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Decarbonisation of agricultural technologies in Ukraine in achieving sustainable development goals

Tetiana Manushkina*
PhD in Agriculture, Associate Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
https://orcid.org/0000-0001-5843-271X
Nadiia Koloianidi
PhD in Agriculture, Senior Lecturer
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
https://orcid.org/0009-0008-1494-9715
Lyudmila Hyrlya
PhD in Chemistry, Associate Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
https://orcid.org/0000-0002-8964-4253
Alla Bondar
PhD in Agriculture, Associate Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
https://orcid.org/0000-0002-5546-0528

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Abstract. The study intended to draw attention to the distinctive aspects of Ukraine's agricultural decarbonisation process to carry out the sustainable development plan. The research methodology included statistical observation, analytical and structural grouping, and forecasting. The study established key areas for future development, assessed the extent to which sustainable agricultural production technologies are implemented in Ukraine, and identified reserves. Decarbonisation, which involves a progressive change in the agricultural sector, was discussed in the strategic progress towards a sustainable climate. The significant level of degradation of agricultural areas and the widespread spread of the "organic food" trend were identified as tangential stimulating factors. The expediency of decarbonisation of agricultural technologies in terms of participation in global climate dynamics was substantiated. The main relevant

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*Corresponding author

challenges and risks were highlighted, and the level of development of the industrial regulatory framework was studied. An analysis was conducted on the characteristics of the agricultural production management system. The most effective means of putting strategies into practice to encourage investment in the agriculture industry were determined. The study demonstrated how farmers can be effectively motivated financially and organisationally to adopt technologies that emit few or no greenhouse gases into the atmosphere, monitor and manage the load on agricultural landscapes, create a targeted land bank, and guarantee quality standards and safety regulations. The vectorial of improving the algorithms for transforming farming systems towards decarbonisation within the strategy of dynamic development from traditional to sustainable agricultural production is determined. The study established that an effective process of decarbonisation of agricultural production technologies is seen as the basis for intensifying the competitiveness of agricultural production. The study demonstrated how Ukraine's agriculture sector has developed in the modern era should be embodied in the technical re-equipment of production processes and fundamental changes in technological methods and approaches to minimise carbon emissions

Keywords: sustainable land use; carbon emission reduction; agroecosystem; certification; strategic management; monitoring

INTRODUCTION

The destruction of landscapes that have long been involved in intensive agricultural activities, in synergy with irreversible global climate change, is making it necessary to move from exhausting forms of agricultural production to organic and environmentally friendly ones. The global trend in the modern development of the integrated community today is the active fight against the emission of carbon and other greenhouse gases. Most countries have diverse practical platforms to improve the ecological state of agricultural landscapes and actively combat irreversible climate change, most of which provide a comprehensive approach to ecosystems and increase the economic efficiency of the industry. Ukrainian realities are characterised by gradual dynamics towards decarbonisation of most technical and technological solutions, although the dynamics of transformation in the Ukrainian space are not rapid. To achieve sustainable development goals, the issue of Ukraine's rapid growth of decarbonisation agricultural technologies is particularly pertinent to this notion.

The issue of implementing sustainable development goals in agricultural production is reflected in the scientific work of modern scientists. A study of current publications shows that studies mostly focus on finding alternative technological opportunities in the agricultural sector to more intensively promote national agricultural progress towards sustainability and environmental safety. B. Babaniyi *et al.* (2024) addressed the basics of adapting organic farming to conventional agricultural systems, highlighting the relationship with global climate dynamics concerning crop production. The researchers identified the functional and structural elements and basic parameters of environmental monitoring of agricultural landscapes, the criteria for assessing the effectiveness of preventive and regeneration strategies of environmental, managerial and financial orientation to intensify the process of decarbonisation of agricultural production in different regions. Scientists address the environmental and economic efficiency of decarbonisation technologies, while its specifics in countries in crisis and instability remain unaddressed.

J. Brinken *et al.* (2023) addressed the complexities of implementing decarbonised agricultural technologies in a crisis economic environment, with an emphasis on legal regulation and motivation in the field. A. Galinis *et al.* (2021), and D. Kuzmanović (2023) deemed it necessary to invest in innovative projects, apply innovative practices of successful international experience, and establish mechanisms for financing decarbonisation projects. At the same time, the functionality of innovation provision in motivating technology transfer and innovation implementation is explored only fragmentarily by researchers.

