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Cost accounting and costing of crop production in agribusinesses of various forms of ownership

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► **Abstract.** The purpose of this study was to analyse the effectiveness of cost accounting methods and costing of production in crop enterprises of varying scales and forms of ownership. To achieve this aim, 5 agricultural enterprises in Ukraine engaged in crop production were examined: a small farm Zeleny Lan, a medium-sized farm Sonyachnyi Sad, a large agricultural holding AgroProstir, a cooperative enterprise Zernovy Kray, and a private enterprise Zolotyi Kolos. The research methods included an analysis of the financial statements of these enterprises for the period 2021-2023, the use of spreadsheets to structure data, and statistical analysis to assess cost variability. Particular attention was given to the comparison of costing methods, such as direct costing, the equivalent unit method, and automated accounting systems Debet+ and Enterprise Resource Planning (ERP). The impact of automation on the accuracy of calculations, transparency of financial transactions, and opportunities for cost optimisation was assessed. The challenges associated with manual accounting in small farms, the lack of integration of overhead costs in private enterprises, and the need for cooperation to reduce costs in medium-sized and cooperative enterprises were analysed. The paper proposes ways to improve accounting practices, including the implementation of

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automated cost accounting systems, standardisation of cost calculation, expansion of cooperative opportunities, and the development of innovative approaches to cost management using geoinformation technologies, the Internet of Things, and artificial intelligence. It is concluded that enhancing accounting methods is key to increasing the efficiency of agricultural enterprises and their adaptation to modern market conditions

▸ **Keywords:** agriculture; enterprise economics; resource management; cooperatives; seasonal costs; information systems

▸ Introduction

Cost accounting in crop production is a crucial aspect of effective agribusiness management, influencing the profitability of enterprises regardless of their size or form of ownership. The contemporary conditions of agricultural management – characterised by the introduction of new technologies and ongoing legislative changes – necessitate the continuous improvement of cost accounting methods. The core problem addressed in this study is the identification of optimal cost accounting approaches that can ensure accuracy, efficiency, and effectiveness in cost management across various types of agricultural enterprises.

V. Zhuk *et al.* (2023) analysed the consequences of Russia's military aggression against Ukrainian agribusiness, particularly focusing on the disruption of logistics and the destruction of industrial facilities. The authors proposed a simplified methodology based on five accounting tools – inventory, documentation, valuation, accounts and balance sheet, and reporting – to enable the rapid determination of direct losses. Experimental calculations demonstrated that the object-based methodology yields significantly higher and more reliable loss estimates (e.g., USD 63.88 billion for real estate) compared to the rapid global assessments conducted by organisations such as the World Bank. The study underscores the advantages of comprehensive expert evaluations over generalised assessments, advocating for their application in compensation and recovery processes.

N. Bondarenko & N. Rizchenko (2019) examined methods of accounting for costs and output in crop production, highlighting the necessity of implementing modern information systems to enhance accounting accuracy. The authors emphasised the importance of precise accounting of production costs and crop output to improve the efficiency of accounting practices in agricultural organisations. The competitive environment necessitates a detailed examination of sector-specific characteristics, including the utilisation of specialised labour resources, the influence of environmental factors, the length of production cycles, and the availability of standardised documentation and reporting (Musayeva *et al.*, 2024). A thorough understanding of these factors contributes to the timely provision of accurate and comprehensive data on the volume of produce, its pricing, and associated production costs, thereby supporting effective current, operational, and strategic management of agricultural enterprises.

O. Demchuk (2023) substantiates the necessity of assessing accounting costs from both financial and managerial perspectives, as well as recognising the influence of technological and agrobiological characteristics on the organisation of accounting. The study stresses the inclusion, within the unit cost of finished crop production calculated through the management accounting system, of not only actual resource expenditures but also estimated costs and lost profits. The study by I. Sukhonosenko & V. Gryn (2021) identifies the primary functions of accounting for agricultural production costs, with a particular focus on cost management and the monitoring of production activities. The authors underline the significance of treating costs as objects of both financial and managerial accounting, addressing contemporary challenges such as enhancing production efficiency and improving product quality. Additionally, the study considers the impact of external factors, particularly market volatility and insufficient material incentives. The authors emphasise the role of accounting as the principal means of obtaining reliable information essential for economic decision-making and risk forecasting in agricultural operations.

The study by H. Alkarawy & N. Al-Ssadi (2023) explores the assessment and structuring of production cost accounting and the regulation of biological costs in agriculture, alongside the verification of the accuracy of production cost calculations for the objective determination of cost indicators and management of production processes. Within an agricultural firm, biological costs were evaluated based on both the actual and fair value of products, enabling the identification of artificially reduced or inflated profits during the sale of produce. Additionally, production and sales costs were categorised by cost items, which enhanced the informational and administrative aspects of accounting and increased the overall efficiency of agricultural production.

Despite the substantial body of existing research, several gaps remain in the scientific literature that warrant further investigation. One such gap concerns the adaptation of cost accounting methods to the specific characteristics of different types of agricultural enterprises, including small farms and large agricultural holdings. Moreover, the impact of accounting process automation on the effectiveness of cost management remains insufficiently studied. The implementation of new technologies – particularly information systems for cost accounting – has the potential to significantly transform cost management practices (Hnatyshyn *et al.*, 2025), yet this area has not received adequate attention in academic discourse.

The literature analysis also highlights the need for the development of new accounting methods that reflect contemporary technological and economic changes. The integration of information systems into accounting processes can considerably enhance the accuracy and speed of data processing, which is vital for effective cost management (Marmul *et al.*, 2023). In light of these considerations, this study aims to analyse and improve existing cost accounting methods in crop production, as well as

to develop new approaches aligned with the current demands of agribusiness.

The objective of this research was to examine the features of cost accounting, its organisation, and the methods of calculating the cost of crop production in agricultural enterprises of various sizes and forms of ownership. To achieve this objective, the following tasks were undertaken: analysing existing approaches to cost accounting in crop enterprises; assessing the influence of enterprise size and ownership form on the organisation of cost accounting; developing recommendations for optimising product cost calculation.

