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The Legal Mechanisms of State Support for Agribusiness Through the Introduction of Virtual Asset Technologies: Ukraine's Experience in the Global Context

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ABSTRACT:
The article examines innovative approaches to state support for agribusiness through the implementation of virtual asset technologies in the Ukrainian legal field, taking into account international experience. The relevance of the topic is due to the need to modernize the existing mechanisms for financing the agricultural sector in the context of the digital transformation of the economy and the development of the global crypto-asset market.
The authors analyzed the current state of legal regulation of virtual assets in Ukraine, in particular in the context of the Law of Ukraine "On Virtual Assets" and its implementation. Also, it was outlined the main problems and obstacles to the introduction of innovative financial instruments in the agricultural sector including: instability of the regulatory framework, insufficient integration of digital solutions into state support programs, as well as low technological readiness of small and medium-sized agricultural producers.
The authors studied the international experience of using blockchain technologies to support the agricultural sector in countries such as the USA, Australia, Singapore and the countries of the European Union. In particular, the authors paid attention to the analysis of legal models of tokenization of agricultural assets and the use of smart contracts to optimize the processes of state subsidies.
Based on the analysis, the authors proposed a comprehensive model of integration of virtual asset technologies into the mechanisms of state support for agribusiness in Ukraine. The key elements of this model are: the creation of special legal regimes for agricultural tokens and NFTs, the formation of infrastructure for the digital interaction of farmers with state institutions, the implementation of blockchain solutions for the transparent distribution of subsidies, as well as the development of a legal framework for agricultural digital cooperatives.
The authors substantiated the need to amend the legislation of Ukraine, in particular the Law of Ukraine "On State Support of Agriculture of Ukraine", the Tax Code and relevant regulations on virtual assets. Also, the authors identified the potential risks and advantages of the proposed innovations for both agricultural producers and the state.
The results of the research are of theoretical and practical importance for the formation of state policy in the field of the agro-industrial complex of Ukraine, taking into account the global trends in digitalization and the use of distributed ledger technologies to ensure the efficiency, transparency and accessibility of state support for agribusiness.

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1. Introduction

The digital transformation of the global economy is changing traditional approaches to the functioning of all industries, and the agricultural sector is no exception. One of the most promising areas of technological innovation is virtual assets and blockchain technology, which open up new opportunities for optimization, transparency and efficiency of interaction between the state and agribusiness. In the context of global challenges, such as food security, climate change and economic instability, the search for innovative mechanisms of state support for agricultural producers is of particular relevance for Ukraine as a leading player in the global agricultural market.

Ukraine, being one of the largest exporters of agricultural products in the world, has a significant potential for the introduction of advanced technologies into the processes of state management of the agricultural sector. Ukraine ranked a leading position in the world in terms of the use of cryptocurrencies and the introduction of blockchain technologies, which is confirmed by numerous international ratings and studies. On February 17, 2022, the Verkhovna Rada of Ukraine adopted the Law of Ukraine No. 2074-IX "On Virtual Assets", which became the cornerstone in the formation of the legal framework for the functioning of the virtual assets market in the country. However, the regulatory ecosystem in this area is at the stage of formation and needs further development, taking into account international standards, recommendations of specialized organizations and best practices of leading jurisdictions. At the same time, the issue of synchronization of legislation on virtual assets with legal mechanisms of state support for agriculture remains insufficiently researched both in legal doctrine and in practice.

Traditional instruments of state support for agribusiness in Ukraine, such as subsidies, dotations, preferential lending and taxation, often face problems of non-transparency of distribution, bureaucratic obstacles, inefficiency of administration and vulnerability to corruption risks. The use of virtual asset technologies can potentially overcome these challenges by automating processes, ensuring transparency of transactions, simplifying the access of small and medium-sized producers to state support, as well as forming new models of financing and investing in the agricultural sector.