A. Panfilova and V. Fedorchuk (2022), V. Pichura *et al.* (2024) detailed in depth how the decarbonisation of agriculture's technological approaches is influencing the process of economic development. The authors underscored the necessity of incorporating cutting-edge biotechnologies, ensuring safe handling and preservation, and modifying technological frameworks to collaboratively attain a zero-carbon agricultural footprint and guarantee the ecological soundness of organic products. However, the issue of effective mechanisms to stimulate the reduction of greenhouse gas emissions in agricultural production remains unresolved, which requires further elaboration and search for optimal solutions.

Thus, the study aimed to draw attention to the distinctive aspects of Ukraine's agricultural decarbonisation process to carry out the sustainable development plan.

MATERIALS AND METHODS

The basic categorical concepts and principles of the phenomenon under study were identified, and a definition of the integrity of management processes in the field of decarbonisation of agricultural production was formed. Using an abstract and logical conceptual approach, the conceptual apparatus was determined, and theoretical generalisations and conclusions were formed.

To pinpoint the precise workings of the object under investigation, statistical observation, comparison, analytical and structural grouping, and forecasting were employed. Utilising statistical observation, generalisable data that accurately represents the attributes of the full range of properties of the event under investigation was obtained. To determine the specifics of the dynamics of the growth of decarbonisation and greening systems in the agricultural sector, the primary indicators of qualitative changes were compared. Proposals for optimising the management system in the examined area were developed, along with aspects of developing zero carbon emission systems within the circularity of economic production processes strategy.

The development of technology aimed at decarbonising agricultural output in Ukraine was analysed and synthesised through strategic vectors. To preserve agricultural landscapes and reduce environmental risks in agricultural production complexes, the study outlined the ideal circumstances and solutions within the framework of an efficient and feasible set of management measures for regional agricultural production systems. Based on sustainable decarbonisation of technical processes and "green" sustainable development, the primary vectors for optimising regional agricultural production systems were determined. The conditions were set, particularly about the idea of Ukraine's post-war recovery and the active subsidy and investment assistance from the integrated global community, for the active and practical application of decarbonisation technology in the country's agriculture management system.

A consistent transition from general abstract informative data on decarbonisation technologies in the agricultural sector to the current state of agricultural activity in Ukraine and the creative potential of organic agriculture was created by going from the abstract to the specific. To assess the dynamics of the current practice of implementing innovative agricultural technologies for decarbonisation and minimising the impact on climate dynamics in Ukraine, statistical data from the Ministry of Agrarian Policy and Food of Ukraine, as well as information provided by the official resources of the Information and Analytical Portal of the Agro-Industrial Complex of Ukraine and the National Research Centre "Institute of Agrarian Economics" were used.

The characteristics, benefits, and efficacy of particular techniques and solutions within the framework of the decarbonisation of the agricultural sector were determined using a methodical manner. Particular attention is given to the need to resolve any obstacles to the efficient implementation of agricultural production plans' decarbonisation in light of the economic realities of developing countries. With an emphasis on environmental safety and economic viability, the study seeks to identify solutions in the contemporary agro-industrial complex. These factors work together to create a system of cyclical, sustainable economic activity in the agricultural sector.

RESULTS

Official statistics show that as of 2021, there were 528 organic producers in Ukraine. In comparison, in 2002, only 31 farms were registered (Ukraine ranks 20th..., 2024). The most rapid growth in quantitative indicators in this regard was characteristic of the period from 2015 to 2019, after which the positive dynamics stopped. As of 2024, 475 certified farms in Ukraine successfully operate intensive ecological methods of agricultural production.

The trends in the number of organic farming businesses in Ukraine between 2002 and 2024 show that the agricultural industry has a large amount of potential in the country's economic system, especially during difficult and unstable periods. The data for 2023 show a slight positive trend, which indicates the adaptability and flexibility of the industry, and the willingness of farmers to transform their farming methods in line with current conditions. An analysis of sectoral characteristics and important benchmarks is required to execute a methodical strategy to decarbonise the agriculture industry in the national Ukrainian area. Ecological decarbonised farming technologies are a complex innovation and production system that requires the development of an algorithm for effective sectoral functioning in terms of proportionality of resource and financial potential and corresponding performance. In addition, an integrated approach requires ensuring an appropriate level of resource potential reproduction and minimising environmental impact.

