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The use of outsourcing in the public service delivery system to enhance the efficiency of agricultural production

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Abstract. Outsourcing in agriculture is a key tool for improving resource management efficiency, facilitating the implementation of innovative technologies, and reducing costs. In Ukraine, where the agricultural sector constitutes a significant share of the gross domestic product, evaluating the efficiency of such models is essential to ensuring the competitiveness of farms. This study focused on analysing the economic efficiency of outsourcing agrochemical soil services, satellite monitoring, and the adoption of precision farming, as well as assessing the impact of public-private partnerships. Statistical and comparative analyses were applied, including data from Ukrainian companies such as AgriLab and international practices. The analysis was based on data on costs, yields, and the efficiency of agricultural infrastructure over the period 2019-2024. The results indicate that soil maintenance costs decreased from 98 EUR/ha in 2019 to 84 EUR/ha in 2024, reflecting a 14% cost reduction. Administrative expenses fell by 25%, while overall agricultural infrastructure costs in Ukraine declined from UAH 5 billion to UAH 3.5 billion (a 30% reduction). The use of precision farming increased yields by 15-20%, depending on the crop, while fertiliser savings amounted to 20%. The implementation of outsourcing and innovative technologies ensures cost reduction and improved efficiency for farms. In particular, outsourcing significantly optimises production processes, as evidenced by an 18% increase in wheat and maize yields following the adoption of field zoning recommendations

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and precision fertiliser application. The findings can be used to develop government support strategies, implement outsourcing models, and promote the sustainable development of Ukraine's agricultural sector

Keywords: agricultural sector; cost optimisation; precision farming; farms; soil analysis; yield improvement

INTRODUCTION

With the rapid development of the agricultural sector and the need to enhance resource efficiency, outsourcing has become one of the key tools for optimising production processes. The trend towards adopting innovative technologies, particularly precision farming, significantly reduces the costs of maintaining agricultural infrastructure and ensures a steady increase in yields. This is particularly relevant for many countries, including Ukraine, where agricultural development plays a crucial role in the national economy. Studies highlight the significant economic potential of outsourcing in the agricultural sector. For instance, F. Andersson *et al.* (2019) emphasise the importance of balancing cost and quality in outsourcing services in agriculture, allowing for increased efficiency in production processes. Similarly, Q. Mi *et al.* (2020) found that engaging external service providers in production helps improve the well-being of small farmers by reducing their production costs and increasing profitability. The experiences of the Netherlands and China demonstrate the prospects of implementing outsourcing models to enhance agricultural sector productivity.

Ukraine is also actively adopting new approaches to managing agricultural infrastructure by incorporating outsourcing services. The potential of such changes is confirmed by N. Potryvaieva & A. Palieiev (2023), who highlight outsourcing as an effective tool for reducing operational costs and increasing business competitiveness. In the research of L.Z. Buranbaeva *et al.* (2020), the emphasis is placed on the importance of cooperation between enterprises to ensure sustainable development and reduce environmental impact. V. Shebanin *et al.* (2022) stress the significance of implementing closed-loop technologies for the sustainable development of socio-economic systems. The authors underline that adopting innovative approaches through outsourcing models contributes to cost reduction and enhances the environmental efficiency of agricultural enterprises.

The study by T. Reardon *et al.* (2024) focuses on outsourcing as a mechanism for transforming agricultural production on a global scale through access to cutting-edge technologies and increased productivity. The authors examine the role of outsourcing services in helping farmers adapt to new value-added chains. Research by L. Shi *et al.* (2024) suggests that with government support, the implementation of "green" technologies through outsourcing becomes more accessible for farmers, reducing their carbon footprint and increasing production efficiency. G. Nguyen *et al.* (2022) conducted a statistical analysis of outsourcing in France's agricultural sector, identifying it as a growing trend. Their study revealed that farmers are increasingly outsourcing tasks such as equipment maintenance, allowing them to optimise costs.

J. Jiafang & Y. Junxiao (2022) highlight the importance of socialising agricultural machinery services in China to improve the management of large land areas. They note that outsourcing technical services enables farmers to utilise resources more effectively and expand cultivated areas. S. Xie *et al.* (2023) explore the impact of farmers' participation in outsourcing services on production levels and risks. Using case studies of farms in China, they demonstrate that outsourcing increases production volumes through access to advanced technologies while also helping to mitigate agricultural risks. Thus, the aim of this study was to analyse the economic efficiency of outsourcing models in Ukraine's agricultural infrastructure, particularly in terms of reducing agrochemical service costs, increasing yields, and adopting innovative technologies.