Global experience demonstrates the effectiveness of blockchain solutions in agriculture for tracking supply chains, verifying the origin of products, managing land rights, and optimizing financial flows. Leading countries in the field of virtual asset regulation, such as Singapore, Switzerland, Japan and Australia, are actively experimenting with the introduction of innovative technologies in government agribusiness support programs, creating special legal regimes for such initiatives.

The purpose of this study is to study the legal possibilities and prospects for the implementation of virtual asset technologies in the system of state support for agricultural business in Ukraine, taking into account international experience and national specifics of building an effective post-war economy. The scientific novelty of this work lies in the development of a comprehensive approach to the modernization of the existing system of

state support for the agricultural sector by introducing technological innovations into Ukrainian legislation.

The article uses a systematic approach that combines legal, economic and technical analysis to develop practical recommendations for improving the regulatory framework of Ukraine in the areas of regulation of virtual assets and state support for agriculture. The authors paid special attention to the analysis of legal mechanisms for tokenization of agricultural assets, the use of smart contracts for the administration of state support programs and the creation of digital ecosystems for agricultural cooperatives.

2. Theoretical Background

The study of legal mechanisms of state support for agribusiness through the introduction of virtual asset technologies is at the intersection of several scientific areas, which necessitates the analysis of interdisciplinary literature that covers legal, economic and technological aspects of the problem.

The foundational work laying the theoretical foundation for the legal regulation of blockchain and virtual assets is P.S. de Filippi and A . Wright's monograph is "Blockchain and the Law: The Rule of Code" (Filippi & Wright, 2018), in which the authors explore the legal aspects of blockchain technology and its application in various fields to the creation and circulation of virtual assets. The authors pay particular attention to the legal regulation of smart contracts, decentralized autonomous organizations (DAOs), and jurisdictional issues in the blockchain sector. However, the identified regulatory gaps significantly hinder the financing of agribusiness and the development of innovations. The lack of a clear legal framework for the tokenization of agricultural assets prevents farmers from accessing alternative sources of financing through fractional ownership models and blockchain-based investment platforms. Uncertainty about the enforceability of smart contracts undermines the development of automated agricultural insurance systems and supply chain financing mechanisms that can reduce transaction costs and improve capital efficiency. Furthermore, jurisdictional ambiguities create barriers to cross-border financing of agricultural trade and limit the creation of decentralized agricultural commodity exchanges. These regulatory shortcomings particularly affect small and medium-sized agribusinesses, which find it difficult to demonstrate compliance with ambiguous legal requirements, limiting their access to digital financial instruments and innovative financing mechanisms needed for agricultural modernization and sustainable growth in the economy.

In the study of Kudia O.O. "The Phenomenon of Virtual Assets: Economic and Legal Aspect" (Kudia 2020)] a systematic analysis of the legal nature of virtual assets is carried out and a classification of their types is proposed, which is important for understanding the possibilities of their application in the agricultural sector.

One of the first comprehensive studies of the legal nature of cryptocurrencies in Ukrainian legal science was the monograph by K.G. Nekit "Development of Legal Regulation of the Circulation of Virtual Assets (Cryptocurrencies) in Ukraine" (Nekit 2021), in which the author analyzes various approaches to determining the legal nature of cryptocurrencies, considers them as objects of civil rights, explores the problems of legal regulation of relations related to cryptocurrencies, and formulates proposals for improving

the legislation of Ukraine in this area. The researcher of the monograph pays special attention to the issues of the legal regime of cryptocurrencies and the protection of ownership rights to them.

The collective monograph proposed by M.V. Karavanskyi "Financial Policy of the State and Economic Entities: Coevolution and Synergistic Effect" (Karavanskyi 2022) analyzes the problems of taxation of transactions with virtual assets, in particular, the issue of determining the object of taxation, the tax base, tax rates and the procedure for administering taxes when carrying out transactions with cryptocurrencies. The authors substantiate the need to form a special tax regime for virtual assets with taking into account their specifics and international experience.

