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## Digitalization and innovative technologies for the development of the agricultural sector within the food security framework

I. O. Androshchuk

**Purpose.** The purpose of the article is to provide a theoretical substantiation and systematization of the impact of innovative technologies and the digital transformation of the agricultural sector on the formation of food security, as well as to identify the channels, risks, and managerial conditions under which digitalization is transformed from a technological process into a factor of resilience of agri-food systems.

**Methodology.** The methodological basis of the study includes systemic, structural-functional, process-based, risk-oriented, and institutional approaches. The article applies the methods of theoretical generalization, comparative analysis, typologization, structural-logical modelling, formalization, and the indicator-based approach.

**Findings.** The article demonstrates that the digital transformation of the agricultural sector affects food security through four basic channels: increasing production volumes, reducing food losses, lowering transaction costs, and strengthening quality and safety control of products. A structural-functional model of the digital transformation of the agri-food chain is substantiated, in which production, supply, and regulation are connected by a two-way exchange of data and managerial decisions.

**Originality.** The scientific novelty lies in the deepened theoretical interpretation of digitalization of the agricultural sector as a multi-level determinant of food security, the development of the author's typology of innovative agrotechnologies according to their channels of influence on food-security components, and the formalization of the integrated relationship among technological, market, quality-related, and risk parameters of the agri-food system.

**Practical value.** The practical significance of the results lies in the possibility of using them in the development of national and regional agri-food policy, agricultural digitalization programmes, strategies for supporting agricultural producers, investment projects in the AgTech sector, and monitoring systems for risks related to cybersecurity, agricultural data, infrastructure, and human resources.

**Keywords:** food security, agricultural sector, digital transformation, innovative technologies, precision agriculture, AgTech, biotechnology, digital platforms, traceability, cybersecurity.

### Introduction

In the contemporary global economy, the agricultural sector is gradually moving from models in which outcomes were determined primarily by natural and climatic conditions, land resources, and capital toward models in which data, the speed of managerial response, the precision of technological operations, and the ability of producers to operate within digital value chains play a decisive role. This is particularly important for food security, since its parameters depend not only on the physical availability of products but also on the stability of supply, the accessibility of food, its quality and safety, and the capacity of the agri-food system to respond to shocks.

Digital tools - sensors, drones, satellite monitoring, cloud services, artificial intelligence, blockchain, digital platforms, and fintech solutions - are changing the logic of agricultural-sector functioning. They make it possible to analyse the condition of crops in real time, forecast yields and weather risks, optimize fertilizer application, manage inventories, ensure product traceability, and strengthen trust among market participants (Nehrei, 2023; Metelenko, Svintsova, & Nikitenko, 2025).

The relevance of the study is reinforced by the fact that digitalization of the agricultural sector is not a neutral technical modernization. It creates opportunities for reducing losses and lowering costs, but at the same time it generates new risks: cyber threats, dependence on global technology suppliers, the problem of protecting agricultural data, uneven infrastructure development, energy vulnerability, and a shortage of digital competencies. Therefore, scientific analysis must combine technological, economic, institutional, and security dimensions.

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In this context, innovative technologies should be considered as a separate determinant of food security along with trade, market mechanisms, and institutional regulation. While trade increases the movement of food flows, technologies directly transform the very basis of supply formation: productivity, losses, costs, quality, risks, and trust in products. For this reason, digital transformation requires systematic interpretation as a factor of food resilience.

### **Literature Review**

In the academic literature, the digital transformation of the agricultural sector is interpreted as a multidimensional process that includes technological renewal of production, organizational change, the development of digital-platform markets, increased environmental efficiency, and strengthened risk management. Nehrei (2023) focuses on the prospects, challenges, and managerial solutions of agricultural digitalization, emphasizing the role of data in improving the productivity and adaptability of agribusiness. Metelenko, Svintsova, and Nikitenko (2025) link digitalization to the implementation of green technologies and sustainable development, which is important for connecting food and environmental security.

Palii and Kantsedal (2025) consider digital transformation as a factor in increasing the competitiveness of agricultural enterprises in Ukraine. Their approach is important because digitalization is interpreted not only as a set of individual tools but also as a transformed ability of an enterprise to manage costs, quality, and market relations. Melnyk (2025) details the economic advantages of digital transformation, including cost reduction, increased speed of decision-making, and the integration of production information with market signals. Yaroshchuk (2024) substantiates the impact of digital technologies on the efficiency of agricultural production, which is directly linked to the physical availability of food products.