▸ Materials and methods

In the conducted study, 5 agricultural enterprises in Ukraine engaged in crop production were selected. The research was conducted throughout 2023 and comprised several stages: data collection, data processing, and analysis of the results. The sample included agricultural enterprises of varying sizes and forms of ownership: a small farm Zelenyi Lan with a cultivated land area of up to 50 hectares (Clarity Project, 2022); a medium-sized farm Soniachnyi Sad with an area of 100-200 hectares (Clarity Project, 2023a); and a large agricultural holding AgroProstir with more than 1,000 hectares of cultivated land (Clarity Project, 2023b). In addition, a cooperative agricultural enterprise Zernovyi Krai (Clarity Project, 2023c) and a private agricultural enterprise Zolotyi Kolos, with an area of up to 500 hectares (Clarity Project, 2023d), were included in the analysis.

The inclusion criteria for the sample were: active involvement in crop production, availability of financial statements for the period 2021-2023, and willingness to cooperate and participate in the study. For the enterprise Zelenyi Lan, the analysis was conducted for the years 2021-2022, in contrast to the other enterprises, for which reporting data covered the period 2022-2023. This deviation was due to data availability limitations for Zelenyi Lan, which prevented full comparability across a uniform time frame. The study accounted for this limitation in the interpretation of results, and conclusions were adjusted accordingly to consider potential effects of economic changes between the different periods.

Data collection was conducted through the analysis of the official financial statements of the selected enterprises. These statements provided information on the structure of costs, methods of cost accounting, the utilisation of information systems, and the degree of automation in accounting processes. To supplement this information and gain a deeper understanding of internal operations, direct observation of accounting practices at the enterprises was undertaken. This facilitated a more detailed understanding of resource utilisation and cost management practices. A key focus of the analysis was the examination of cost accounting methods and the application of financial reporting standards. In small farms, national accounting systems with minimal automation were predominant, whereas large agricultural holdings employed international standards, enabling more detailed cost control and compliance with investor requirements.

Computers equipped with cost accounting software, such as Debet+ and SAP Enterprise Resource Planning (ERP), were used for both data collection and processing. Data were input into spreadsheets created using Microsoft Excel for subsequent analysis. The use of Microsoft Excel enabled convenient structuring and systematisation of the information, facilitating further statistical analysis. The analysis of the collected data employed various statistical techniques; in particular, correlation analysis was used to determine the relationship between the level of automation in accounting processes and the efficiency of cost management. The application of diverse methods of data collection and analysis provided a comprehensive overview of the state of cost accounting in crop production across agricultural enterprises in Ukraine. The study enabled the identification of key factors influencing the efficiency of cost accounting and helped to determine possible avenues for its optimisation.

▸ Results

Financial analysis of agricultural enterprises of different forms of ownership. The financial analysis of each enterprise commenced with an assessment of the structure of assets and liabilities. It was found that the micro-enterprise Zelenyi Lan has a significantly simpler asset structure compared to the other enterprises under study (Clarity Project, 2022). At both the beginning and end of the reporting period (2021-2022), the enterprise's assets consisted primarily of current assets, including inventories valued at UAH 5 thousand at the beginning of the year and UAH 8 thousand at the end. The absence of non-current assets indicates a limited level of investment activity within the enterprise. The liabilities of Zelenyi Lan also remained stable during the analysed period, with a modest increase in retained earnings from UAH 4 thousand to UAH 7 thousand. This reflects a positive financial outcome but suggests constrained potential for further expansion or development (Table 1).

Table 1. Structure of assets and liabilities of enterprises (thousands UAH)

Indicator	Zelenyi Lan (2021-2022)	Soniachnyi Sad (2022-2023)	AgroProstir (2022-2023)	Zernovyi Krai (2022-2023)	Zolotyi Kolos (2022-2023)
Fixed assets, thousand UAH	0	30.80	14,537	14,819	0
Current assets, thousand UAH	8	473.10	77	6,520	9
Equity, thousand UAH	7	-78.40	14,514	29,057	-538
Short-term liabilities, thousand UAH	0	582.30	100	15,135	666
Net profit (loss), thousand UAH	2	156.80	-32	-586	-17

Source: created by the authors

The small enterprise Soniachnyi Sad exhibited notable changes in its asset structure over the reporting period. At the beginning of the year, the enterprise did not possess fixed assets; however, by the end of the period, it had made substantial investments in the modernisation of production and expansion of its production capacity. This reflects the enterprise's commitment to development and improving operational efficiency. Simultaneously, a decrease in current assets may suggest a reduction in inventories or receivables, which is common when resources are actively allocated towards modernisation efforts. Despite these shifts, the enterprise successfully reduced its losses, indicating effective financial management and a gradual improvement in its financial standing. This case exemplifies how appropriate investment decisions can drive sustainable development, even under resource constraints (Clarity Project, 2023a).

AgroProstir, in contrast, maintained a substantial volume of non-current assets, indicative of prior large-scale investments in long-term assets such as equipment and infrastructure. However, no new investments were recorded during the reporting period, which may suggest either a temporary pause in investment activity or the absence of immediate capital needs. The decline in current assets may be attributed to reduced working capital or a fall in accounts receivable. The company's reported losses imply that it was unable to effectively leverage its resources to generate profit. Nevertheless, the considerable asset base suggests a potential to restore financial stability in the future, provided that management practices are improved (Clarity Project, 2023b).

Zernovyi Krai reported a significant increase in current assets, likely linked to an expanded customer base or increased sales on deferred payment terms. These developments may reflect the success of the enterprise's commercial strategies. However, the simultaneous rise in short-term liabilities indicates potential challenges in managing current assets and accounts payable. To ensure long-term sustainability, the enterprise must enhance its cash flow management to mitigate liquidity risks (Clarity Project, 2023c).

