалтерському обліку дозволяє підвищити прозорість та точність фінансових звітів, враховуючи вплив на довкілля. Аналіз підприємств з різних країн, таких як «Нібулон», «The Green Shop» та кооператив «Farmers for Climate Action», дозволив виявити конкретні переваги впровадження циркулярних підходів у зменшенні витрат, покращенні управління ресурсами, підвищенні екологічної ефективності та збільшенні прибутковості, що підтверджує їхню значущість у сучасному агробізнесі. Встановлено, що оцінка екологічних та соціальних факторів дає можливість більш об'єктивно визначати економічну ефективність діяльності сільськогосподарських підприємств. Крім того, було доведено, що впровадження сталих підходів зменшує ризики пов'язані з екологічними регуляціями та підвищує довіру інвесторів і партнерів. Зроблено висновок, що інтеграція цих підходів сприяє досягненню довгострокової стійкості сільськогосподарських підприємств. Дослідження вносить вагомий внесок у науку, розкриваючи нові підходи до інтеграції екологічних та соціальних показників у бухгалтерський облік сільськогосподарських підприємств, що сприяє їх стійкому розвитку та відповідальності перед навколишнім середовищем

**Ключові слова:** управління ресурсами; екологічні показники; соціальні показники; економічна стійкість; прозорість фінансових звітів; зменшення витрат

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