A closed production cycle must be maintained to apply the concepts of sustainable development to the agriculture sector and the decarbonisation of technological processes. Thus, organic farming should be developed in the strategic direction of regeneration and circular economic processes. To reduce financial costs due to the replacement of traditional technologies with decarbonised ones, it is necessary to introduce a definition of the stabilisation interval required to implement a full range of decarbonisation measures in terms of individualising existing production prerequisites. This strategy requires additional financial and time costs, but it is seen as an inevitable stage in the greening and decarbonisation of agricultural production processes. Agrarian formations working towards decarbonising technologies are characterised by different scales of activity (Organic production in..., 2024). The number of small eco-farms is currently growing, with a priority being given to specialising in organic production and export orientation.

Agricultural producers in Ukraine's diverse agricultural regions need to be driven both financially and organisationally, based on the current state of decarbonisation technology development. The degree to which

regional investment programs are implemented and the agricultural producers' willingness to change the management system both have a significant impact. European criteria of sustainable development can be applied thanks to innovative technology capabilities that make the shift from overly intensive farming techniques to innovative biologisation tactics easier. The worldwide community acknowledges these standards as alternate, renewable methods for reducing greenhouse gas emissions in the agriculture industry. Based on the findings of the study carried out by the Mykolaiv National Agrarian University Training and Research Centre, as well as the findings of an analysis of industry publications, the most negative effects of global climate change on organic agricultural production include sharp temperature and weather fluctuations, an increase in the difference between night and day temperatures, intensification of weathering and evaporation of moisture from the soil surface, heterogeneity of precipitation and snowy winters. Climate change affects the resilience of agroecosystems, which is noticeable when conventional crop production is transformed into organic.

Creating environmentally safe zones with a minimum volume of 10-15% is the best preventive measure to reduce the amount of agricultural production areas that are ploughed. This will allow for environmental regeneration (Korkhova *et al*., 2023). In the context of decarbonisation, greening Ukraine's agriculture has great promise for raising production's degree of economic efficiency. Simultaneously, several administrative, financial, and technical actions, including those carried out at the national level, must be taken for this strategic idea to be implemented practically and effectively (Beillouin *et al*., 2022). These include giving agricultural producers access to current information about cutting-edge technologies with low greenhouse gas emissions, creating nationally recognised organic quality standards and certification, drawing in both domestic and foreign investment, forming alliances, creating a plan for raising farmer awareness through communication, enhancing agricultural organic policy, and encouraging innovation and research (Ramesh *et al*., 2019). Despite many associated risks and challenges, decarbonisation technologies for agricultural production in Ukraine have significant potential for advancement, with strong international support and investment.

Market economic processes in the concept of ecologization transform the basic goal of agricultural production, namely, increasing financial profitability and productivity growth. In the agriculture industry, a pertinent management plan is created by the synergistic development of profit and environmental impact. The main goal of the latter is to intensify productivity and sustainability in a complex of interrelated organisational and information tools, levers and principles. The proposed approach will improve the competitiveness of agricultural enterprises. The following should be emphasised as some of the most crucial elements of the system of requirements for putting the plan for the development of decarbonisation of agricultural output into practice (Kovalenko *et al*., 2024):

- scientific and legislative (awareness of the norms and requirements of the Ukrainian legal framework and the ability to predict and model potential legislative changes in the industry, as well as the study of foreign experience, are the primary prerequisites for the effective development and implementation of strategic innovations);
- technological and technical (the adoption of the newest creative methods, technologies, and concepts based on a preliminary study of statistical data and financial and economic information is a necessity for sustained progress towards decarbonisation of agricultural technology);
- human resources (regional development potential is based on an awareness of local needs and resources, considering the specifics of the communication process between farmers and territorial governments).

Among the basic concepts of strategic management of farm productivity in the direction of decarbonisation are systematic, efficient, flexible, balanced, risk minimisation, and others (Table 1).