Zelenyi Lan, while demonstrating stable performance, continues to face constraints in development due to the absence of investment in long-term assets (Clarity Project, 2022). In contrast, Zolotyi Kolos requires urgent intervention to improve financial sustainability and restore profitability (Clarity Project, 2023d). The broader macroeconomic context remains a critical factor influencing the overall production costs faced by enterprises. For agricultural producers, the prices of fuel, lubricants, and energy are especially significant, as they constitute a major portion of expenditure. A 12% increase in energy prices over the reporting year had a marked impact on production costs across all surveyed enterprises. This effect was particularly pronounced for Soniachnyi Sad and Zernovyi Krai, both of which exhibit a high degree of mechanisation and operate with a large volume of equipment.

Features of cost accounting in crop production. Financial analysis of agricultural enterprises provides insights not only into their asset and liability structures but also into the effectiveness of cost management throughout the production cycle. The enterprises examined in this study demonstrate varying volumes and compositions of costs, which can be attributed to differences in their size, form of ownership, and the specific nature of their operations. Among the key cost-related aspects are seasonality, the use of fertilisers and fuel, and equipment depreciation, all of which significantly influence production costs.

The seasonality of costs in crop production has a pronounced impact on the structure and volume of financial investment in agricultural enterprises, particularly during the sowing, crop maintenance, and harvesting phases (Makhazhanova *et al.*, 2024). The sowing campaign is a period of heightened expenditure for all enterprises, marked by concentrated costs for seeds, fertilisers, and fuel. Zelenyi Lan, operating with limited resources, allocates a substantial portion of its budget – approximately 50-60% – to basic inputs such as seeds and fertilisers. The enterprise primarily relies on internal reserves or short-term loans to finance these expenses (Clarity Project, 2022). Soniachnyi Sad channels investment into the modernisation of machinery and the application of plant protection products, with approximately 55-60% of its annual expenditure directed toward increasing production efficiency and reducing costs in later stages (Clarity Project, 2023a). AgroProstir, the largest enterprise in the sample, invests heavily in hybrid seeds and operates a large fleet of machinery. The sowing campaign accounts for around 55% of its annual expenses (Clarity Project, 2023b). The cooperative Zernovyi Krai benefits from joint procurement arrangements, securing discounts on fertilisers and fuel, thereby reducing its overall expenses. Its sowing campaign constitutes approximately 50% of the annual budget (Clarity Project, 2023c). Zolotyi Kolos, facing financial difficulties and a high credit burden, spends about 60% of its annual expenditure on sowing. This significantly constrains its liquidity and hinders its ability to maintain stable operations throughout the year (Clarity Project, 2023d).

The next stage of the production cycle is crop care, which includes the costs associated with fertiliser application, plant protection, and inter-row tillage. In the micro-enterprise Zelenyi Lan, these costs remain moderate due to the use of simplified technologies, comprising approximately 15% of the annual budget (Clarity Project, 2022). Soniachnyi Sad invests in advanced agricultural technologies aimed at reducing expenditure on fertilisers and plant protection products, with these costs amounting to 18% of the annual budget (Clarity Project, 2023a). AgroProstir allocates significant resources to agricultural automation, which has enabled the optimisation of crop care expenses, maintaining them at around 15% of annual costs (Clarity Project, 2023b). Zernovyi Krai, benefiting from the cooperative model of investment distribution, achieves a similar level of efficiency, with crop care expenses representing 18% of the annual budget (Clarity Project, 2023c). Zolotyi Kolos, constrained by limited resources, utilises the most affordable plant protection products available, with crop care accounting for 20% of its annual expenditures (Clarity Project, 2023d).

At the harvesting stage, agricultural enterprises face high costs related to the use of machinery, fuel, and labour. In the case of Zelenyi Lan, harvesting expenses are

relatively low due to the limited production volume, with 15-20% of the annual budget allocated to the hiring of machinery. Soniachnyi Sad incurs fuel and labour costs amounting to 20-25% of its annual expenditure, reflecting its reliance on seasonal labour during the harvest period. AgroProstir allocates approximately 20% of its budget to harvesting, which includes significant outlays for fuel and machinery – some of which is rented due to the scale of operations (Clarity Project, 2023b). Through the cooperative use of machinery, Zernovyi Krai manages to reduce harvesting costs to 17% of its annual budget (Clarity Project, 2023c). Zolotyi Kolos, lacking its own equipment, is entirely dependent on machinery rentals, which increases its harvesting expenses to 25% of the annual budget (Clarity Project, 2023d).

The uneven distribution of costs throughout the year imposes a significant burden on financial turnover, often compelling enterprises to resort to loans or utilise internal reserves. This issue is particularly relevant for enterprises such as Soniachnyi Sad and Zolotyi Kolos, where seasonal financing needs lead to an increased credit burden. In contrast, AgroProstir, through the adoption of automation and innovative technologies, has succeeded in reducing operational costs, thereby contributing to the stabilisation of its financial position.

An examination of cost accounting practices reveals that Zelenyi Lan, a small farm cultivating up to 50 hectares, employs simplified accounting methods based primarily on Microsoft Excel. The enterprise focuses mainly on the calculation of direct costs – namely seeds, fertilisers, and fuel – which comprise over 50-60% of its annual budget. However, this approach has several limitations, including the absence of automation, the complexity of manual processes, and the inability to perform in-depth cost analysis. These shortcomings complicate financial management, particularly in the face of rising prices for fertilisers and energy. The implementation of even basic-level information systems could significantly enhance cost efficiency, enabling Zelenyi Lan to generate more accurate data for financial planning and control (Clarity Project, 2022).

The medium-sized farm Soniachnyi Sad (100-200 hectares) has achieved notable success through the implementation of the Debet+ system. This system enabled the automation of cost accounting at key production stages: sowing, crop care, and harvesting. The application of precision farming technologies facilitated optimal use of fertilisers and plant protection products, thereby reducing resource losses. Fertilisers and fuel represent approximately 40% of the enterprise's annual expenses. Debet+ contributes to the accuracy of financial data, minimises the risk of human error, and enhances decision-making in resource planning (Clarity Project, 2023a).