A separate body of research is devoted to food security as an economic and social category. Hmyria (2019) considers food security as one of the basic vectors of national economic development. Hlushkov (2025) systematizes the evolution of the concept of food security and the modern imperatives of its provision, while Stashkevych (2025) emphasizes the threats affecting the level of food security in Ukraine. These studies form a theoretical context in which technological modernization can be assessed not only by production indicators but also by its influence on the accessibility, stability, and quality of nutrition.

International studies complement this approach by analysing the role of digitalization in achieving the sustainability goals of agricultural systems. MacPherson et al. (2022) show that future agricultural systems will increasingly depend on digital tools capable of integrating environmental, economic, and social dimensions. In biotechnology, Bouis and Saltzman (2017) reveal the importance of biofortification for improving nutritional quality, while ISAAA (2019) materials demonstrate the scale of commercialization of biotechnology crops. Thus, the innovation dimension of food security includes both digital and biological technologies.

Despite the substantial body of research, the issue of the specific channels through which digital and innovative technologies transform the components of food security remains insufficiently systematized. The analysis of digitalization risks in the agricultural sector and of the institutional conditions under which technological opportunities are converted into real socio-economic results also requires further development.

### **Purpose of the Study**

The purpose of the study is to theoretically substantiate the impact of innovative technologies and the digital transformation of the agricultural sector on food security, to systematize the channels of this impact, to develop a structural-

functional model of digital transformation of the agri-food chain, and to identify the key risks that should be taken into account in national and corporate agricultural-digitalization policy.

### **Methodology**

The methodological logic of the study is based on a combination of systemic and structural-functional approaches. The systemic approach makes it possible to view the agricultural sector as part of the agri-food system in which production, storage, processing, logistics, the market, financial instruments, and regulation are mutually dependent links. The structural-functional approach is used to determine the role of individual technological blocks in ensuring the availability of products, access to them, supply stability, quality, and safety.

The typologization method is applied to group innovative agrotechnologies according to the main channels of their influence on food security: increasing production, reducing losses, lowering transaction costs, and quality and safety control. Structural-logical modelling is used to build a model of the digital transformation of the agri-food chain in which data are converted into decisions at the levels of production, supply, and regulation.

The risk-oriented approach is applied to identify the limitations of digitalization related to cybersecurity, confidentiality of agricultural data, technological dependence, financial barriers, infrastructure unevenness, energy risks, and human-resource provision. The indicator-based approach is used to propose a system of indicators for monitoring the impact of digitalization on food security.

### **Results and Discussion**

#### **Digitalization as a Multi-Level Determinant of Food Security**

Within the framework of this study, innovative technologies should be interpreted as a set of technical, biological, and information-analytical solutions that provide new approaches to the production, processing, storage, handling, and control of agri-food products. This definition avoids reducing innovation exclusively to digital services and reflects the real transformation of the agricultural sector at the intersection of precision agriculture, biotechnology, robotization, platform models, logistics technologies, fintech solutions, and regulatory digital systems.

The influence of digitalization on food security has a cause-and-effect structure. At the first stage, technologies change production, storage, and logistics processes. At the second stage, these processes transform production outcomes: yields, losses, costs, risks, and product quality. At the third stage, changes are transferred into the components of food security: physical availability of food, economic and physical access for the population, stability of supply over time, and the quality and safety of nutrition. At the same time, the institutional environment and public policy act as moderators: they can accelerate or limit technological effects.

The proposed logic shows that digitalization is not limited to technical renewal of production. It forms a closed management circuit in which data become the basis for decisions, decisions change the operational parameters of agricultural production, and results influence the market, the consumer, and public policy. Therefore, food security in the digital era depends not only on land potential but also on the quality of digital infrastructure, trust in data, the ability of farmers to work with analytics, and the readiness of public institutions to integrate digital tools into agricultural-sector regulation.

#### **Structural-Functional Model of Digital Transformation of the Agri-Food Chain**

The digital transformation of the agri-food chain has at least three interconnected levels: production, logistics and supply, and management and regulation. The first

level generates primary data through sensors, drones, satellite images, precision-agriculture systems, automated machinery, and yield analytics. The second level converts physical product flows into managed digital chains through smart warehouses, cold chains, transport trackers, demand forecasting, and inventory management. The third level provides strategic coordination through traceability, digital certification, safety control, analytics, and platforms Table 1).