MATERIALS AND METHODS

The study was conducted using an empirical approach to analysing outsourcing practices in the field of agricultural infrastructure maintenance, including soil analysis and consultancy on innovative technologies. The analysis was based on data on costs, yields and efficiency of agricultural infrastructure for the period 2019-2024. The key legislative acts of Ukraine have been considered: Law of Ukraine No. 922 (2015) – ensures transparency in the selection of private service providers. Law of Ukraine No. 2404-VI (2010) – regulates the principles of cooperation between the state and the private sector. Resolution of the Cabinet of Ministers of Ukraine No. 102 (2021) – promotes the introduction of innovations in agriculture. State support programmes for farmers, particularly the "Affordable Loans 5-7-9%" programme, encourage farmers to collaborate with private companies to implement innovations (Ministry of Finance..., 2022). Decentralisation Reform (n.d.) – allowed local communities to enter

into agreements with private companies for the maintenance of agricultural infrastructure. EU directives under the Association Agreement between the European Union and its Member States, on the One Part, and Ukraine, on the Other Part (2014), particularly the directives on environmentally sustainable agriculture, encourage the involvement of innovations through the private sector.

The experience of Ukrainian companies has been analysed, including: AgriLab – a leading Ukrainian company that offers comprehensive agrodiagnostic services, including agrochemical soil analysis, satellite monitoring, and fertilisation recommendations to increase crop yield based on geoinformation data. National Scientific Center "Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky" – a state institution that collaborates with private companies within soil analysis programmes for precision agriculture. The "AgroRegion" group of companies – implements AgriLab's recommendations to optimise fertilisation, using field zoning and a differentiated approach to field processing.

The activities of European companies were studied, such as: SoilCares (AgroCares) (Netherlands) – an international company from the Netherlands that specialises in soil analysis, using advanced technologies such as Lab-in-a-Box and Soil Scanner. These portable solutions enable farmers to obtain real-time data on soil micro- and macro-elements. The company provides fertilisation recommendations, helping to optimise costs and increase crop yields. SoilCares also works on local adaptation of its technologies in various regions of the world, including countries in Africa, Latin America, and Asia. Société Générale de Surveillance (SGS) (Switzerland) – a Swiss company that is a global leader in inspection, verification, testing, and certification, offering a full range of agricultural services. Its agricultural division provides soil analysis, evaluates soil fertility and condition, and offers recommendations for precision agriculture. SGS uses advanced laboratories to quickly and accurately determine the physical and chemical properties of soils, optimising fertiliser use and reducing environmental impact.

Analysis methods: statistical analysis – applied to process data on the economic efficiency of outsourcing models. Official reports from the Reports on the work of the Ministry of Agrarian Policy (2025) were used. An analysis was carried out on changes in state expenditures on agricultural infrastructure before and after the implementation of outsourcing, as well as the impact of these changes on crop yields; comparative analysis – analysed Ukrainian and international experience to identify best practices for implementing outsourcing solutions.

Tools described in the study: satellite monitoring and geoinformation systems for assessing soil quality, specifically EOSDA Crop Monitoring; portable laboratories such as AgroCares SoilCares Manager (12-month licence) & Handheld Scanner; IT platforms, including "MyAg riLab", for agronomic planning. The methodology allowed for the assessment of outsourcing efficiency in agriculture, particularly reducing government spending and increasing crop yields through the rational use of resources.

RESULTS

Outsourcing of services in agricultural infrastructure significantly reduces government spending on maintenance and support of agricultural infrastructure, particularly in the context of soil analysis and the implementation of innnovative technologies. A comparison of expenses before and after the introduction of outsourcing models in Ukraine shows a significant reduction in costs for agrochemical services (Aranchii & Ihnatenko, 2021). Specifically, according to AgriLab, which provides agrochemical soil analysis and satellite monitoring services, the cost of soil maintenance using outsourcing services can be reduced by 20-30% compared to traditional management methods. This is achieved through precise and timely fertiliser application, field zoning, and optimisation of agronomic processes.