AgroProstir, a large agricultural holding managing over 1,000 hectares, utilises the SAP ERP system. This system integrates data across income, expenses, inventories, and production operations. A key advantage of ERP implementation is the ability to analyse costs in real time and automatically plan expenditure in accordance with seasonal fluctuations. In 2023, equipment and fertiliser costs constituted between 40-50% of the annual budget. Additional SAP modules support the consolidation of large-scale datasets and assist in identifying opportunities for cost reduction. Despite the high implementation and maintenance costs, investments in accounting automation enhance the competitiveness of the holding (Clarity Project, 2023b).

The cooperative enterprise Zernovyi Krai is in the process of modernising its information systems, transitioning from 1C to Debet+. Automation enables transparent accounting of cooperative expenditures and ensures an equitable distribution of costs among members. The principal expense category is fuel and technical support, which accounts for up to 17% of the annual budget. The adoption of precision farming technologies has led to a 15% reduction in fertiliser costs through optimised application. The cooperative model provides access to discounts and advanced technologies, thereby enhancing overall profitability (Clarity Project, 2023c).

The private agricultural enterprise Zolotyi Kolos (up to 500 hectares) operates with limited financial resources, which has resulted in manual accounting practices using Excel. A substantial share of its expenditure is allocated to fertilisers (60% of the budget) and equipment rental (up to 25%). The lack of automation increases the risk of ineffective planning and complicates cost control. Even the basic implementation of information systems could significantly improve accounting efficiency, reduce overall expenses, and enhance the enterprise 's liquidity (Table 2).

Table 2. Comparison of costs, automation and accounting features in agricultural enterprises

Enterprise	Accounting programme	Seeding campaign (% of budget)	Crop care (% of budget)	Harvest (% of budget)	Automation
Zelenyi Lan	Excel	50-60	15	15-20	None
Soniachnyi Sad	Debet+	55-60	18	20-25	Partial
AgroProstir	SAP ERP	55	15	20	Full
Zernovyi Krai	Debet+	50	18	17	Partial
Zolotyi Kolos	Excel	60	20	25	None

Source: created by the authors

Macroeconomic factors such as inflation, rising energy prices, and currency fluctuations have a significant impact on the cost structures and overall financial performance of agricultural enterprises in Ukraine. The analysis below illustrates how these factors have affected specific enterprises, based on relevant financial data. For the micro-enterprise Zelenyi Lan, inflation – which reached 8% – resulted in increased costs for essential inputs such as fertilisers and plant protection products (Clarity Project, 2022). This had a notable impact on the

enterprise's operating costs. Due to the absence of long-term contracts and limited capacity for bulk purchasing, Zelenyi Lan is unable to benefit from significant supplier discounts. Furthermore, a 5% increase in the exchange rate raised the cost of imported plant protection products, placing additional pressure on the enterprise's budget.

In the case of the medium-sized enterprise Soniachnyi Sad, the effects of inflation and a 12% increase in energy prices were more pronounced, owing to the enterprise's greater reliance on machinery and corresponding expenditure on fuel (Clarity Project, 2023a). Additionally, exchange rate volatility contributed to higher costs for imported fertilisers, which represent a substantial portion of the enterprise's expenses. To mitigate these challenges, Soniachnyi Sad has actively invested in precision agriculture technologies, aiming to reduce dependency on input volumes and optimise resource use. Nevertheless, intense competition in the domestic market has constrained the enterprise's ability to increase product prices, thereby reducing overall profitability.

As a large agricultural holding with access to export markets, AgroProstir has partially benefited from the devaluation of the national currency, which has increased its revenue in hryvnia terms. However, inflation at 8% and a 12% rise in energy prices have led to higher costs for fertilisers and plant protection products (Clarity Project, 2023b). The enterprise's substantial equipment inventory also results in significant energy expenditure. Consequently, management is actively considering the implementation of new technologies to optimise energy use and enhance the efficiency of cost management in order to mitigate the adverse impact of macroeconomic factors on overall financial performance.

The cooperative enterprise Zernovyi Krai has likewise benefited from the devaluation of the hryvnia, due to its export-oriented operations. Nevertheless, high energy prices and inflationary pressure have increased the cost of its resource base, creating a financial burden, particularly during the sowing campaign. Zernovyi Krai actively employs cooperative mechanisms to reduce the cost of fertiliser and fuel procurement, which partially offsets the impact of external economic pressures (Clarity Project, 2023c). In light of these challenges, the enterprise is also planning to invest in energy-efficient technologies that could contribute to long-term cost reduction.

In contrast, the private enterprise Zolotyi Kolos, which operates solely within the domestic market, does not benefit from currency fluctuations (Clarity Project, 2023d). Rising energy prices and inflation have driven up the costs of fertilisers and fuel, negatively affecting profitability. The enterprise is compelled to take out loans to finance its operating expenses, thereby increasing its reliance on credit and limiting opportunities for future development. Due to the absence of export activity, Zolotyi Kolos remains especially vulnerable to macroeconomic shocks and rising input costs, which it cannot consistently offset through price adjustments.

In summary, macroeconomic factors such as inflation, exchange rate volatility, and increasing energy costs affect agribusinesses differently depending on their size and market orientation. Export-oriented enterprises such as AgroProstir and Zernovyi Krai enjoy certain advantages from foreign exchange earnings, whereas domestically focused enterprises like Zolotyi Kolos are more heavily impacted by rising costs, which undermines their competitiveness and financial resilience.

Approaches to calculating the cost of production in agricultural enterprises of different sizes using information systems. Direct costs – such as seeds, fertilisers, and fuel – constitute the core of production expenditures in agricultural enterprises. However, the approach to cost accounting varies considerably depending on the size of the enterprise and the degree of digitalisation in use. At Zelenyi Lan, direct costs are calculated manually, with limited granularity. For instance, seeds are purchased without consideration of zonal requirements, and fertilisers are applied without reference to soil characteristics. All expenses are recorded as aggregate figures, which restricts opportunities for planning and cost optimisation. Furthermore, overhead costs – such as labour and equipment maintenance – are largely excluded from the accounting process. This omission compromises the accuracy and completeness of full production cost calculations, resulting in a less realistic financial picture.