The research of Novak T.S. "Legal Support for Sustainable Agroecological Development: Evidence from Ukraine" (Novak 2023) deserves special attention, in which the author analyzes legal instruments for ensuring sustainable agroecological development in Ukraine. In her study, Novak puts forward the concept of an "ecosystem approach" to the legal regulation of state support for agribusiness, which provides for the integration of environmental requirements with economic incentives. The researcher highlights the legal mechanisms that allow for effective adaptation to technological innovations, including digital tools for monitoring and verifying compliance with environmental conditions for receiving state support. This work is of significant value for our research, as the conceptual model proposed by author Novak can be extrapolated to the field of implementation of virtual asset technologies in the mechanisms of state support for environmentally responsible agribusiness.

The practical aspects of the implementation of distributed ledger technologies in agriculture are considered in the article Buyak L., Pryshliak K., Buyak L. "Blockchain Technology as a Means of Selling Lease Rights on Agricultural Land" (Buyak et al. 2022) investigates the process of conducting land auctions for the sale of lease rights on agricultural land by the procedure for introducing electronic auctions using Blockchain technology.

International experience in the implementation of blockchain solutions in the agricultural sector is presented in the works of foreign researchers such as Lin Y.P., Petersen M. and Thompson K., who in the monograph "E-Agriculture in Action: Blockchain for Agriculture Opportunities and Challenges" (Lin et al. 2019) analyzed practical cases of implementing blockchain platforms in different countries and identified legal barriers to their scaling.

An important contribution to the study of cybersecurity in the agricultural sector is the work of Tsebula R. "Government Support for Cybersecurity in Agriculture: Opportunities and Limitations" (Tsebula 2021). The author analyzes the cybersecurity risks that arise during the introduction of digital technologies in agriculture, and the role of state support in minimizing them. The author Tsebula emphasizes the need to form a special legal regime to ensure the security of digital infrastructures of agribusiness, which is especially important in the context of virtual asset technologies that require a high level of protection. The researcher proposes the concept of "public-private partnership in the field of cybersecurity" as an optimal mechanism for protecting digital solutions in the agricultural sector. These findings are essential for our study, as security issues are critical when implementing blockchain solutions into government support mechanisms.

The fundamental question about the potential of blockchain to ensure transparency in agricultural supply chains is explored in the work of Kraft S.K. and Kellner F. "Can Blockchain Be a Basis to Ensure Transparency in an Agricultural Supply Chain?" (Kraft and Kellner 2022). The authors conduct a systematic analysis of the technical, organizational and legal prerequisites for the implementation of blockchain solutions to ensure transparency in the agricultural sector. Of particular value is the methodology developed by them for assessing the readiness of the legal system for the implementation of blockchain technologies in agricultural production, which can be adapted to analyze the readiness of Ukrainian legislation.

Based on empirical data, the authors prove that the introduction of blockchain technologies contributes to raising ethical standards of production and the fair distribution of state support among small farmers. The researchers identify the key legal barriers that prevent the scaling of blockchain solutions and suggest ways to overcome them through the modernization of the regulatory framework. This experience has significant potential for adaptation to Ukrainian realities, taking into account the specifics of national legislation and the structure of the agricultural sector.

3. Methods

The methodological basis for the study of legal mechanisms for state support of agribusiness through the implementation of virtual asset technologies is a comprehensive interdisciplinary approach that combines legal, economic and technological methods of analysis. To ensure a comprehensive study of the problems and the formation of relevant conclusions, the work used:

formal-legal methodology (for the analysis of regulatory legal acts of Ukraine and foreign countries in the field of regulation of virtual assets and state support of agriculture, which allows determining the features of the legal structure of virtual assets from the point of view of possible use for supporting agribusiness, identifying legal conflicts and gaps in current legislation);

comparative-legal methodology (comparison of legal models for regulating virtual assets in different jurisdictions and analysis of the possibilities of adapting advanced international experience to Ukrainian realities, thereby identifying the most effective practices and assessing the possibility of their implementation in Ukraine);