Additionally, according to the Reports on the work of the Ministry of Agrarian Policy (2025), the introduction of outsourcing allows for a reduction in administrative costs, as many functions previously handled by government agencies are transferred to the private sector. This includes not only soil maintenance but also consulting services for farmers, which reduces infrastructure costs by 25-30% through improved efficiency and better use of relevant technologies.

The implementation of outsourcing models for soil analysis and fertilisation recommendations significantly increases agricultural production efficiency, particularly in terms of increased crop yields. The application of innovative solutions allows for the acquisition of accurate data on soil conditions, enabling more precise fertiliser application and maximising the use of available resources. According to AgriLab and studies within precision farming programmes, yield increases of 15-20% have been observed across various crops after implementing recommendations based on soil analysis and satellite monitoring. For example, in the case of wheat and maize in Ukraine, the use of precision farming technology resulted in an average yield increase of 18%, while fertiliser savings amounted to about 20% (Ministry of Agrarian…, 2024). On the other hand,

international companies such as SGS (Switzerland) also demonstrate positive results when using advanced soil analysis technologies and fertilisation recommendations. For instance, the use of laboratories and accurate soil condition data led to a 15% increase in yield on fields where these technologies were applied, compared to traditional processing methods. This approach not only reduces fertiliser costs but also improves long-term soil fertility.

Ukrainian laws have created a legal framework for effective interaction between state institutions and private companies. This is particularly important in the agricultural infrastructure sector, where the involvement of private service providers promotes increased productivity. Public procurement transparency: Law of Ukraine No. 922 (2015) ensures competitive conditions for selecting suppliers. The use of the electronic procurement system (Prozorro) reduced the average time to conclude contracts to 21 days in 2024, which is 15% faster compared to 2021 (Resolution of the..., 2021). This enables faster implementation of innovations in the agricultural sector. Public-private partnership mechanisms: Law of Ukraine No. 2404-VI (2010) stimulates investment in innovative technologies, for example, through the transfer of soil analysis services to private companies. These agreements reduce state administrative costs by 20-25%, as functions are delegated to more competent specialised organisations.

The contribution of the "Affordable Loans 5-7-9%" programme. This state support programme is an important tool for helping small and medium-sized agricultural enterprises in Ukraine, promoting their financial stability, the implementation of new agricultural technologies, and increasing agricultural production efficiency. It provides preferential loans with low interest rates (5-9%), allowing farmers to significantly reduce financial burdens and more effectively utilise resources for the development of their farms. Thanks to these preferential loan rates (5-9%), farmers have been able to reduce financing costs, which allowed them to increase investments in innovative technologies. This has been a key factor in ensuring economic growth and increased productivity for agricultural enterprises in various regions of the country.

A prominent example of successful programme implementation is Odesa region, where more than UAH 1.2 billion was allocated under the programme. This enabled local agricultural enterprises to implement innovative technologies to increase yields and farming efficiency. It has been noted that even small farms in the region were able to access advanced agro-technologies, such as precision farming systems, allowing them to achieve significant yield increases per unit area. This confirms that state-level support programmes are an effective tool for stimulating the development of agricultural enterprises even in rural areas, where small farmers do not always have the means to finance innovations independently.

"Affordable Loans 5-7-9%" not only support the development of technologies in the agricultural sector but also provide an economic benefit to the entire industry (Ministry of Finance..., 2022). Investments in agricultural machinery and innovations improve the competitiveness of Ukrainian farmers on both domestic and international markets. The programme also creates co nditions for the development of sustainable agriculture, reducing dependence on the import of technologies and equipment, and promoting the growth of agricultural product exports. Importantly, the implementation of such programmes contributes not only to the development of individual farms but also to strengthening the economies of regions where agriculture is the primary sector. Overall, this programme has proven to be an effective tool for stimulating the development of agriculture in Ukraine by providing access to financing and encouraging the implementation of innovations, which in turn enhances the competitiveness of agricultural enterprises in domestic and international markets.