In contrast, the medium-sized farm Soniachnyi Sad benefits from the implementation of the Debet+ accounting system, which enables more detailed and accurate cost tracking. Seed usage is accounted for by zone, reflecting the needs of specific field plots. Fertiliser requirements are calculated automatically based on agrochemical analyses, and the system presents cost data dynamically over time. In relation to fuel, Debet+ ensures transparent recording of transport and refuelling costs, which is particularly critical during the sowing campaign. Overhead costs, including logistics and maintenance, are allocated through automated modules, thereby enhancing the accuracy, transparency, and comprehensiveness of the enterprise's cost data.

In AgroProstir, both direct and overhead costs are integrated within a unified SAP ERP system, offering the highest level of detail and analytical capacity. For instance, the cost of hybrid seeds is calculated with consideration of transportation expenses and yield forecasts. Fertiliser requirements are determined through integration with a geographic information system (GIS), enabling tailored application based on the agrochemical characteristics of soils in each region. Overhead costs are automatically allocated via ERP modules according to crop area or production volume, encompassing logistics, equipment depreciation, and administrative expenses. This high level of automation enables real-time cost optimisation and supports strategic decision-making (Kuzub *et al.*, 2023).

The cooperative enterprise Zernovyi Krai employs the Debet+ system to facilitate joint procurement of seeds and fertilisers. Costs are allocated among cooperative members in proportion to the area of land cultivated. Fertilisers are used efficiently due to the centralised approach, allowing for considerable cost savings. Overhead expenses, such as machinery maintenance and logistics, are included and automatically distributed among members, promoting transparency and improving cost-efficiency across the cooperative.

By contrast, at Zolotyi Kolos, cost accounting remains highly simplified due to the absence of automated systems. Seeds and fertilisers are procured in minimal quantities,

and key overhead costs – including equipment depreciation and personnel expenditure – are largely overlooked. This results in reduced accuracy of cost calculations and hampers effective financial management. Elevated costs for fuel and machinery rental further intensify financial strain, increasing the enterprise's vulnerability and jeopardising its operational stability. Costing methods play a critical role in determining the accuracy of cost estimation and, ultimately, the financial efficiency of an enterprise. Depending on the scale of operations, the availability of automated systems, and the selected cost accounting strategy, agricultural enterprises adopt various approaches to determine production costs.

Zelenyi Lan employs a direct costing method. This is the most basic approach, allowing the enterprise to account only for primary cost items such as seeds, fertilisers, and fuel. Cost accounting is conducted without the allocation of overheads, significantly reducing the accuracy of total cost estimation. The absence of automation further limits the enterprise's ability to disaggregate costs by crop type or cultivated area. Although this method is suitable for small farms due to its minimal financial and technical requirements, it restricts strategic planning and hinders informed decision-making.

Zolotyi Kolos similarly relies on direct costing. Owing to financial constraints, the enterprise lacks access to automated systems and, therefore, performs all cost calculations manually. As a consequence, overhead costs – particularly those associated with equipment depreciation and maintenance – are either insufficiently considered or entirely excluded. This undermines the assessment of actual profitability and constrains the enterprise's capacity to accurately forecast and manage future expenses.

In contrast, Soniachnyi Sad complements direct costing with the functionalities of the Debet+ system. This system partially automates the costing process, accounting for seasonal cost fluctuations, field-specific conditions, and logistical expenses. As a result, the enterprise is able to include not only seeds and fertilisers but also pesticides, fuel, and administrative overheads in its cost analysis. This more comprehensive approach enables the farm to assess the profitability of individual crops more effectively and to reduce losses through the optimisation of field operations.

Large enterprises such as AgroProstir utilise the equivalent unit method, which provides a high degree of accuracy in cost calculations by incorporating both direct and overhead costs. The SAP ERP system automatically allocates these costs across different crops or plots by analysing yield, soil quality, and resource usage. This method enables the enterprise to assess the cost and profitability of individual crops, thereby informing strategic decisions. However, the implementation and maintenance of an ERP system entail substantial financial investment, rendering this approach largely inaccessible to smaller farms.

In Zernovyi Krai, cost calculation is performed through the automated Debet+ system, which facilitates the distribution of shared cooperative costs among participants. Centralised procurement of seeds, fertilisers, and fuel contributes to cost optimisation, while the system ensures transparent allocation. The cost calculation method is based on a proportional approach, wherein each member' costs are determined according to their respective land area. This supports the minimisation of losses and promotes the rational use of shared resources.

Automated systems such as Debet+ and ERP offer enhanced transparency and accuracy, significantly reducing the influence of human error (Table 3). For instance, Debet+ at Soniachnyi Sad enables the seasonal and zonal tracking of expenses – capabilities that are not available to enterprises relying on manual accounting. In large companies such as AgroProstir, ERP enhances the efficiency of cost calculations and facilitates the modelling of future expenditures. Conversely, enterprises without automation, such as Zolotyi Kolos, face considerable challenges in cost accounting, along with a heightened risk of errors. These limitations undermine financial planning and reduce overall operational efficiency.

Table 3. Comparison of cost calculation methods in enterprises of different scales and forms of ownership

Enterprise	Calculation method	Cost elements taken into account	Advantages/Disadvantages
Zelenyi Lan	Direct counting	Seeds, fertilisers, fuel	Easy to implement; no overhead costs
Soniachnyi Sad	Direct calculation + Debit+	Seeds, fertilisers, pesticides, fuel	Partial automation; takes seasonality into account
AgroProstir	Equivalent units method	All direct and overhead costs	High accuracy, high implementation cost
Zernovyi Krai	Debit+, basic distribution	Shared resources: machinery, fertilisers	Transparent distribution of costs between participants
Zolotyi Kolos	Direct counting	Fertilisers, fuel	Labour intensive, low accuracy

Source: created by the authors

The automation of costing is essential for the effective management of agricultural enterprises. Those utilising advanced methods – such as the equivalent unit method employed by AgroProstir – demonstrate greater accuracy in cost calculation and an enhanced capacity to analyse the profitability of individual products. For smaller enterprises, it is advisable to begin with the implementation of basic information systems. Even at a foundational level, such systems can significantly improve cost control and contribute to greater financial stability.