system-structural method (for a comprehensive analysis of the system of legal regulation of state support for agribusiness in Ukraine and determining the place of virtual assets in this system, thereby considering the legal mechanism as a holistic structure of interconnected elements, determining their hierarchy and functional relationships);

legal modeling method (for developing a conceptual model of integrating virtual asset technologies into the mechanism of state support for agribusiness, which allows predicting the possible consequences of the introduction of innovative technologies and presenting optimal ways to modernize the existing regulatory and legal framework);

statistical method (for analyzing data on the volume and structure of state support for agribusiness in Ukraine and foreign countries, as well as assessing the economic effect of the introduction of virtual asset technologies in the agricultural sector).

The use of a comprehensive methodology and various sources of information allowed us to ensure the comprehensiveness and objectivity of the study of the legal mechanism of state support for agribusiness through the introduction of virtual asset technologies and to formulate scientifically sound conclusions and practical recommendations for improving the relevant legislation of Ukraine.

4. Results

The analysis of the Laws of Ukraine "On Virtual Assets" and "On State Support of Agriculture of Ukraine" revealed that the current legal framework creates basic prerequisites for the use of virtual assets in the economy, but contains significant gaps in their application in the mechanisms of state support for agribusiness.

For example, the legal status of secured virtual assets remains insufficiently regulated, which complicates the process of tokenization of agricultural assets. Article 4 of the Law of Ukraine "On Virtual Assets" provides for the division of virtual assets into secured and unsecured. Thus, the security of a virtual asset is understood as its certification of property rights, in particular the rights of claim to other objects of civil rights. At the same time, the security of virtual assets is not a security for the fulfillment of an obligation, and the certification of property rights is understood as confirmation of the right of the owner of the secured virtual asset to demand the object of security. At the same time, there are no special rules on the specifics of the issuance and circulation of virtual assets secured by agricultural products or land, which does not allow them to be used as an asset for agribusiness entities.

The tax regime of transactions with virtual assets in the agricultural sector does not take into account the specifics of the industry (seasonality, specifics of the sales market, etc.). An analysis of the relevant provisions of the Tax Code of Ukraine showed the absence of tax incentives for the use of virtual assets in agriculture.

The regulatory framework for smart contracts in the context of state support administration is fragmented. Although the Law of Ukraine "On Virtual Assets" introduces the concept of a smart contract, there are no mechanisms for its use in the processes of providing state support to agricultural producers.

The institutional structure of regulation is characterized by a lack of coordination between the bodies responsible for the regulation of virtual assets (the National Securities and Stock Market Commission) and the bodies administering state support for agribusiness (the Ministry of Agrarian Policy and Food of Ukraine).

A comparative analysis of the legal regimes for the use of virtual asset technologies to support agribusiness in different jurisdictions allows us to identify several models with adaptation potential for Ukraine, requiring specific institutional frameworks to overcome regulatory gaps:

1. Agrarian Token Model (USA) – Institutional Framework: Joint Agricultural-Financial Regulatory Task Force

The USA's future harvest tokenization model enables farmers to issue crop-backed tokens for funding, potentially increasing farmers' financing access by 35-40% (De Jong 2020). To implement this in Ukraine, establishing a Joint Agricultural-Financial Regulatory Task Force comprising representatives from the Ministry of Agrarian Policy,

National Bank of Ukraine, and Securities Commission would be essential. This inter-agency body would develop standardized tokenization protocols, create farmer eligibility criteria, and establish investor protection mechanisms while streamlining approval processes across regulatory domains.

2. Blockchain Subsidies Model (EU) - Institutional Framework: Digital Agriculture Innovation Hub

The European Regulatory Sandbox for Blockchain Technologies facilitates smart contract-based subsidy distribution, enhancing transparency and reducing administrative costs. Ukraine could establish a Digital Agriculture Innovation Hub as a specialized unit within the Ministry of Digital Transformation, collaborating with agricultural and financial regulators to pilot blockchain-based subsidy programs, develop technical standards, and provide regulatory guidance for automated government support mechanisms.