**Table 1**  
**Structural-Functional Model of Digital Transformation of the Agri-Food Chain**

| Level of digital transformation | Main technologies and data   | Managerial decisions  | Effect on food security  |
|---------------------------------|--|---|--|
| Production                      | IoT sensors, GPS/GIS, drones, satellite images, robotization, yield analytics, field maps.                           | Differentiated application of fertilizers and plant-protection products, irrigation schedule, crop selection, yield forecasting, preventive plant protection. | Productivity growth, resource saving, reduction of weather and technological risks, and a more stable food supply. |
| Supply and logistics            | Smart warehouses, cold chain, transport trackers, demand-forecasting systems, digital inventory management.          | Route optimization, management of storage periods, supply planning, reduction of downtime and overloads.  | Reduction of post-harvest losses, higher supply stability, and better product availability in the market.          |
| Management and regulation       | Blockchain registers, electronic certification, platforms/marketplaces, reporting analytics, safety-control systems. | Verification of product origin, digital confirmation of standards, regulatory monitoring, and investment incentives.  | Market transparency, consumer trust, lower transaction costs, and compliance with safety standards.                |

*Source: systematized by the author based on Nehrei (2023), Melnyk (2025), and Yaroshchuk (2024).*

A key element of this model is the two-way exchange of «data – decisions». Production data affect logistics, contracting, certification, and regulatory control, while market signals and institutional requirements adjust production parameters. As a result, an integrated agri-food system is formed in which efficiency, transparency, resilience, and quality become interconnected outcomes of digitalization.

### **Typology of Innovative Agrotechnologies by Channels of Influence**

For comprehensive analysis, innovative technologies in the agricultural sector should be grouped not only by their technical origin but also by the food-security elements they strengthen and the economic channel through which they operate. This approach makes it possible to move from a simple list of technologies to an understanding of their functional contribution to food resilience (Table 2).

The first group of technologies affects the physical availability of food. Precision agriculture with GPS navigation, variable rates of fertilizer application, and remote sensing makes it possible to move from “average norms” to management of individual field zones. This reduces excessive resource use, stabilizes yields, and makes production more predictable (Palii & Kantsedal, 2025; Yaroshchuk, 2024).

The second group is aimed at reducing post-harvest losses. For food security, this is as important as increasing production, since losses in storage and logistics reduce the actual supply of food. Sensor systems in warehouses, temperature and humidity control, transport trackers, and demand forecasting make it possible to reduce inefficient movements and prevent product spoilage.

The third group is associated with digital platforms and financial technologies. Marketplaces, smart contracts, electronic payments, and alternative models for assessing producers’ creditworthiness reduce the number of intermediaries, decrease information asymmetry, and facilitate access of small and medium-sized agricultural

**Table 2**

**Typology of Innovative Agrotechnologies by Areas of Influence on Food Security**

| Technology group              | Examples of tools  | Channel of influence   | Food-security component  |
|-------------------------------|--|--|--|
| Increasing production volumes | Precision agriculture, AI yield forecasting, modern breeding, biotechnology, robotization.   | Resource optimization, productivity growth, adaptation of crops to stress.             | Physical availability of food and stability of production.             |
| Reducing food losses          | Cold chain, sensor-based storage systems, logistics forecasting, smart warehouses.           | Reduction of spoilage, downtime, excessive stocks, and mechanical damage.              | Supply stability, product availability, and reduced price pressure.    |
| Lowering transaction costs    | Marketplaces, smart contracts, digital payments, fintech solutions, electronic certificates. | Reduction of information asymmetry, acceleration of contracting, access to financing.  | Economic access, market competition, and inclusion of small producers. |
| Quality and safety control    | Traceability systems, digital laboratory systems, blockchain registers, HACCP integration.   | Verification of origin, control of storage conditions, rapid recall of unsafe batches. | Quality, safety, and nutritional value of products; consumer trust.    |

*Source: compiled by the author based on Nehrei (2023), Palii and Kantsedal (2025), Metelenko, Svintsova, and Nikitenko (2025), and Stashkevych (2025).*

producers to the market (Kalachenkova, 2025; SPILCA, n.d.; Tradomatic, n.d.). The fourth group forms the basis of trust: digital traceability and safety-control systems make it possible to verify origin, storage conditions, and compliance with quality standards.

### Precision Agriculture and the Digital Management Cycle

Precision agriculture is one of the clearest examples of how digitalization changes agronomic practice. Its essence lies in differentiated management of technological operations depending on the spatial heterogeneity of soils, microclimate, crop condition, and forecast yield. Unlike the traditional approach, where resources are often applied according to average norms, precision agriculture focuses on the specific needs of each field zone.

In the digital management cycle, primary information on soil, crop, and weather conditions is transformed into field management-zone maps. These maps support differentiated application of fertilizers, water, and plant-protection products. Machine-learning algorithms integrate spatial data with time series, making it possible to forecast yields, disease and pest risks, the consequences of weather anomalies, and the optimal timing of agrotechnological operations (MacPherson et al., 2022).

