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# FORMATION OF A MECHANISM FOR INTEGRATION OF ORGANIZATIONAL AND ECONOMIC POTENTIAL OF BLOCKCHAIN TECHNOLOGIES IN THE AGRIBUSINESS SYSTEM

# ФОРМУВАННЯ МЕХАНІЗМУ ІНТЕГРАЦІЇ ОРГАНІЗАЦІЙНО-ЕКОНОМІЧНОГО ПОТЕНЦІАЛУ ТЕХНОЛОГІЙ БЛОКЧЕЙН У СИСТЕМУ АГРОБІЗНЕСУ

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The article explores the theoretical and methodological principles of integrating the organizational and economic potential of Blockchain technologies into the agribusiness system in the context of increasing demands for transparency and sustainability of value chains. The essence of Blockchain is revealed as a tool for forming a trusted information infrastructure that ensures data immutability, transaction automation and business process optimization based on smart contracts. It is substantiated that the use of distributed ledger technologies contributes to the decentralization of management, reduction of transaction costs, digitalization of product quality control and increase of the export potential of agricultural enterprises. Scientific approaches to the development of Blockchain solutions for agri-food supply chains are analyzed. A mechanism for integrating Blockchain into centralized and decentralized agribusiness platforms is proposed, which involves the development of digital competencies, the creation of support infrastructures and indicators for assessing the readiness of enterprises to implement distributed ledger technologies.

**Keywords:** organizational and economic potential, blockchain, technologies, agribusiness, adaptive scaling of digital solutions, smart contracts, supply logistics, tokenization of agricultural assets, decentralized autonomous organizations (DAO), digital liquidity of resources, economic effect, supply chain transparency.

У статті досліджено теоретико-методичні засади інтеграції організаційно-економічного потенціалу технологій блокчейн у систему агробізнесу в умовах зростання вимог до прозорості та сталості ланцюгів створення вартості. Розкрито сутність блокчейн як інструменту формування довірчої інформаційної інфраструктури, що забезпечує незмінність даних, автоматизацію транзакцій та оптимізацію бізнес-процесів на засадах смарт-контрактів. Обґрунтовано, що використання технологій розподілених реєстрів сприяє децентралізації управління, скороченню трансакційних витрат, цифровізації контролю якості продукції та підвищенню експортного потенціалу аграрних підприємств. Проаналізовано наукові підходи до розробки блокчейн-рішень для агропродовольчих ланцюгів постачання, зокрема з урахуванням потреб інформаційної безпеки, простежуваності та відповідності міжнародним стандартам. Наголошено на ролі блокчейну як каталізатора цифрової трансформації, що змінює архітектуру системи агробізнесу, сприяючи формуванню мережевої моделі взаємодії між учасниками ринку. Доведено, що поєднання блокчейн-інновацій із принципами ESG-управління посилює конкурентоспроможність суб'єктів господарювання, забезпечує доступ до інституційного фінансування та підвищує рівень інформаційної прозорості. Запропоновано механізм інтеграції блокчейн у централізовані та децентралізовані платформи агробізнесу, що передбачає розвиток цифрових компетенцій, створення інфраструктур підтримки та індикаторів оцінювання готовності підприємств до впровадження технологій розподілених реєстрів. Практичне значення дослідження полягає у визначенні нових економічних можливостей для українського агробізнесу шляхом посилення довіри на продовольчих ринках, формування децентралізованих бізнес-моделей та підготовки підприємств до участі в майбутніх ланцюгах постачань, де цифрова прозорість стане базовою умовою конкурентоспроможності. Результати



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дослідження спрямовані на розробку дорожніх карт блокчейн-інтеграції, формування стратегій цифрової трансформації суб'єктів агробізнесу при виборі ефективних інноваційних механізмів розвитку.

**Ключові** слова: організаційно-економічний потенціал, блокчейн, технології, агробізнес, адаптивне масштабування цифрових рішень, смарт-контракти, логістика постачання, токенізація аграрних активів, децентралізовані автономні організації (DAO), цифрова ліквідність ресурсів, економічний ефект, прозорості ланцюгів поставок.

**Formulation of the problem.** Modern transformation processes, increased competition, increasing requirements for transparency and traceability of commodity flows necessitate the implementation of innovative solutions that can increase management efficiency and reduce risks. In this context, the organizational and economic potential of Blockchain technologies plays a more significant role, as it ensures data reliability, protects information flows and strengthens trust between participants in agricultural value chains.