Table 1. *Concepts of strategic management of decarbonisation of agricultural technologies in Ukraine*

No.	Principle	Meaning
1	Adaptability	Variability of the dynamics of the algorithm for implementing management strategies under the influence of exogenous and endogenous factors
2	Possibility of implementation	Identification of strategic goals of the organisation's development includes consideration of its resource potential to assess the possibility of their implementation
3	Structuredness	The process of decarbonisation project management should have a structure, regulations and an individual algorithm for practical implementation
4	Prospectivity	Focus on long-term perspective development of the agricultural sector
5	Economic effect	Implementation of decarbonisation measures should be financially viable
6	Monitoring	Management measures should ensure the controllability of decarbonisation processes with a system of control indicators
7	Systematic approach	Decarbonisation covers all aspects of the organisational activities to achieve the overall goal

Source: *compiled by the authors based on T. Ramesh et al. (2019) and E. Durán-Lara et al. (2020)*

Given its substantial resource potential for active growth, the agricultural sector is considered one of the top priorities for economic national development. Agricultural enterprises are currently positioned as a small form of entrepreneurship, and therefore have significant advantages, including a simplified process of implementation into the market environment, increased adaptability of the economic activity process due to small production scales, and a quick response to market dynamics (Gamajunova *et al.*, 2021; Kazimierczuk *et al.*, 2023). Small agricultural producers have advantages over other agricultural entities in terms of the decarbonisation process, as savings on on-farm transport, management costs, and an interest in improving operational efficiency contribute to the successful development of the agricultural segment. Because of the existing circumstances in Ukraine, it is necessary to optimise the legal and methodological framework and put into action workable steps to increase their profitability and competitiveness (Zelisko *et al.*, 2024).

It is worth noting that agricultural production is a sector highly dependent on the combined impact of natural and climatic factors. Sometimes, even their timely forecasting is not able to prevent the risks of unprofitable agricultural activities. The approach of modelling production processes in the whole set of interdependencies and elements of influence should serve as the foundation for the perspective vectors of the agricultural sector development. Figure 1 displays the overall decarbonisation strategy management algorithm for the agriculture industry.

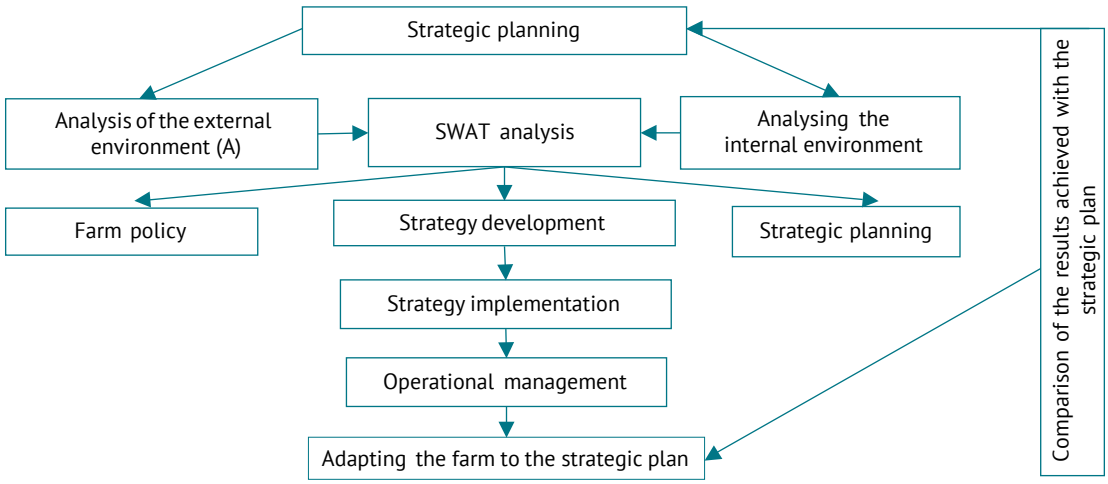

***Figure 1**. Algorithm of management strategy for decarbonisation of agricultural technologies in Ukraine*
***Source:** compiled by the authors based on T. Ramesh et al. (2019), E. Durán-Lara et al. (2020), R. Sroufe and A. Watts (2022)*

The decarbonisation of agricultural production can be achieved through the integration of systemicity and alternative concepts, together with proactive risk prevention. These approaches will work in concert to promote the expansion of agricultural production's economic efficiency. It makes it possible for agriculture to advance via technological innovation and environmental sustainability, encouraging investments in updated equipment and the use of sustainable development ideas in the agricultural industry. Modernisation also implies the use of research and development opportunities in practice, which directly affects the growth of the export potential of agricultural production.