3. Public-Private Partnership Model (Singapore) - Institutional Framework: Ukraine Agri-Blockchain Consortium

Singapore's Blockchain Innovation Programme (SBIP) with USD 9 million investment demonstrates effective government-private sector collaboration. Ukraine should create the Ukraine Agri-Blockchain Consortium, incorporating representatives from relevant ministries, leading agricultural enterprises, fintech companies, and research institutions. This consortium would coordinate investment strategies, establish shared blockchain infrastructure, and facilitate knowledge transfer between public and private stakeholders.

4. Regulatory Sandbox Model (Switzerland) – Institutional Framework: Agri-Tech Regulatory Laboratory

Switzerland's controlled testing environment for agricultural blockchain solutions, exemplified by the 2019 land lease blockchain prototype, provides a model for innovation testing. Ukraine needs an Agri-Tech Regulatory Laboratory operating under the joint oversight of the Ministry of Agrarian Policy and the Ministry of Digital Transformation. This laboratory would offer temporary regulatory relief for pilot projects, provide legal certainty for innovators, and generate evidence-based recommendations for permanent regulatory frameworks.

Cross-Cutting Institutional Mechanism: National Agri-Digital Council

To ensure coordination across all models, Ukraine should establish a National Agri-Digital Council chaired by the Deputy Prime Minister, including heads of relevant ministries, agricultural associations, and technology sector representatives. This council would harmonize inter-agency efforts, resolve jurisdictional conflicts, and provide strategic oversight for the comprehensive digital transformation of agricultural support mechanisms.

The analysis of international experience has shown that the most successful models are characterized by an integrated approach that combines legal regulation with the development of technological infrastructure and financial incentives.

Based on the study, it is worth proposing for discussion a conceptual model for the integration of virtual asset technologies into the mechanisms of state support for agribusiness in Ukraine, which will include the following components:

1. Regulatory framework, which will provide for the creation of a special legal regime for agricultural virtual assets, the development of a regulatory framework for the

use of smart contracts in the processes of administering state support in the field of agribusiness, the harmonization of legislation on virtual assets and state support for agriculture to the regulatory framework of the European Union countries and the introduction of mechanisms for legal protection of system participants.

2. The institutional component will include the creation of an interagency coordination council on the implementation of virtual asset technologies in the agricultural sector, the formation of an infrastructure for supporting and training experts (training centers, consultation points, etc.) and the development of a system for monitoring and evaluating the effectiveness of the implementation of technologies in the field of agribusiness.

3. The technological component provides for the creation of a national blockchain platform for the administration of state support for agribusiness, the development and approval of standards for the tokenization of agricultural assets, integration with existing state information systems and registers, as well as the implementation of cybersecurity solutions.

4. The economic component will ensure the development of a system of financial incentives for ecosystem participants, the creation of mechanisms for compensating the costs of digitalization for small and medium-sized producers, and the formation of a market for agricultural virtual assets.

In our opinion, the proposed model takes into account the success factors of international practices and the specifics of the Ukrainian agricultural sector identified in the process of the study and will ensure sustainable development in the agricultural sector, which is the key to post-war recovery.

5. Discussion

The results of the research indicate the presence of significant legal gaps in the regulation of the use of virtual assets to support agribusiness in Ukraine. The problem of the legal status of secured virtual assets in the context of agricultural production deserves special attention. As noted by Kud O.O. (2020), the tokenization of real assets requires clear legal mechanisms for establishing a connection between a virtual asset and its collateral. In the case of agricultural assets (land, future harvest, agricultural machinery), this problem is complicated by the specifics of objects, which often have a special legal regime.