The cooperation of AgroRegion with the state farmer support programme "Affordable Loans 5-7-9" has significantly eased access to financing, ensuring the purchase of precision farming technologies. The programme has demonstrated substantial results in Ukraine's agricultural sector. According to the Ministry of Agrarian Policy and Food of Ukraine, in 2024, approximately 7,600 agricultural enterprises received loans totalling UAH 39.4 billion. These funds were used to modernise technical infrastructure, develop precision farming, conduct soil analysis, and purchase new equipment. AgriLab has become one of the leaders in the field of agrochemical soil analysis, offering farmers efficient solutions for optimising costs and increasing crop yields. Thanks to accurate analysis of the physical and chemical properties of soils, its services allow for rationalising the use of fertilisers and resources. Specifically, field zoning and individual recommendations help reduce fertiliser costs by 20%. In projects such as soybean cultivation in western Ukraine, after agrodiagnostics, fertiliser costs dropped from EUR 98/ha to EUR 84/ha (Fig. 1). Furthermore, due to the implementation of AgriLab's approaches, there was a 15% increase in yield. The analysis showed that accurate fertiliser selection based on the actual needs of soils increases the effectiveness of nutrition systems and allows for consistently higher yields.

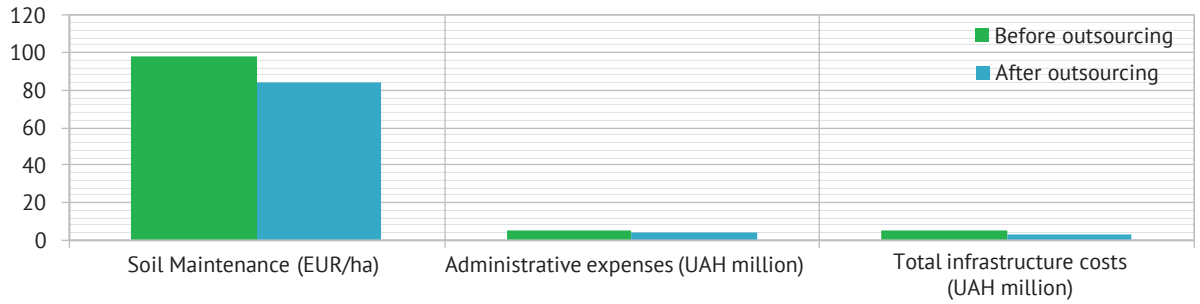

Figure 1. *Comparison of agrochemical service costs before and after outsourcing in Ukraine*
Source: *compiled by the authors based on Reports on the work of the Ministry of Agrarian Policy (2025)*

Project "Agrocultura Mostyska" In Lviv Region, AgriLab conducted agrodiagnostics on a 1,000 ha plot used for growing soybeans. The analysis revealed an issue with low soil pH in certain areas, which significantly impacted productivity. The use of GPS-linked zoning enabled the precise identification of problematic areas, and laboratory analysis indicated the need for soil liming to improve fertility. Recommendations for localised fertilisation were provided to reduce costs. Economic Results: excluding unprofitable areas from cultivation helped optimise production processes. Adhering to the recommendations reduced fertiliser costs, and as a result, overall yield on suitable areas increased by 3%. This case demonstrates the importance of field zoning as an economically effective tool for agriculture. Thanks to zoning, farmers were able to achieve higher productivity without increasing overall costs.

"Loretta Agro" in Khmelnytskyi Region focused on restoring long-neglected lands for active use. By using agrochemical soil analysis, the company obtained valuable information that helped develop an effective strategy. The lands, which had not been cultivated for a long time, had low nitrogen levels and significant erosion problems. A technological map was developed, which included recommendations for nitrogen and other micronutrient applications according to the needs of specific areas. The first harvests on the "restored" lands were high, even in adverse weather conditions. The correct proportions of fertiliser helped minimise the costs of crop nutrition while ensuring stable yield growth. The results of this case highlight the importance of using a comprehensive agrodiagnostic approach to cultivate land previously considered unsuitable. The innovative solutions provided by AgriLab allowed the restoration of productivity on these lands without excessive investment.

Both cases illustrate how the use of cutting-edge technologies and a scientific approach enhances the economic and ecological efficiency of agricultural production. They confirm that precision farming can bring not only economic benefits but also ensure sustainable management of natural resources. The technologies used by AgriLab include satellite monitoring of crop conditions and the creation of geographic information maps for agronomic planning. These tools allow for: identifying heterogeneities in soil structure and optimising fertiliser application by zones; reducing unnecessary field treatment costs; and obtaining real-time data for making quick decisions regarding nutrient systems. The additional economic efficiency is achieved by reducing the misallocation of resources through process automation and shortening the time required for decision-making, thanks to the prompt analysis of satellite data.