Blockchains open up new opportunities for optimizing production processes, digitalizing resource accounting, product quality control and increasing the sustainability of the entire agribusiness complex by introducing innovative technologies that have a set of immutable centralized and decentralized records of verifications of executed smart contracts, which significantly strengthen the organizational and economic potential of Blockchains with a focus on creating a trusted information network between agribusiness entities. However, the lack of Blockchain solutions in the agribusiness system based on organizational and economic tools that should ensure transparency in the implementation of digital transformation by entities does not allow activating the full traceability of agricultural products, reducing the likelihood of counterfeiting goods, increasing trust between market participants and optimizes transaction costs. According to estimates by international organizations, the use of Blockchain in the field of agricultural production can increase the efficiency of logistics processes by 20-30%, and reduce administrative costs by up to 40% [16]. In this context, an urgent scientific problem is the formation of a holistic mechanism for integrating the organizational and economic potential of Blockchain technologies into the agribusiness system, which allows to increase competitiveness, technological flexibility and sustainability of value chains.

**Analysis of recent research and publications.** The issues of digitalization of agribusiness and the introduction of innovative technologies in its development have been studied by both Ukrainian and foreign scientists. M. Porter's works explore the strategic impact of digital innovations on the competitive advantages of enterprises [11]. R. Tapscott was one of the first to scientifically substantiate the possibilities of Blockchain as a mechanism of trust in digital ecosystems, noting its role in ensuring security and decentralization of transactions [13]. Similar conclusions are given in a systematic review by F. Kasino, T. Dasaklis and K. Patsakis [2], where Blockchain is considered as a tool for increasing data security and trust between market participants.

One of the fundamental directions of modern research is the study of the possibilities of Blockchain technology in ensuring transparency and traceability of agri-food supply chains. The work of A. Kamiloris, A. Fonts and F. Prenafet-Boldiu [5] summarizes the first results of Blockchain integration in the agricultural sector and identifies its potential in reducing information asymmetry. Considerable attention is paid to the issues of improving the product traceability system in the study of K. Demestichas [3], who emphasizes that the combination of Blockchain with RFID technologies allows adapting agricultural chains to the requirements of international quality standards. Similar conclusions are also contained in the work of F. Tian [14], who analyzed the technical features of the development of the Chinese food safety control system based on Blockchain.

In the domestic scientific environment, the problems of digital transformation of the agro-industrial complex are highlighted in the works of I. Lukinov, who emphasized the importance of modernizing the management system of agricultural enterprises under the influence of technological innovations [19]. The issues of information transparency and digital monitoring were considered by O. Shpychak and A. Dibrova, who emphasize that in recent years digital technologies have become a determining factor in the development of agricultural markets [20].

Despite a significant number of studies, the issues of integrating Blockchain into internal agribusiness management systems based on the methodology for assessing its organizational and economic potential, and the formation of a comprehensive mechanism for introducing

technologies into centralized agribusiness structures remain insufficiently developed. This determines the scientific novelty and relevance of the proposed study.

**Formation of research objectives.** The purpose of the article is to theoretically substantiate and develop a mechanism for integrating the organizational and economic potential of Blockchain technologies into the agribusiness system, as well as to determine tools, methods and indicators for assessing the readiness of business entities to use distributed ledger technologies.

**Presentation of the main research material.** Technological determinants of the organizational and economic potential of Blockchain in the agribusiness system accelerate the digital transformation of the industry. In this context, O. Dovgan formed a modern concept of the digital transformation of agribusiness in the context of global digitalization of the economy, which became a reference point for understanding how digital technologies change financial models of investment potential sustainability and corporate governance of the architecture of business structures in the international space. The author considers digitalization not as an additional tool, but as a fundamental driver of the transformation of the economic system of enterprises, emphasizing that digital technologies change the logic of resource redistribution, create new flows and models of monetization, increase the accuracy of forecasts, and reduce administrative costs. In his opinion, the digital transformation of agribusiness is part of a broader process of transition to “data-driven agriculture”, where data becomes the basis for strategic decisions [17, p. 147].

Digital transformation of the agribusiness system through Blockchain is not only a technological upgrade, but also a modernization of the institutional foundations of competition, where companies with a high level of digital readiness gain a strategic advantage in domestic and foreign markets. In the future, it is such enterprises that will form new standards of global agri-food trade with an emphasis on traceability, environmental friendliness and trust as key determinants of competitiveness.