Implementing advances in agriculture happens in phases: scientific solution – technology – production – consumption. The implementation algorithm directly depends on a set of features of the agricultural sector regional and functional, financial, social and managerial, and other factors. The pace of agricultural modernisation depends on some of these factors, including the availability of innovative infrastructure, which determines the level of integration, readiness to implement functional changes, and resource potential. To decarbonise the agricultural sector, technological advancements must intensify resource use's energy efficiency. This can be achieved by breeding, precision agriculture, innovative equipment and technological system optimisation, breeding, and the organic chemicalisation of agricultural processes, among other key strategic decisions (Holmes *et al.*, 2021; Soofi *et al.*, 2022). Today, modern bioenergy strategies are gaining popularity as an additional area of technological modernisation towards zero carbon emissions. This strategy is the most appropriate in the current economic environment, given the priority of the principles of sustainable development in all areas of production, including agriculture.

To effectively execute a methodical strategy for optimising the decarbonisation of Ukraine's agricultural industry, it is imperative to tackle the sector's particularities as well as the standards that constitute an exemplar of productive agriculture. Decarbonisation of

agricultural technology is defined as a complex of production modernisation, the management of which, to be effective, necessitates taking into account metrics related to resource potential, the particulars of sectoral functioning, and the assurance of adequate reproduction processes. It is necessary to guarantee an agricultural production cycle that is technologically closed to adhere to the principles of sustainable development. Decarbonisation should be implemented in the form of practical reproduction algorithms, considering the existing influencing factors, in particular, production, material and technical, organisational, economic, environmental and social. The innovative technology for decarbonising the agricultural sector involves identifying reliable field characteristics, using GPS technology tools, and drawing up electronic maps. The difference between modern technologies in agricultural production is the absence of destructive impact on the environment, preservation of soil fertility and obtaining environmentally friendly products by following an algorithm of a set of safe biotechnological techniques. A separate aspect is to ensure zero or minimal emissions of carbon and other greenhouse gases that cause global climate change.

The process of gathering, accumulating, and analysing information data is the foundation for developing eco-technologies, making effective management decisions, and modifying the schemes of agricultural production processes. This is how the strategic concept of implementing decarbonisation technologies in the agricultural sector to achieve circular economic processes and sustainable development goals is based (Fig. 2).

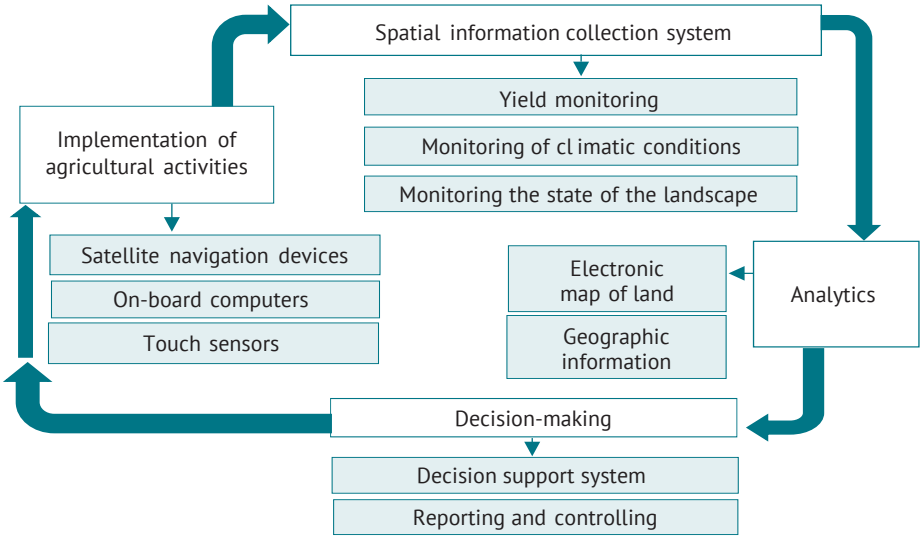

***Figure 2**. Components of the implementation system of agricultural decarbonisation systems*
***Source:** compiled by the authors based on T. Ramesh et al. (2019), E. Durán-Lara et al. (2020), R. Sroufe and A. Watts (2022)*

To assess the economic efficiency of implementing modern decarbonisation technologies, in addition to the traditional indicators of payback and profitability, yield growth and productivity, and annual economic effect per unit area, metrics for reducing the impact of climate change are also used, which are determined from informative data on the qualitative and quantitative composition of carbon emissions into the environment.