AgroRegion actively collaborates with AgriLab, implementing precision farming recommendations and optimising fertilisation practices. Their methods demonstrate significant improvements in financial and operational efficiency. Examples of this include increased farm profitability. Thanks to the introduction of a precision fertiliser application system based on agrochemical soil analysis, the profitability of farms increased by an average of 18%. This was made possible by using analysis data to create individual fertilisation maps and optimising field zoning, which allows for more efficient resource distribution and reducing costs on unjustified agrochemical operations. The use of satellite monitoring and geographic information systems reduced costs on agrochemicals by 20%, which was achieved through accurate calculation of soil nutrient needs and the rational use of natural resources. In turn, technologies like satellite monitoring and field zoning not only increased yield but also ensured sustainable land resource management. This approach enables high results even under adverse climatic and market conditions. Thus, AgroRegion serves as an example of successful innovation in agriculture, promoting increased profitability and ecological sustainability of farming operations.

The National Scientific Centre "Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky" plays a key role in the development of precision farming programmes in Ukraine. Its activities

focus on integrating scientific research with the practical needs of the agricultural sector, particularly through collaboration with private companies. The centre conducts a wide range of soil research, including agrochemical analysis, evaluation of physico-chemical properties, and monitoring changes in soil structure. This research helps farmers adapt their technological approaches to local conditions, including optimising fertilisation systems by analysing the micro- and macro-element composition of soil, as well as using geographic information systems for field zoning, which reduces fertiliser costs by 15-20%. The centre collaborates with companies such as AgriLab to provide farmers with access to new soil analysis methods and precision farming recommendations. This allows for the scaling of precision farming practices throughout Ukraine, contributing to a 10-15% increase in yield, depending on the crop. Thanks to government support programmes, the centre coordinates between scientific institutes, farmers, and private companies, facilitating the integration of innovative technologies into the agricultural infrastructure. Therefore, outsourcing significantly reduces costs both in Ukraine and abroad. At the same time, such models contribute to yield growth by implementing precision farming and new technologies (Table 1). Data shows that state expenditures on soil maintenance under outsourcing have decreased from UAH 5.2 billion in 2019 to UAH 3.9 billion in 2024.

Table 1. *Comparison of costs, yield, and resource savings in different management models*

Indicator	Traditional mode	Ousourcing	Precision farming
Soil maintenance costs (EUR/ha)	98	84	78
Administrative costs for soil maintenance (million UAH))	5.2	3.9	3.2
Total costs for agricultural infrastructure (billion UAH)	5	3.5	3.1
Yield growth (average, %)	-	15-20%	18-25%
Fertiliser savings (%)	-	20%	25%
Data processing and planning time (days)	7-10	3-5	1-2

Source: *compiled by the authors based on data from AgriLab, Precision Farming Study based on Reports on the work of the Ministry of Agrarian Policy (2025)*

International experience. SoilCares (Netherlands) is part of the AgroCares group and specialises in the development of portable laboratories and scanners for real-time soil analysis. These technologies significantly simplify and reduce the cost of analysis. The company has developed devices such as Lab-in-a-Box and Soil Scanner, which provide data on the micro- and macro-element composition of soil in just minutes, reducing soil analysis costs by up to 40% compared to traditional methods. This is particularly relevant for small farms. SoilCares is implementing its solutions in Africa, Asia, and Latin America, where their technologies help significantly improve yields even in challenging climatic conditions. In the Netherlands, farmers report a 20-25% reduction in fertiliser costs thanks to recommendations created based on scanner data.

SGS (Switzerland) is a global leader in soil analysis, certification, and agrotechnologies. The company offers comprehensive services that optimise fertiliser use and reduce environmental impact. SGS uses laboratories for fast and accurate analysis of physical and chemical properties of soils. Their services help reduce excessive fertiliser use, cutting costs by 15-20% and promoting soil fertility preservation. SGS is actively implementing solutions to reduce environmental impact, such as soil monitoring and recommendations for eco-friendly land treatment technologies, and supporting organic farming programs through precise fertility analysis and natural fertilisation recommendations.