The fragmentation of legislation on smart contracts revealed in the study is consistent with the conclusions of Kraft S.K. and Kellner F. (Kraft and Kellner 2022), who note that the successful implementation of blockchain technologies in agricultural supply chains requires not only technical solutions, but also the adaptation of the legal system to new technological realities. At the same time, our results show that smart contracts have a particularly high potential in the field of state support administration, where process automation can significantly increase transparency and efficiency.

Another important aspect identified in the study is the need for coordination between different regulatory bodies. This finding correlates with a study by Tsebula R. (Tsebula 2021), which emphasizes the importance of a comprehensive approach to regulating digital technologies in agriculture. However, unlike his work, our study focuses

on specific coordination mechanisms in the field of virtual assets used for state support of agribusiness.

The results of a comparative analysis of international models of the use of virtual asset technologies in the agricultural sector show a significant potential for their adaptation in Ukraine, however, taking into account a number of limitations. In particular, the American model of agricultural tokens, which has demonstrated high efficiency, needs to be adapted to Ukrainian realities, taking into account the peculiarities of land legislation and the structure of the agricultural market.

The model of blockchain subsidies being implemented in the EU looks especially promising for Ukraine in the context of European integration processes and harmonization of legislation. However, as Novak T.S. (Novak 2023) notes, the introduction of such innovations should take into account not only technological aspects, but also environmental and social dimensions of sustainable development of the agricultural sector.

According to our research, the Singapore model of public-private partnership may be particularly relevant for Ukraine, given the limited public resources and the need to attract private investment in the development of digital infrastructure. This is consistent with the findings of Mohammed I. et al. (Mohammed I. et al. 2024), who have proven the importance of combining public and private initiatives to ensure the successful implementation of blockchain technologies in agriculture.

One of the most alarming results of our study is the identification of a significant gap in the readiness of various categories of agricultural producers to implement virtual asset technologies. This is especially true for small farms, which demonstrate the lowest level of technological readiness and legal education. These data indicate the risk of deepening existing inequalities in access to resources and state support.

This finding correlates with the results of research by Mohammed I. et al. (Mohammed I. et al. 2024), which prove that without special compensatory mechanisms, technological innovations can lead to the marginalization of small producers. In the context of Ukraine, this problem can be especially acute, given the significant number of small farms and their role in ensuring food security and employment of the rural population.

Therefore, the conceptual model proposed in our study includes special mechanisms to support the digitalization of small and medium-sized producers, which can ensure a more inclusive nature of technological innovations.

The results of the analysis of the Ukrainian agricultural sector revealed one of the key dilemmas of the introduction of virtual asset technologies into the mechanisms of state support for agribusiness – the need to ensure a balance between stimulating innovation and maintaining the stability of legal regulation. On the one hand, overly tight regulation can stifle innovation and limit the potential of new technologies. On the other hand, the lack of a clear legal framework creates uncertainty and risks for market participants.

In this context, the Swiss model of regulatory sandboxes is of particular interest, which allows experimenting with new approaches in a controlled environment with further scaling of successful practices. This approach is consistent with the concept of "regulatory experiments" proposed by Kuznetsova N.S. (Kuznetsova 2021) for the introduction of digital innovations into traditional legal structures.

For Ukraine, this approach can be especially relevant, as it allows to reduce the risks of introducing radical changes throughout the country and ensure the evolutionary nature of legal transformations.

The conceptual model of integration of virtual asset technologies into the mechanisms of state support for agribusiness proposed in the study is based on the idea of synergy of legal, technological and economic factors. This approach differs from the technologically deterministic view common in the literature, which focuses mainly on the technical aspects of implementing blockchain solutions.

Our results show that the successful implementation of virtual asset technologies in the agricultural sector requires comprehensive changes in the legal field, institutional structure and economic mechanisms. This is consistent with the conclusions of Borshchevskyi O.M. (Borshchevskyi 2022), who emphasizes the need for a systematic approach to the regulation of the virtual asset market.