From the perspective of strategic scenarios for the development of Blockchain infrastructure in the agribusiness system, an innovative vector of total digitalization is traced, which allows it to be gradually integrated into digital tools for managing resources, financial flows and information interactions between all participants in the agricultural ecosystem. Within the framework of this approach, agricultural enterprises move away from fragmented accounting and control systems to single decentralized platforms, which allows for a continuous flow of data, where each record is transparent, immutable and available for verification [13; 8, p. 318].

Blockchain architecture forms an integrated agribusiness environment in which key functions (contracting, trading, certification, ESG auditing, risk insurance, logistics management) become digitized and automated [8, p. 319; 4, p. 2067]. The transition to such a model opens up the possibility of creating full-fledged digital markets for agricultural products (lots are not only goods, but also future crops, land plots, water resources, carbon units) [10, p. 17], the development of smart agrologistics (the movement of products is controlled by sensors with direct data registration in the Blockchain) [6, p. 47], the development of innovative business models (DAO farms and digital cooperatives of collective investment and joint asset management) [7, p. 83], strengthening the export potential of agricultural producers through automated international certification and global digital supply chains [9].

The strategic development of Blockchain in the agricultural sector system involves the emergence of new organizational roles – technology brokers, digital auditors, smart contract operators and platform integrators, which reduce dependence on traditional intermediaries and create competitive advantages at the industry level. The key principle of such transformation is networking, which ensures equality of participants and forms a system of economic interaction based on trust, rather than formal control [10, p. 19].

Blockchain infrastructure becomes an evolutionary catalyst for the innovative system of agribusiness, that is, from a raw material-oriented industry to a high-tech industry capable of generating added value through digital services and the use of data as a strategic resource. In the future, its full-scale integration will determine not only the efficiency of internal operations of enterprises, but also their competitiveness in global food chains, where transparency, traceability and technological sovereignty become key drivers of development [4, p. 2070].

Technological innovations in the agribusiness system provide transparency and trust in supply chains: Blockchain technologies allow tokenizing agricultural receipts and simplifying access to financing, RPA provides automation of financial transactions, reducing costs and minimizing

human errors. Cloud ERP systems (platforms) provide access to data in real time, scalability of the agribusiness system, optimization of costs for Blockchain infrastructure [1, p. 307].

One of the central directions of the transformation of the agribusiness system is information transparency – this is a key element of transformation in the agribusiness system before entering commodity markets. The problems of transparency in Ukrainian agribusiness companies are insufficient reporting detail, limited availability of non-financial data, unstructured internal information flows, and an underdeveloped corporate reporting culture. In our opinion, to solve these problems, it is necessary to introduce international reporting standards (IFRS); creation of internal departments with a high level of digital maturity, strengthening of the controlling function, improvement of corporate governance and compliance. That is, the integration of Blockchain into the agribusiness system is a complex process that encompasses innovation, digitalization, ESG approaches, changing strategic thinking and increasing transparency of reporting. It is these components that provide agribusiness with the opportunity to become competitive in food markets.

O. Hopka and O. Kovtun, considering ESG strategy as part of the integration of Blockchain into the agribusiness system, especially when agricultural companies enter international food markets, emphasize its focus on ensuring long-term sustainability and increasing the competitiveness of the company, which goes beyond traditional economic indicators [18, p. 56]. At the same time, they emphasize that the integration of Blockchain technologies into the agribusiness system on the basis of ESG strategy becomes not just an element of corporate responsibility, but a key economic determinant, which manifests itself in two aspects. First, non-financial risks (E-factor) in the agricultural sector with an emphasis on climate and environmental (soil degradation, water resource use, greenhouse gas emissions) are directly related to economic transformation integrated into ESG and aimed at implementing climate financing instruments, ensuring compliance with international environmental standards, which reduces the likelihood of fines and asset losses [18, p. 80].

Secondly, by expanding access to capital (G-factor) through international institutional investors and banks (EBRD, World Bank), agricultural companies are increasingly using ESG ratings as a key criterion to improve corporate governance (transparency, independence of the supervisory board), which allows the company to attract "green" and social bonds (Green and Social Bonds) and receive financing at a lower cost of capital compared to competitors that ignore these requirements [18, p. 81]; thirdly, the creation of long-term value (S-factor) allows for increased social sustainability (working conditions, development of local communities), which, in turn, strengthens the reputation and capitalization of agricultural companies, and, thus, reduces their operational risks associated with conflicts, and ensures the sustainability of supply chains [18, p. 82]. Thus, we agree with the authors that ESG strategy is an integral part of Blockchain technologies in the agribusiness system, as it transforms non-financial indicators into financial advantages, making agribusiness companies more sustainable and attractive to the competitive environment.