Ways to improve cost accounting and costing of crop production. Enterprises of all sizes should consider the phased introduction of automated accounting systems, tailored to their financial capacities. Small farms, such as Zelenyi Lan, are encouraged to adopt affordable software solutions – particularly basic versions of Debet+ – to

automate the recording of direct costs (seeds, fuel, fertilisers) and enhance the accuracy of cost calculations. For medium and large enterprises, such as Soniachnyi Sad and AgroProstir, it is advisable to implement specialised cost accounting modules within ERP systems. These should ideally be integrated with geographic information system (GIS) technologies to facilitate detailed zonal analysis and more precise cost allocation.

1. Standardisation of costing methods. There is a need to develop uniform methodological guidelines for cost calculation that are appropriate for enterprises of varying sizes. For small farms, a focus on direct cost accounting will ensure basic financial transparency and simplicity. Medium-sized enterprises should apply cost distribution methods by crop, incorporating considerations of seasonality and resource usage. For large agricultural holdings, the equivalent unit method – with an emphasis on real-time analytics and forecasting – is most suitable, supporting strategic planning and profitability analysis.

2. Optimisation of accounting processes through cooperation. Small enterprises are advised to form accounting cooperatives that offer shared access to automated systems and professional financial analysis. For instance, the creation of cooperatives comprising multiple farmers using a unified accounting platform such as Debet+ can significantly reduce the cost of software and data processing. This cooperative model enhances cost-efficiency, enables access to expert support, and promotes the adoption of modern accounting practices among smaller producers.

3. Integration of innovative technologies. Large agricultural holdings and medium-sized farms are well-positioned to adopt innovative accounting solutions, including artificial intelligence (AI)-based modules capable of forecasting costs and optimising resource consumption. The integration of Internet of Things (IoT) sensors in agricultural fields facilitates the automated collection of data on the agrochemical composition of soil, thereby enabling more accurate calculation of fertiliser requirements and improving overall cost efficiency.

4. Financial support for accounting automation. There is a clear need for the development of government support programmes to encourage the automation of accounting processes. Initiatives similar to the "Affordable Loans 5-7-9%" programme could be extended to include grants or low-interest loans for small and medium-sized agricultural enterprises. Such financial instruments would help alleviate the burden of initial investment in modern accounting systems and encourage broader adoption of digital technologies.

5. Development of training programmes for personnel. Staff training should be prioritised to ensure effective use of automated systems and modern accounting techniques. Specialised courses and training programmes for employees of agricultural enterprises – particularly accountants and agronomists – can significantly enhance awareness and understanding of advanced accounting tools, automated solutions, and data analytics in cost management. A skilled workforce is essential for maximising the benefits of technological integration.

6. Monitoring and regular review of accounting policies. Agricultural enterprises should conduct regular internal audits of their accounting policies and cost calculation methodologies. This ensures alignment with evolving market conditions, technological advancements, and legislative requirements. Continuous review promotes the relevance and reliability of financial data, supporting effective management and strategic planning.

The implementation of these measures will enhance the accuracy of accounting, the transparency of cost calculations, and the financial stability of agricultural enterprises, ultimately strengthening their competitiveness in the face of modern challenges.

International experience in optimising costs in agriculture through modern technologies. In European Union countries such as Germany and France, cost accounting methodologies in agriculture are undergoing significant modernisation, driven by the adoption of advanced information technologies (Gocht *et al.*, 2016). In Germany, the implementation of cost management software enables agricultural enterprises to automate accounting processes at every stage of the production cycle – from the procurement of raw materials to harvesting. This ensures both accuracy and transparency in determining production costs and supports more effective resource management (Hentschl *et al.*, 2023). French agricultural enterprises actively utilise ERP systems to integrate all aspects of their operations, thereby streamlining financial transactions and minimising operational costs. For example, the company Vignerons de la Méditerranée has implemented the SAP Business One ERP system to optimise business processes and reduce overall costs (Boussemart & Parvulescu, 2021). Such systems enable agricultural companies to reduce administrative expenses while enhancing production efficiency.

Modern information systems in the EU offers several key advantages. Firstly, they automate cost accounting procedures, significantly reducing the time required for data processing and the preparation of financial reports. This is particularly beneficial for large agricultural enterprises that handle substantial volumes of data. Secondly, these systems provide real-time access to financial and operational data, enabling managers to make timely and well-informed decisions regarding cost management and investment planning. The present study highlights that the automation of accounting operations enhances the accuracy of cost accounting and supports compliance with international standards. When agricultural enterprises implement modern technologies, they are better positioned to minimise operational costs and improve their overall competitiveness in a global market (Pushak *et al.*, 2021).

Strategic cost management in agribusiness in the United States and Canada is underpinned by the implementation of energy-efficient technologies and integrated resource management systems, which optimise energy and resource usage to enhance profitability. Numerous agricultural enterprises in the United States are investing in solar panels, geothermal heating and cooling systems, and energy recovery technologies (Clark, 2020). These innovations contribute significantly to the reduction of energy costs, which typically represent a major component of operating expenses in the agricultural sector. In parallel, farmers are adopting technologies to improve irrigation efficiency, thereby optimising water usage and minimising related costs. These strategies have

demonstrated substantial economic benefits. Despite increasing energy and resource prices, farmers are able to increase gross income by three to four times, raise profit margins by up to 2.5 times, and significantly reduce transportation and storage expenses. Investments in such technologies generally pay off within two to three years, while stable demand for agricultural products reduces financial risks and strengthens overall business profitability.