These examples demonstrate how innovative approaches and international experience can be integrated into Ukrainian agriculture to increase efficiency, save resources, and protect the environment. Analysis of Technology Efficiency. Satellite technologies, particularly EOSDA Crop Monitoring, significantly improve the accuracy of agrodiagnostics, positively affecting agricultural process management. Zoning accuracy is ensured by using vegetation indices such as NDVI, which allows the identification of uneven crop development across different areas of the field. This enables precise fertiliser and plant protection applications, reducing costs by 15-20%. Field condition data is updated every 1-3 days, allowing agronomists to quickly respond to changes, such as pest or disease outbreaks. Satellite monitoring also contributes to more accurate planning, reducing the risk of overspending or crop losses.

"MyAgriLab" is a leading example of a digital platform that provides farmers with analytical tools. It allows for fertiliser application planning, generating fertilisation maps based on soil analysis data, achieving fertiliser savings of up to 25%. Built-in algorithms also forecast yield depending on current conditions and past performance. The platform is compatible with precision farming systems such as GPS equipment for

automated machinery. New technological solutions not only enhance economic efficiency but also reduce environmental impact. Thanks to precise zoning and calculation of required fertiliser doses, agrochemical use is reduced by 20-30%. This decreases the risk of nitrates entering water resources and prevents soil degradation. Continuous monitoring of fertility indicators helps avoid soil overexploitation. Systems like EOSDA Crop Monitoring help maintain an optimal balance of mineral substances, preserving the long-term ecosystem of fields. The use of such tools facilitates the transition of farmers to organic farming, ensuring accurate identification of environmentally-friendly fertilisation and plant protection methods.

DISCUSSION

This study highlights the economic and agronomic potential of outsourcing in agricultural infrastructure. The results show significant cost reductions and improvements in efficiency and productivity. These findings contribute to expanding the discussion on the role of outsourcing in enhancing competitiveness and sustainable development in the agricultural sector. The study found that outsourcing services, such as soil analysis and precision agriculture technologies, reduce operational costs by 20-30% and increase yields by 15-20%. These findings align with the research by R. Du *et al.* (2024), which showed that production outsourcing contributes to the adoption of low-carbon technologies in China, reducing production costs and ensuring ecological sustainability. These results are particularly relevant for Ukraine, where the transition to innovative agricultural practices is critical for long-term competitiveness and resource optimisation.

These results are crucial in addressing systemic challenges in the agricultural sector. Outsourcing not only reduces financial barriers but also democratises access to advanced technologies. E. Vandergeten *et al.* (2016) in their meta-analysis noted that outsourcing in agriculture can bridge the gap between small farmers and technology providers, ensuring fair resource distribution. However, they also highlight the risks of "land grabbing," which need to be considered when developing policies. The findings of this study are consistent with the conclusions of G.M. de Oliveira & D. Zylbersztajn (2017), who examined outsourcing contracts in mechanised services for Brazil's coffee business and found that outsourcing enhances efficiency and better resource allocation. The similarity of results indicates the universal benefits of outsourcing in various agricultural contexts, despite differences in cultures and economic structures. However, there are some differences from the research by S.M. Mulewa (2019), who studied outsourcing in Kenya's food industry. S.M. Mulewa (2019) emphasises the importance of strategic management for the successful implementation of outsourcing, while this study in Ukraine achieved significant cost reductions even without advanced strategic approaches. This difference highlights the role of contextual factors, such as regulatory conditions and market dynamics.

The results are also consistent with the study by S. Yekimov *et al.* (2021), who analysed outsourcing accounting services for small agricultural enterprises in Ukraine. They found that outsourcing significantly reduces administrative costs, which supports the findings regarding cost savings. Meanwhile, the emphasis on financial management contrasts with the focus on operational aspects, indicating the complementary advantages of different forms of outsourcing. The strategic significance of outsourcing in agriculture goes beyond cost reduction. M. Charles & S.B. Ochieng (2023) note that outsourcing improves productivity by allowing businesses to focus on key competencies. This conclusion matches the findings of this study, which show that transferring soil analysis and consulting services allowed Ukrainian farmers to focus on optimising agricultural practices, positively impacting productivity.