Also, unlike most studies that mainly consider the implementation of blockchain technologies in the private sector, our work focuses on their use in the field of public administration and state support. This leads to additional challenges related to the need to ensure the public interest, adhere to the principles of good governance, and take social aspects into account.

For example, the development of the digital system in Estonia, where 99% of public services are digital and integrated through the X-Road platform, contrasts sharply with Ukraine's fragmented institutional landscape. Estonian farmers access integrated digital services through a single portal, while agricultural aid in Ukraine covers several unconnected entities – the Ministry of Agricultural Policy, the National Bank and regional administrations.

Estonia has almost universal internet coverage, while nearly 30% of rural Ukraine does not have reliable connectivity, which has been exacerbated by the war. This requires hybrid analogue-digital support mechanisms that Estonia's fully digitized system does not require. Estonia has gained digital governance experience over 15 years of gradual transformation. Ukraine must simultaneously build technical capacity while implementing blockchain solutions, which requires accelerated institutional learning and extensive international assistance.

Ukraine's military context complicates the benefits of blockchain transparency, requiring a careful balance between open governance principles and national security concerns – challenges that do not exist in Estonia's stable peacetime environment.

These challenges underscore that blockchain integration in Ukraine requires a broader institutional transformation with respect to governance capacity, democratic accountability, and social inclusion – areas where the Estonian experience provides valuable lessons but cannot be directly replicated given the unique context of Ukraine's post-conflict reconstruction.

It is necessary to recognize some limitations of the study carried out. Firstly, its base is formed in the context of a limited practice of using virtual assets in the agricultural sector of Ukraine, which leads to a certain hypothetical nature of certain conclusions. Secondly, the dynamic nature of the development of both technologies and the regulatory environment requires constant updating and refinement of results.

Given these limitations, promising areas of further research are:

1. Conducting pilot projects on the implementation of virtual asset technologies in separate programs of state support for agribusiness with scientific support and evaluation of results.
2. An in-depth analysis of legal mechanisms for tokenization of specific agricultural assets, in particular agricultural land, taking into account the restrictions established by land legislation.
3. Development of a methodology for assessing the impact of the introduction of virtual asset technologies on the effectiveness of state support for agribusiness and the availability of support programs for different categories of producers.
4. Study of the cross-sectoral effects of the introduction of virtual asset technologies, in particular their impact on related industries (financial sector, logistics, processing industry) and rural development in general.

6. Conclusions

The study of legal mechanisms of state support for agribusiness through the introduction of virtual asset technologies allows us to formulate a number of conclusions: The existing regulatory framework of Ukraine in the field of virtual assets creates only basic prerequisites for their use in the mechanisms of state support for agribusiness, without providing comprehensive regulation of specific aspects of their use in the agricultural sector. The authors identified the key legal gaps that hinder the effective implementation of blockchain technologies such as: insufficient regulation of secured virtual assets; lack of special mechanisms for the use of smart contracts in the administration of state support; non-adaptation of the tax regime to the specifics of the agricultural sector; lack of coordination between regulators in the financial and agricultural sectors.

The analysis of international experience shows the effectiveness of four key models of using virtual asset technologies to support agribusiness: the model of agricultural tokens (the USA), the model of blockchain subsidies (EU), the model of public-private partnership (Singapore) and the model of regulatory sandboxes (Switzerland). Each of these models has the potential for adaptation in Ukraine, provided that the national specifics of legal regulation and the structure of the agricultural sector are taken into account.

Empirical data indicate different levels of readiness of agricultural market participants to introduce virtual asset technologies, which creates a risk of deepening the digital divide between different categories of producers. The most vulnerable in this context are small farms, which demonstrate the lowest level of technological readiness and legal education. This requires the development of special compensatory mechanisms to ensure the inclusive nature of technological innovations.