Canada is also progressively adopting strategies to reduce energy-related costs in agriculture (Jamil *et al.*, 2023). Agricultural enterprises are deploying advanced production management systems that automate energy storage and distribution operations. In addition, the adoption of smart farming technologies has enabled full automation and integration of agricultural activities – from soil data collection to energy consumption monitoring – within a unified management framework. This approach not only lowers operational costs but also improves production efficiency by enabling accurate forecasting and resource optimisation.

The current study underlines the value of investing in modernisation as a means of reducing production costs, as exemplified by Soniachnyi Sad. Similar to practices observed in the United States and Canada, the enterprise focuses on the adoption of modern technologies to reduce operational expenses. This demonstrates that, even under financial constraints, well-considered investments in energy efficiency can support sustainable development and enhance profitability. The broader implementation of such technologies in agriculture can increase competitiveness and ensure long-term financial resilience.

State support plays a vital role in the development of small and medium-sized agricultural enterprises in countries such as Spain and the Netherlands. Spain operates a comprehensive subsidy system aimed at supporting farmers engaged in organic agriculture, the use of renewable energy, and the implementation of environmentally friendly practices (Marini *et al.*, 2023). Subsidies are allocated for the modernisation of equipment, the adoption of new technologies, and the integration of precision farming systems. In addition, preferential credit schemes targeted at young farmers facilitate the creation of new agricultural enterprises and improve access to finance. Notably, the Programa de Desarrollo Rural (Rural Development Programme) in Spain provides funding for farmers who practise organic and environmentally sustainable agriculture. Similarly, the Green Climate Agreement in the Netherlands offers subsidies to support the transition to renewable energy and the reduction of CO_2 emissions in agriculture. These forms of government support enhance the competitiveness of farmers in domestic markets and aid their integration into international markets.

The Netherlands places particular emphasis on state initiatives that encourage innovation and environmental sustainability within the agricultural sector. Small farms receive financial assistance to implement advanced technologies, such as energy-efficient greenhouses, automated irrigation systems, and the use of biodegradable materials in agricultural production (Brazhnyk *et al.*, 2022). Across the European Union – particularly in countries such as Italy, Austria, Germany, France, Sweden, and Poland – specialised support programmes are available for farmers operating in regions with challenging climatic conditions. These include subsidies for mountainous areas, incentives for the adoption of renewable energy, agricultural insurance schemes, and funding for the development of sustainable farming technologies. Such initiatives contribute to the sustainability of agricultural production by helping farmers reduce operational costs, mitigate environmental and economic risks, and adapt to extreme weather conditions. An essential component of these support strategies is the provision of advisory services and training programmes delivered through state institutions. These initiatives equip farmers with the knowledge and skills necessary to adopt modern technologies and best practices in cost management, production efficiency, and sustainability.

This experience mirrors Ukrainian agribusiness support initiatives, which likewise provide subsidies and soft loans to small and medium-sized agricultural enterprises. Soniachnyi Sad, for instance, has utilised soft loans to expand its production capacity. During the reporting period, the enterprise secured financing through preferential loans, enabling investment in fixed assets – specifically, the acquisition of new equipment aimed at improving the efficiency of production processes. Owing to the favourable terms of this financing, including low interest rates, the company was able to enhance its production capabilities, which in turn led to increased productivity and reduced production costs. Such forms of state support enable farmers to access financing that might otherwise be unavailable due to limited financial resources. This strategy not only strengthens the position of small and medium-sized enterprises within the agricultural sector but also contributes to their long-term sustainability. It plays a crucial role in ensuring national food security and improving access to export markets.

▸ Discussion

The results of this study underscore the importance of adapting cost accounting methods to the specific characteristics of different types of agricultural enterprises. Using the example of small farms such as Zelenyi Lan, the research demonstrates that simplified accounting methods can be effective in ensuring operational stability. Conversely, large agricultural holdings require detailed and comprehensive cost accounting at each stage of the production process. This highlights the need for a differentiated approach to cost management, tailored to the scale and complexity of the enterprise.

N. Bondarenko & N. Rizchenko (2019) emphasised the significance of effective cost management and investment in fixed assets as a means of securing the financial stability of agricultural enterprises. The findings of the present study confirm this assertion through the example of Soniachnyi Sad, which achieved positive financial outcomes by investing in the modernisation and optimisation of its production processes. This case illustrates that, even in conditions of limited financial resources, stability and development can be attained through well-informed investment decisions. Similarly, O. Demchuk (2023) highlighted the importance of sound financial resource management in ensuring enterprise stability. The current study corroborates this view, particularly in the case of

AgroProstir, where inadequate management of current assets contributed to reduced liquidity and financial losses. This reinforces the necessity of strategic planning and the optimisation of financial resources to maintain the stability of large agricultural enterprises.

Moreover, the findings align with the conclusions of J. Tingey-Holyoak *et al.* (2023), whose research on decision-making processes in viticulture in Australia's Riverland region also identified the importance of modern technologies and automation in accounting practices for improving cost management efficiency. Both studies emphasise the role of access to timely and accurate accounting information, and the integration of data-driven technologies, in supporting strategic decision-making during periods of economic uncertainty. In particular, the example of Soniachnyi Sad demonstrates that investment in financial management automation can reduce costs and increase profitability, consistent with findings on the importance of accounting data in enhancing the sustainability of viticultural enterprises in the Riverland.

The study by L. Bassotto *et al.* (2022), which applies the theory of the firm to enhance cost management within the agricultural sector, reveals notable parallels with the findings presented in this article. Both studies highlight cost accounting as a fundamental tool for improving the economic efficiency of agricultural enterprises. In each case, the adopted methodologies distinguish between different types of costs – particularly cash and general costs – thereby enabling a more accurate analysis of the financial condition of enterprises (Boiko *et al.*, 2024). The findings of the present study reinforce the relevance of cost differentiation for improved resource management and the optimisation of financial indicators. This aligns with the Custeio Agro approach, which advocates for precise cost assessment in agriculture to support efficient management decisions.