The results also suggest that outsourcing soil and agrochemical analysis services and implementing innovative solutions by private companies lead to more rational resource use. This is supported by V.C. Materia *et al.* (2017), who state that outsourcing strategies facilitate the rapid implementation of innovations, especially in large enterprises where scale and efficiency are critical. The results of this study also align with the findings of F. Azizi *et al.* (2013), who investigated the impact of outsourcing on land preparation for sugarcane cultivation in Iran. The study showed that outsourcing reduced costs by 15-20% and increased productivity through the use of technology. The similarity of these results indicates the universality of outsourcing in optimising operational processes. On the other hand, research by H. Azadi *et al.* (2013) draws attention to outsourcing risks, such as increased dependency on large companies or uneven access to resources. This requires careful consideration of the social aspects of outsourcing when developing policies.

The results of this study also find support in the work of R.C. Yadav & J. Yadav (2013), who emphasise that outsourcing business processes in the primary sector of the economy improves natural resource management and contributes to the stability of farming enterprises. Meanwhile, comparisons with the study by M. Igata *et al.* (2008) show that the success of outsourcing depends on local characteristics. For example, in the Netherlands, this model is a common practice, while in

Japan, farmers tend to rely more on their own resources. The conducted study demonstrates that outsourcing allows farmers to focus on key aspects of their business while outsourcing specialised services to external contractors. This is consistent with the conclusions of P. Bębenek (2017), who notes that outsourcing is a development model for agricultural corporations focused on competencies. Engaging specialised suppliers enables companies to use their resources more efficiently.

J.B. Traversac *et al.* (2011) studied the impact of transaction costs and resource base on the integration of agricultural producers into additional stages of production. The authors emphasise that outsourcing services significantly reduce operational costs for farmers, especially in industries with high transaction costs, such as winemaking. These results align with the findings of this study regarding the economic efficiency of outsourcing to reduce operational costs in agriculture. The conclusions of A.A. Satybaldina *et al.* (2023) on outsourcing in Kazakhstan's agricultural sector are relevant to this study, which also highlights the need to create a favorable regulatory environment. The authors emphasise the potential of outsourcing to enhance the efficiency of agricultural enterprises and note that it can promote the transition to high-tech agriculture, but its implementation is limited by insufficient state support and institutional barriers.

The conclusions that outsourcing provides access to innovative solutions, especially for small farmers, align with the results of R. Tang & C. Chen (2022). The authors studied the impact of outsourcing services on the participation of elderly farmers in rice production in China and found that outsourcing reduces physical strain and encourages farmers to adopt updated technologies. L. Qian *et al.* (2022) analysed the use of farming machinery in comparison to outsourcing technical services in China and concluded that outsourcing allows large farmers to rent land more efficiently and expand cultivation scales. This is consistent with the findings that outsourcing creates conditions for large-scale production and optimal resource use.

The impact of outsourcing agronomy consulting programs on the income of small farmers in the Republic of South Africa was studied by L.J. Baiyegunhi *et al.* (2019). The research showed that farmers using outsourcing services earn higher net incomes due to rational resource use. This result resonates with the conclusions of this study regarding the economic benefits outsourcing provides for small agricultural enterprises. The results of this study align with the conclusions of J. Lin *et al.* (2023), who analysed the impact of outsourcing services provided by cooperatives in China. They found that such services improve farmers' technical efficiency through the use of shared infrastructure and access to professional recommendations. This matches the conclusions that the use of shared services, such as soil agrochemical analysis and field zoning, allows for cost reductions.

Implementing outsourcing models increases the efficiency of farms by optimising resource use and reducing soil maintenance costs, as found by A.J. Picazo-Tadeo & E. Reig-Martínez (2006) in their study on outsourcing in Spain's agriculture, particularly citrus production. The results confirm these findings, especially in the context of scaling up production through the adoption of innovative technologies. The study by L.J. Schulz *et al.* (2004) highlighted difficulties in implementing outsourcing models in extended partnership models within the TOPCROP program in Australia. They emphasise that the success of such models depends on proper management of partnerships and clear contractual agreements. This suggests the need to improve the legal regulation of outsourcing relations in Ukraine's agricultural sector.

The results of this study also find confirmation in the work of N. Zahid (2024), who studied the factors influencing the adoption of outsourcing services among corn farmers in Pakistan. The author notes that economic incentives, such as subsidies and access to credit, significantly increase farmers' willingness to adopt outsourcing services. This corresponds with the findings of this study on the need for state support to encourage outsourcing adoption. Outsourcing allows for the resolution of pressing issues faced by farmers, such as the high cost of maintenance and inefficient resource use. This makes outsourcing not only economically beneficial but also strategically important for enhancing the competitiveness of farming enterprises.