Integration of Blockchain into the agribusiness system involves the formation of a set of organizational, economic, technological and managerial tools that ensure the use of the potential of technology to increase the efficiency of processes (Table 1).

Table 1

**Organizational and economic effects of integrating Blockchain technologies into the agribusiness system**

| Effect | Characteristics | Potential Result |
|---|---|---|
| Decentralization of management | No need for centralized databases | Increased security and reduced risk of manipulation |
| Supply chain transparency | Full product traceability | Increased consumer trust |
| Reducing transaction costs | Automation through smart contracts | Saving enterprise resources |
| Optimization of quality control | Impossibility of falsification of information | Increase in export potential |

*Source: based on [13; 12; 15; 11; 14; 6; 2;]*

The organizational and economic potential of Blockchain technologies is directed, first of all, at the organizational capabilities of the agribusiness system, due to the technology's ability to change the internal architecture of business processes of agricultural enterprises, forming new types of interactions between participants in the value chain. One of the key consequences of integrating Blockchain technologies is the decentralization of operations, which eliminates the need for intermediate intermediaries and a data verification center. All transactions are recorded in an immutable distributed registry accessible to all authorized participants, which increases the level of trust between agribusiness entities [13].

From the point of view of organizational transformations, Blockchain technologies contribute to the restructuring of information flows, since data processing does not occur in a separate centralized system, but in a network of nodes, which guarantees synchronization and integrity of information regardless of the actions of individual participants. This creates the prerequisites for the implementation of digital platforms, automated quality control systems, and new formats of supply chain management that were impossible in traditional IT systems. Also, the organizational capabilities of the agribusiness system in an integrated Blockchain infrastructure form a new type of corporate governance, in which transparency, unambiguity and verifiability of data minimize the risks of information manipulation, simplify auditing and ensure compliance with food safety standards [2, p. 57]. As a result, agricultural companies get a chance to implement DAO management models (decentralized autonomous organizations), which increases the flexibility and efficiency of management decisions.

The economic effects of integrating Blockchain into the agribusiness system are the key justification for reducing transaction costs, which is associated with the elimination of duplication of operations, automation of document flow and a decrease in the need for intermediary institutions (banks, certification centers, logistics intermediaries). As M. Porter notes, in the digital economy, transaction costs form up to 20-30% of the cost of products, which makes their optimization critically important for increasing the competitiveness of enterprises [11, p. 73].

A significant economic effect is the reduction of risks, in particular informational, logistical and financial. Since all records in the Blockchain are immutable, agricultural enterprises receive a reliable tool for protection against product falsification and forgery of production documents. According to World Bank research, the technology allows reducing losses from fraud in agricultural supply chains by up to 35-45% [15, p. 24]. In addition, the automation of transaction verification and the use of smart contracts lead to a reduction in transaction time, which makes it possible to reduce financial gaps and accelerate capital turnover. According to K. Koskelea, S. Kennedy, M. Islam, the use of Blockchain in logistics processes reduces the processing time of a batch of products by 20-25% [6, p. 49]. Thus, the economic effects reflect an increase in operational efficiency, increased transparency of the business environment and the formation of sustainable financial models for the development of agribusiness.

The most important feature of Blockchain integration in the technological aspect is the use of smart contracts, i.e. software algorithms that automatically fulfill the terms of agreements between supply chain participants. Smart contracts provide independent verification of transactions, minimize the human factor, and allow for the automation of payments, logistics operations, quality control, and product certification [3].

The next important technological opportunity is the tokenization of assets, which involves the transfer of agricultural resources (grain, feed, land, machinery, future crops) into digital form. This creates conditions for the development of digital trading, attracting investments through crowdfunding and ICO mechanisms, as well as for the formation of new financial instruments for quality assurance and risk insurance in the agricultural sector [14, p. 4].

Finally, another key technological direction is ensuring the transparency of supply chains, which allows for the creation of a continuous history of products, i.e. "from the field to the end consumer". This is especially important for exports, as European and global markets place high demands on traceability and quality assurance of goods. As K. Koskelea, S. Kennedy, M. Islam point out, Blockchain makes it impossible to change production information retrospectively; this significantly increases the level of trust and security [6, p. 50]. Thus, Blockchain technological capabilities form a new digital infrastructure of agribusiness, ensuring automation, transparency and reliability of operations.