The study by H.-Y. Lee *et al.* (2020), which explores the integration of green accounting through the lens of intellectual capital in agribusiness, reveals significant parallels with the findings presented in this article concerning the implementation of modern cost accounting methods. Both studies underscore the critical role of accounting systems in enhancing the efficiency of cost management and improving the financial performance of agricultural enterprises. The present article highlights that automation of accounting processes and the adoption of modern information systems contribute to cost reduction and increased competitiveness (Shevchuk & Radelytskyy, 2024). This aligns with the concept of green accounting, which integrates environmental costs and intellectual resources – such as innovation and organisational change – as essential components of sustainable agribusiness development. Both perspectives support the need for an interdisciplinary approach to simultaneously advance financial and environmental performance.

The study by A. Jayaraman *et al.* (2023), which analyses the role of social capital in farm production companies in India, also shares commonalities with the findings of this article on cost management in agricultural enterprises. Both studies stress the importance of interpersonal relationships, leadership, and organisational structure as critical factors for business success. In the Indian context, social capital – encompassing social networks and effective leadership – has been shown to enhance coordination and marketing capabilities. Similarly, this article emphasises that optimising accounting processes and automating cost management significantly contribute to improving the financial outcomes of agricultural enterprises. Together, these approaches demonstrate that effective enterprise management – whether driven by social capital or technological innovation – is fundamental to enhancing performance in the agricultural sector.

Thus, the research confirms that the implementation of modern information systems and the optimisation of cost accounting methods are key factors in enhancing the efficiency of agricultural enterprises, irrespective of their scale. This is particularly evident in large agricultural holdings, where the automation of accounting processes contributes to improved resource management and the minimisation of financial losses. At the same time, for small farms such as Zelenyi Lan, the adaptation of simplified accounting methods supports the maintenance of financial stability under resource-constrained conditions. Future research should focus on analysing the influence of external economic factors – such as inflation and exchange rate fluctuations – on the effectiveness of cost management. It is also advisable to develop practical recommendations for the adoption of innovative technologies in cost accounting, with a view to further strengthening the sustainability and competitiveness of agribusiness.

▸ Conclusions

The analysis of cost structures in Ukrainian crop enterprises reveals that cost accounting and costing practices vary significantly depending on the size of the enterprise, the degree of automation, and market orientation. Small farms are typically characterised by reliance on manual accounting and direct cost calculation methods, which reduce the precision of cost estimates and limit managerial capacity. Medium-sized enterprises benefit from the implementation of systems such as Debet+, which facilitate the structured allocation of both direct and overhead costs. Large enterprises, employing ERP systems, are able to conduct high-precision accounting and integrate cost data within a unified analytical framework for resource optimisation. The cooperative model used by Zernovyi Krai demonstrates the advantages of centralised cost management and equitable resource allocation among members, thereby enhancing both transparency and profitability.

The automation of accounting processes and the selection of appropriate costing methodologies are critical for effective management of crop enterprises across different scales. While small farms – such as Zelenyi Lan and Zolotyi Kolos – primarily rely on direct counting, which limits their accounting accuracy and decision-making capabilities, medium and large enterprises – such as Soniachnyi Sad and AgroProstir – employ automated Debet+ and ERP systems. These tools enable detailed, real-time cost tracking, transparent cost allocation, and rational management of overheads. The cooperative model of Zernovyi Krai further illustrates the financial and operational benefits of shared resource management. The results confirm that even basic automation

can serve as a crucial first step toward enhancing the competitiveness of small enterprises.

The adoption of improved cost accounting and costing methods is a vital mechanism for increasing the efficiency of agricultural enterprise management. The development of unified standards, expansion of automation, promotion of cooperative models, and integration of innovative technologies will collectively improve the accuracy of accounting and cost transparency. These measures will not only enhance enterprise profitability but also contribute to the broader development of the agricultural sector in the face of evolving market and macroeconomic challenges. Future research should explore models for adaptation to macroeconomic fluctuations, evaluate the effectiveness of state support measures, and examine the impact of emerging technologies on production costs.

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Облік витрат і калькулювання собівартості продукції рослинництва в агробізнесі різних форм власності

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► **Анотація.** Метою даного дослідження було проаналізувати ефективність методів обліку витрат і калькулювання собівартості продукції у підприємствах рослинництва різного масштабу та форми власності. Для досягнення мети було досліджено 5 аграрних підприємств в Україні, що займаються рослинництвом: мале фермерське господарство «Зелений Лан», середнє фермерське господарство «Сонячний Сад», великий агрохолдинг «АгроПростір», кооперативне підприємство «Зерновий Край» та приватне підприємство «Золотий Колос». Методи дослідження включали аналіз фінансової звітності цих підприємств за 2021-2023 роки, використання електронних таблиць для структурування даних та статистичний аналіз для оцінки варіабельності витрат. Особливу увагу приділено порівнянню методів калькулювання витрат, таких як прямий підрахунок, метод еквівалентних одиниць, автоматизовані облікові системи Дебет+ і Enterprise Resource Planning (ERP). Оцінено вплив автоматизації на точність розрахунків, прозорість фінансових операцій та можливості оптимізації витрат. Проаналізовано виклики, пов'язані із ручним обліком у малих господарствах, відсутністю інтеграції накладних витрат у приватних підприємствах та необхідністю кооперації для зниження собівартості в середніх і кооперативних підприємствах. У роботі запропоновано шляхи вдосконалення обліку, включаючи впровадження автоматизованих систем обліку витрат, стандартизацію калькуляції собівартості, розширення можливостей для кооперації та розвиток інноваційних підходів до управління витратами за допомогою геоінформаційних технологій, Інтернету речей і штучного інтелекту. Зроблено висновок про те, що удосконалення методів обліку є запорукою підвищення ефективності агропідприємств та їхньої адаптації до сучасних ринкових умов

► **Ключові слова:** сільське господарство; економіка підприємства; управління ресурсами; кооперативи; сезонні витрати; інформаційні системи