CONCLUSIONS

The research has achieved its objective, demonstrating that the implementation of outsourcing models in the agricultural sector, particularly in soil agrochemical analysis and satellite monitoring, has a significant economic impact. Reducing agrochemical service costs by up to 30% in Ukraine allows for a decrease in fertiliser costs and an increase in yield by 15-20%. The use of field zoning reduces fertiliser costs by 20%. State-private partnership programs, such as the electronic Prozorro system, have reduced contract signing time by 15% and lowered government administrative costs by 20-25%. This has facilitated the involvement of the private sector in providing services like agrochemical analysis. The "Affordable Loans 5-7-9%" program has helped reduce financial burdens on agricultural enterprises, leading to increased investments

in precision farming technologies. In 2024, farmers received loans amounting to UAH 39.4 billion, which allowed for a 15-20% increase in yield and a 20% reduction in fertilizer costs.

The implementation of precision farming practices, such as field zoning and agrodiagnostics, enables the optimisation of fertiliser costs and increased yield. For instance, in the "Agrocultura Mostyska" project, zoning reduced fertiliser costs by 14 EUR/ha, while yield on suitable plots increased by 3%. Similar results were achieved in the "Loretta Agro" project, where proper fertiliser application restored neglected lands and ensured a stable increase in yield. AgriLab demonstrated successful cases in optimising agrochemical processes, including a reduction in fertiliser costs from 98 EUR/ha to 84 EUR/ha and a 15% yield increase after agrodiagnostics in Western Ukraine. Satellite monitoring and GIS reduced agrochemical costs by 20%, confirming the effectiveness of precision farming technologies. One of the key limitations of this study is the focus on short-term economic indicators, which prevents a full assessment of the long-term consequences of outsourcing on the sustainability of the agricultural sector, particularly soil fertility and ecological balance. Additionally, the study primarily concentrated on large and medium-sized farms, while the specific challenges faced by small-scale farming enterprises under outsourcing conditions require deeper analysis. Given these aspects, promising areas for further research include exploring the social and ecological impacts of outsourcing, the influence of government policy and innovative technologies on its effectiveness, and analysing regional differences in the implementation of outsourcing models in agriculture.

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CONFLICT OF INTEREST

None.

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Використання аутсорсингу у системі надання публічних послуг для підвищення ефективності сільськогосподарського виробництва

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Анотація. Аутсорсинг у сільському господарстві є ключовим інструментом підвищення ефективності управління ресурсами, сприяючи впровадженню інноваційних технологій та зниженню витрат. В Україні, де аграрний сектор формує значну частину валового внутрішнього продукту, оцінка ефективності таких моделей є важливою для забезпечення конкурентоспроможності фермерських господарств. Дослідження було спрямоване на аналіз економічної ефективності аутсорсингу агрохімічного обслуговування ґрунтів, супутникового моніторингу та впровадження точного землеробства, а також на оцінку впливу державно-приватного партнерства. Застосовано статистичний і порівняльний аналіз, включаючи дані українських компаній, таких як AgriLab, і міжнародних практик. Аналіз проводився на основі даних про витрати, врожайність і ефективність аграрної інфраструктури за період 2019-2024 років. Результати показують, що витрати на технічне обслуговування ґрунтів знизилися з 98 євро/га у 2019 році до 84 євро/га у 2024 році, що відповідає скороченню витрат на 14 %. Адміністративні витрати зменшилися на 25 %, а загальні витрати на аграрну інфраструктуру в Україні знизилися з 5 млрд грн до 3,5 млрд грн (30 %). Використання точного землеробства підвищило врожайність на 15-20 % залежно від культури, а економія на добривах становила 20 %. Впровадження аутсорсингу та інноваційних технологій забезпечує скорочення витрат і покращення ефективності фермерських господарств. Зокрема, аутсорсинг дозволяє значно оптимізувати виробничі процеси, що підтверджується зростанням врожайності пшениці та кукурудзи на 18 % після впровадження рекомендацій із зонування полів і точного внесення добрив. Результати можуть бути використані для розробки стратегій державної підтримки, впровадження аутсорсингових моделей і стимулювання сталого розвитку аграрного сектора України

Ключові слова: аграрний сектор; оптимізація витрат; точне землеробство; фермерські господарства; аналіз ґрунтів; покращення врожайності