Further potential study in this area should be devoted to the identification of strategic vectors for creating a stable system of agricultural consulting on decarbonisation, integration of information support and environmental monitoring systems, which in synergy constitute the main resource for optimising the situation. At the same time, the priority function is to attract foreign practical successful experience and develop and improve a comprehensive multifactorial approach to managing farm productivity. Together with efficient management practices and an agricultural-environmental monitoring system, the implementation of the system of target requirements in the context of the maximum environmental impact, bringing current agricultural production standards into compliance with developed country standards, and implementing cutting-edge, innovative technological approaches to agricultural processes based on a closed cycle of resource use optimise the Ukrainian agricultural sector. Further research is needed on the possibilities of expanding the use of geoinformation technologies, using the potential of innovative navigation and mapping devices, as well as agroecological monitoring systems. The recommended course of action can be used to develop a state-of-the-art management decision support system that will guarantee food security, promote sustainable development in the direction of greening and decarbonising agricultural technologies, and significantly improve the productivity of the country's agricultural sector.

DISCUSSION

Modern technological modernisation of agriculture towards decarbonisation is focused on innovative optimisation of agricultural production towards decarbonisation. The strategy provides for the provision of material and technical resources, organisation of production activities following the modern requirements of international industry standards, and effective management of information flows, innovations and technological processes towards sustainable development. Regulatory and legal support for agricultural reforms, environmental protection and diversification, together with innovative technological modernisation of agricultural production, can guarantee favourable preconditions for the most efficient development of sustainable agriculture in Ukraine.

Modern research confirms the fact of economic inexpediency and the extremely negative impact of exhausting traditional methods of agricultural production on the environment, given the intense negative climate dynamics (Shuvar & Korpita, 2023). According to M. Singh (2021), agricultural modernisation should align with the green economic development course's aims as it represents a progressive shift from conventional to technological production. This sentence is notable since it represents the primary scientific hypothesis of the study. M. Singh states that the level of modernisation can be used as a metric of the effectiveness of the practical use of research and development. According to the research of F. Eyhorn *et al.* (2019), actively forms an innovative organisational and managerial algorithm of activity in the agricultural sector. According to M. Diacono *et al.* (2019), the need for trained workers in the local area, the marketing of scientific research, and intense urbanisation are the long-term effects of these processes. The majority of contemporary scientists believe that organic farming systems built on decarbonisation technologies are essential to the long-term health of the ecological network supporting agricultural production. This network serves as the foundation for efficient resource regeneration and wise resource allocation within the agricultural sector within the framework of reorienting economic processes towards sustainability, renewability, and circularity.

M. Krauss *et al.* (2020), in a study on management support for decarbonisation processes as the main prerequisite for intensifying the productivity of the agricultural sector, demonstrate that the system of biological land use and decarbonisation of agricultural technologies has significantly expanded the boundaries of practical implementation, becoming a concept for representing the desired sustainability of future agricultural production. In the absence of proper preventive measures, the researchers stress that the dynamics of conventional agricultural processes are moving towards ecologization, and this is accompanied by a major shift of socio-economic processes that are destabilising. The primary objective of the process of decarbonising agricultural production is to control the balance between production and the natural environment to minimise the detrimental effects of human activity on the quality of the nearby natural resources and climate stability.

The primary objective of decarbonising agricultural technologies, according to A. Le Campion *et al.* (2020), is to create sustainable agroecosystems with the ability to self-ameliorate and mitigate the adverse consequences of climate change. The researchers analyse the component and functional structure of a typical algorithm for environmentally friendly production with minimal emissions of carbon and other greenhouse gases, noting the need to expand the boundaries of the technological potential of innovative agricultural strategies and highlighting the need for intensive sectoral investment. It should be noted that the idea of renewability is now regarded as a crucial component of agricultural-landscape complexes that are sustainable. It guarantees a suitable degree of natural environment component regeneration that can operate well without requiring a substantial amount of financial subsidies (Tanchyk *et al.*, 2024).