Formation of a mechanism for integrating the organizational and economic potential of

Blockchain technologies into the agribusiness system requires a systemic approach, which includes synchronization of technological solutions, organizational changes and economic development tools. At the current stage of digitalization of the agricultural sector, it is Blockchain technology that is able to provide a new quality of resource management, transparency of operations, data reliability, as well as effective interaction between participants in agricultural value chains [5, p. 645].

The mechanism for integrating Blockchain technologies into the agribusiness system should cover key components of digital transformation: infrastructure development, business process optimization, economic justification for implementation, staff competency enhancement, and sustainable supply chain interaction. At the same time, it is critically important to have a performance monitoring and evaluation system that allows tracking the dynamics of implementation effectiveness and adjusting management decisions.

The proposed structural model of the mechanism for integrating Blockchain technologies into the agribusiness system reflects a new paradigm of industry management, based not only on the digitalization of operations, but also on the deep decentralization of economic relations. Its scientific novelty lies in the systematic combination of the organizational and economic potential of enterprises with the technological architecture of distributed registries, which creates self-verified business models and minimizes the need for external control. The model forms a dynamic trust contour, where smart contracts become a tool for automating economic decisions, and the tokenization of assets ensures their digital liquidity. Unlike existing approaches, the mechanism provides for cyclical monitoring of effects and adaptive scaling of Blockchain solutions in accordance with the maturity of the enterprise's infrastructure.

This interpretation of technology integration allows us to consider agribusiness not as a consumer of IT innovations, but as a participant in global network value chains, capable of generating strategic competitive advantages through digital autonomy and transparency. The key novelty of the proposed mechanism is the introduction of cyclical monitoring of effects and adaptive scaling of Blockchain solutions, which allows agricultural enterprises not only to implement the technology, but to develop it evolutionary in accordance with their own digital maturity.

That is, cyclical monitoring of effects involves continuous assessment of the results of the functioning of Blockchain modules according to such key indicators as the level of transparency and traceability of supply chains, reduction of transaction costs and transaction processing time, reduction of risks of fraud and data loss, and increase of trust of counterparties and creditors. It should be noted that cyclical monitoring is not a static audit; it is built into the architecture of solutions itself through smart contracts and data verification mechanisms, creating a self-adaptive management system. At the same time, adaptive scaling of solutions in the new Blockchain model is implemented in stages, with increasing complexity of technologies in accordance with the infrastructure capabilities of business entities in the agribusiness system (Table 2).

Thus, agribusiness is not overloaded with large-scale innovations at the start, but receives an effect at each stage, gradually moving from local integration to industry digital platforms. At the same time, a conceptual breakthrough is

Table 2

**Phase-by-step implementation of adaptive scaling of Blockchain solutions in the agribusiness system**

| Stages | Maturity Level | Tools | Organizational Outcome (Innovation Direction) |
|---|---|---|---|
| Stage 1 | Basic digitalization | Supply registers | Transparent product history |
| Stage 2 | Automation | Smart Contracts | Minimizing Human Intervention |
| Stage 3 | Asset Tokenization | NFT, DeFi Instruments | Digital Asset Liquidity |
| Stage 4 | Network Autonomy | DAO Identity | Decentralized Business Models |
| Stage 5 | Maturity Level | Tools | New Organizational Outcome |
| Stage 6 | Basic digitalization | Supply registers | Transparent product history |
| Stage 7 | Automation | Smart Contracts | Minimizing Human Intervention |

considered that Blockchain acts not as a one-time innovation, but as an evolutionary technological matrix that independently stimulates the further development of management processes. This creates a new type of competitive dynamics when agribusiness entities benefit not only from the use of the technology itself, but from its ability to constantly increase, combine and restore competitive potential, increase added value and maintain food security.

**Conclusions.** Thus, the proposed mechanism for integrating the organizational and economic potential of Blockchain technologies into the agribusiness system confirms the high prospects for the digital transformation of the industry on the basis of decentralization, transparency and increased trust between market participants. The use of Blockchain tools ensures a reduction in transaction costs, acceleration of logistics operations, elimination of information asymmetry and the formation of reliable product traceability systems.

The innovativeness of the approach lies in the phased scaling of technologies depending on the level of digital maturity of agribusiness entities, which allows minimizing implementation risks and ensuring a sustainable economic effect at each phase of development. An important component of the mechanism is cyclical performance monitoring, which provides an opportunity to timely adjust management decisions and adapt the architecture of solutions to changing market conditions. In the future, the introduction of Blockchain into agribusiness will contribute to the formation of new decentralized business models, strengthening the competitiveness of the Ukrainian agrarian sector in the global market and integration into international value chains.

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