The analysis revealed significant potential for the introduction of virtual asset technologies into the mechanisms of state support for agribusiness, especially in the aspects of increasing the transparency of the distribution of support, reducing administrative costs and expanding the access of small and medium-sized producers to government programs. At the same time, the authors identified the key risks: regulatory uncertainty, cybersecurity

problems, digital divide and the complexity of integration with existing information systems.

The proposed conceptual model for the integration of virtual asset technologies into the mechanisms of state support for agribusiness includes four interrelated components: legal (creation of a special legal regime for agricultural virtual assets), institutional (formation of coordination structures and support infrastructure), technological (development of the national blockchain platform and standards) and economic (system of financial incentives and compensatory mechanisms). The model is aimed at ensuring the synergy of legal, technological and economic factors of innovation.

For the effective implementation of the proposed model, it is necessary to amend a number of regulatory legal acts of Ukraine, in particular:

- Supplement the Law of Ukraine "On Virtual Assets" with provisions on the specifics of virtual assets in agriculture and their use in state support mechanisms, including mandatory cybersecurity standards for agricultural blockchain platforms, requirements for the protection of farmers' personal data, and technical specifications for the secure deployment of smart contracts in agricultural tokenization;
- Amend the Law of Ukraine "On State Support for Agriculture of Ukraine" to provide for the possibility of using blockchain technologies and smart contracts to administer support programs, while establishing cybersecurity compliance requirements for participating platforms and mandatory security audits for government-integrated blockchain systems;
- Amend the Tax Code of Ukraine with provisions to stimulate taxation of virtual asset transactions in the agricultural sector, including tax breaks for farmers investing in cybersecurity infrastructure and deductions for digital literacy training costs;
- Develop a special law on regulatory sandboxes for blockchain projects in agriculture, including mandatory cybersecurity testing protocols and security admission procedures for sandbox participants.
- Adopt regulations on agricultural blockchain security that will establish minimum cybersecurity standards for virtual agricultural asset platforms, including requirements for encryption protocols, multi-factor authentication, incident reporting procedures, and regular security assessments. This legislation should provide for cooperation between the State Service for Special Communications and Information Protection and agricultural blockchain operators;
- Create legal provisions for a “National Agricultural Cybersecurity Response Center” within the existing emergency response framework, ensuring rapid response to incidents of attacks on agricultural blockchain infrastructure and coordination with national security agencies.
- Amend the Law of Ukraine “On Education” to include digital literacy requirements specifically for agricultural professionals, establish standards for certification of blockchain competence, and create legal pathways for government-subsidized digital learning programs;
- Amend budget legislation to create a special “Digital Literacy Fund in Agriculture” that will provide subsidies for educational programs for farmers, purchase of technical equipment, and development of rural internet infrastructure necessary for access to the blockchain platform;

- Develop regulations for "Digital Agricultural Advisory Services", expanding the mandate of agricultural advisory services, including blockchain technology guidance, cybersecurity awareness training, and technical support for virtual asset implementation.
- Create a legal framework for agricultural blockchain insurance, which will enable the use of specialized insurance products covering cybersecurity incidents, smart contract failures, and technology implementation risks for farmers participating in virtual asset programs;
- Introduce legislation on a rural cybersecurity cooperative, which will allow farmers to collectively invest in shared cybersecurity infrastructure and expertise, with government support for the costs of establishing and operating cooperatives.

These comprehensive legislative changes will create a robust legal ecosystem that supports both technological innovation and security resilience in Ukraine's efforts to digitize agriculture.

Therefore, the introduction of virtual asset technologies into the mechanisms of state support for agribusiness should be carried out in stages, starting with pilot projects in certain regions and support programs, followed by scaling up successful practices. This approach will minimize risks and ensure the adaptation of the regulatory framework based on practical experience.

At the same time, special attention should be paid to ensuring a balance between stimulating innovation and maintaining the stability of legal regulation. The regulatory sandbox model, which involves the experimental implementation of innovations in a controlled environment, can be an effective tool.

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