The synergy between the decarbonisation of agricultural technologies and sustainable development goals was actualised by A. Gamage *et al.* (2023). Decarbonising agricultural production technology improves important environmental metrics like air quality and the dynamics of the global climate while balancing the socioeconomic balance of business and society. The researchers also the importance of applying sustainable management principles to the agricultural sector and the associated issues, including those about the financing and investment system and the availability of trained individuals. Comparing the results of this study with the conclusions reached by scientists, it is important to keep in mind that, as Ukraine rebuilds itself after the war, it is becoming more likely to attract focused investment opportunities and international cooperation mechanisms, which will significantly increase the range of workable agricultural-environmental solutions.

T. Clunies-Ross and G. Cox (2023), in continuation of the problem, focuses scientific attention on the priority of closed-loop technologies in agricultural production, which minimise the environmental impact of the agro-industrial complex, contributing to the sustainable development of the industry. Scientists argue that today the agricultural sector needs large-scale support in the form of investment and lending aimed at maintaining agricultural landscapes, reducing greenhouse gas emissions and preventing climate change. Numerous contemporary scientists, including S. Parizad and S. Bera (2023), contend that integrated management in agricultural production will enable the successful resolution of strategic tasks like resource optimisation, enhancing the sustainability of agricultural-ecological systems, superior monitoring,

and efficient handling of environmental risk situations. Limiting activities that cause chemical and other hazardous contamination of natural resources and their deterioration, as well as efficiently controlling the impact of agricultural production processes, are important to minimise the detrimental influence on the environment (Havryliuk *et al.*, 2022).

A priority area for optimising the industry's circumstances is, according to G. Wu *et al.* (2020), the establishment of an efficient system of managerial and financial incentives at the national, regional, and local levels to promote the use of decarbonisation projects. Sustainable development incentive programmes should include subsidies and benefits for active participants in the process of decarbonising production. Such a management strategy's anticipated long-term outcomes were detailed by J. Pombo-Romero and O. Rúas-Barrosa (2022) include the improvement of the social and environmental microclimate, the improvement of the living environment and the growth of the economic efficiency of innovative projects. According to M. Ouikhalfan *et al.* (2022), the establishment of a mechanism for state support for agricultural innovations, farmer motivational policies, the organisation of a unified investment system, and the global integration of the network of agricultural innovation transfer centres are some of the driving forces behind the successful technological modernisation of the agricultural sector.

Summarising the results of the work of modern authors and the conclusions drawn in this paper, it is possible to identify the specifics of the technological modernisation of agriculture in the direction of decarbonisation and minimisation of the impact on global climate change. Primarily, the adoption of technical breakthroughs boosts the competitiveness of agricultural production by increasing the productivity and economic efficiency of agricultural activities. C. Granjou *et al.* (2024) share this position. At the same time, modernisation creates a shortage of qualified personnel and the need to develop scientific potential. When agricultural output is successfully optimised, the agricultural sector's export potential will increase and both domestic and international investment will be drawn in. After analysing and summarising the foregoing, the prognostic viewpoint calls for extending the decarbonisation technologies' functionality within the management policy strategy of Ukraine's agricultural sector. This will considerably boost the sector's productivity and introduce safe management practices that adhere to the principles of sustainable green development.

Therefore, enhancing the productivity of farming businesses and guaranteeing steady food security can only be achieved by a well-balanced approach to automation and mechanisation, as well as through technologically optimising fundamental production processes that adhere to the principles of sustainable agriculture. A successful technical modernisation process will complete the transition to a creative growth model, reduce detrimental processes in agricultural landscapes, and increase production efficiency.

CONCLUSIONS

The implementation of decarbonisation in agricultural technologies in Ukraine ought to be achieved by optimising the sector's management policy in terms of priority. To achieve sustainable development goals, an analysis of the key elements of Ukraine's issue with the decarbonisation of agricultural technologies reveals several inter-sectoral gaps that must be immediately closed through sectoral regulatory and legal regulation, the application of international greening industry principles and standards, the drawing of international investment levers, and the establishment of stringent liability measures. To effectively manage contemporary agroecosystems in the context of preventing climate change and decarbonisation, a coordinated effort is needed to improve the systems' functionality, efficiency, and capacity for regeneration. For the agricultural sector to optimise its management paradigm, the system of strategic planning, operational management, effective regeneration, and preventive measures are considered to be the most important factors. A strategy like this will offer the best way to address emerging issues, such as changing agricultural practices to better reflect the dynamics of the global climate.

The progressive replacement of conventional, labour-intensive agricultural processes with intensive ones founded on the ideas of sustainable development and the green economy should be the main focus of Ukraine's agricultural sector's technological modernisation towards decarbonisation and sustainable development. The study supports the necessity for national regulatory frameworks to incorporate the international experience of decarbonising the agriculture industry and to encourage innovation, investment processes, and the financial and organisational incentives of agricultural producers. These strategic measures, employed together, form the optimal prerequisites for solving current problems in the field of agricultural production. Based on the ideas of diversification and production process rationalisation, the study finds the most viable methods for the decarbonisation of agricultural technologies. According to the study, the only way to considerably reduce environmental impacts and boost agricultural production efficiency is to apply managerial, economic, and technological measures in concert with the introduction of novel monitoring techniques.

Prospects for research include the formation of strategic vectors for decarbonising the agricultural sector in different regions of Ukraine. To analyse and address the issues facing the business, a workable procedure for combining cutting-edge agricultural and environmental monitoring skills must also be established. Active involvement of international experience, development

and implementation of innovative management methods in the agricultural sector based on regeneration and sustainable land use, and improvement of institutional frameworks are seen as necessary preconditions for Ukraine post-war regeneration and European integration.

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CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

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Декарбонізація аграрних технологій в Україні у контексті досягнення цілей сталого розвитку

Тетяна Манушкіна
Кандидат сільськогосподарських наук, доцент
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
https://orcid.org/0000-0001-5843-271X
Надія Колояніді
Кандидат сільськогосподарських наук, старший викладач
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
https://orcid.org/0009-0008-1494-9715
Людмила Гирля
Кандидат хімічних наук, доцент
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
https://orcid.org/0000-0002-8964-4253
Алла Бондар
Кандидат сільськогосподарських наук, доцент
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
https://orcid.org/0000-0002-5546-0528

Анотація. Дослідження спрямоване на виокремлення специфічних рис аграрної декарбонізації в Україні в межах реалізації стратегії стійкого розвитку. Методологія дослідження передбачала використання методів статистичного спостереження, аналітично-структурного групування та прогнозування. У дослідженні визначено рівень імплементації технологій стійкого сільськогосподарського виробництва в Україні, ідентифіковано існуючі резерви, сформовано пріоритетні напрями перспективного поступу. Поступова трансформація аграрного сектору в концепті декарбонізації розглядається в статті у контексті пріоритетності стратегічного поступу в напрямку стійкого клімату. Дотичними стимулюючими факторами визначено значний рівень деградації аграрних територій та масштабне поширення тренду «organic food». Обґрунтовано доцільність декарбонізації аграрних технологій у аспекті участі в глобальній динаміці клімату. Виділено основні дотичні виклики та ризики, вивчено рівень розвитку галузевої нормативно-правової бази. Проаналізовано особливості системи управління у галузі сільськогосподарського виробництва. Визначено пріоритетні шляхи імплементації методологій стимулювання інвестування у аграрну сферу. Доведено доцільність дієвої фінансової та організаційної мотивації аграріїв щодо впровадження технологій з мінімальним чи нульовим викидом парникових газів у атмосферне повітря, моніторингу та контролінгу навантаження на агроландшафти, формуванні цільового земельного банку, забезпеченні стандартів якості та вимог безпеки. Визначено векторність вдосконалення алгоритмів трансформації систем землеробства у напрямку декарбонізації в межах стратегії динамічного розвитку від традиційного до стійкого аграрного виробництва. Встановлено, що ефективний процес декарбонізації технологій аграрного виробництва вбачається основою інтенсифікації конкурентоспроможності сільськогосподарського виробництва. У дослідженні вдалося довести, що сучасний розвиток галузі аграрного виробництва в Україні повинен знаходити втілення у технічному переоснащенні виробничих процесів та фундаментальній зміні технологічних прийомів та підходів задля мінімізації емісії вуглецю

Ключові слова: стійке землекористування; зменшення емісії вуглецю; агроекосистема; сертифікація; стратегічний менеджмент; моніторинг