It is important that digital forecasts go beyond the field. They are combined with data on prices, demand, logistical constraints, and resource availability. As a result, farmers receive not only agronomic recommendations but also economically justified decisions: what to sow, when to sow it, for which market, with what costs and risks. This shifts food-supply management from a reactive logic to a proactive one.

### Biotechnologies as an Instrument of Long-Term Resilience

Alongside digital forecasts that enable faster responses to weather and operational risks, biotechnologies operate at a deeper level - the level of the genetic resilience of crops. The biotechnology segment of agricultural innovation is aimed at increasing plant resistance to drought, salinity, pests, and diseases, as well as improving the nutritional value of products. This is directly related to food security, because it ensures yield stability where traditional intensification tools are limited.

Biofortification is an example of a technology that affects not only the quantity but also the quality of nutrition. HarvestPlus studies show that enriching crops

with micronutrients can reduce the manifestation of nutrient deficiency and thus influence “hidden hunger”, when the caloric value of food is sufficient but its micronutrient value is low (Bouis & Saltzman, 2017). Therefore, biotechnologies strengthen the quality and nutritional-value components of food security.

At the same time, biotechnologies require balanced regulation, transparent communication with consumers, and scientifically grounded risk assessment. Their contribution to food security will vary depending on the regulatory regime, laboratory infrastructure, trust in institutions, farmers’ access to technologies, and the state’s ability to balance innovation, safety, and public acceptance.

### **Digital Platforms, Fintech, and Product Traceability**

Digital platforms change the mechanisms of interaction among producers, processors, traders, logistics operators, and financial institutions. Their importance for food security lies not only in the convenience of trade but also in reducing transaction costs, improving small producers’ access to markets, accelerating contracting, and increasing the transparency of pricing.

Platform solutions such as SPILCA or Tradomatic show that a digital agricultural market can cover the full cycle - from verification of lots and documents to comparison of offers, logistics, and payments. The producer gains wider access to buyers, while the buyer receives more information about quality, origin, and delivery conditions. This reduces dependence on traditional intermediaries and can strengthen market competition.

Fintech solutions complement the platformization of the agricultural market. Alternative data sources - satellite imagery, yield history, meteorological forecasts, and digital contracts - can be used to assess producers’ creditworthiness and insure risks. In the long term, this changes the model of farmers’ access to finance, since credit or insurance coverage can be provided not only against traditional collateral but also against forecast harvests or digitally verified assets.

Product traceability is another block of digital transformation. It creates a digital passport for a product batch, recording its origin, cultivation conditions, laboratory-test results, storage conditions, transportation, and sale. As a result, consumers, exporters, and regulators can verify the product’s path “from field to consumer”, and if an unsafe batch is detected, the problem can be localized quickly.

### **Risks of Digital Transformation of the Agricultural Sector**

The implementation of digital solutions does not bring only positive effects. The more the agricultural sector depends on digital platforms, cloud services, sensors, satellite data, and automated machinery, the more vulnerable it becomes to cyber incidents, power outages, data loss, or external technological dependence. Therefore, digitalization should be viewed not only as an opportunity but also as a sphere of managing new risks (Vakulenko, Yuntao, & Smetan, 2024; Tsykunov, 2025) (Table 3).

National security of agricultural data is becoming especially important. Data on production volumes, crop structure, yields, logistics routes, and food stocks can be considered a strategic resource. Therefore, management of the digital transformation of the agricultural sector should include not only technological standards but also rules for data access, protocols for data storage, criteria for localizing critically important information, and mechanisms of interaction among the state, producers, and technology companies.

### **Formalization of the Impact of Digitalization on Food Security**

Given the multichannel nature of digitalization’s influence, the integral effect of innovative technologies on food security can be represented as a function of five blocks:

**Table 3**

**Risks of Digital Transformation of the Agricultural Sector and Managerial Responses**

| Risk group                           | Nature of the risk  | Possible consequences for food security   | Managerial response  |
|--------------------------------------|---|---|--|
| Cybersecurity                        | Attacks on platforms, machinery-control systems, warehouses, logistics, and financial services.                 | Suspension of production and logistics processes, data loss, supply disruptions.              | Cyber-risk audits, backups, cyber hygiene, national security standards, and incident response.                       |
| Confidentiality of agricultural data | Commercially valuable data on fields, yields, crop structure, and logistics flows may be used by third parties. | Market manipulation, unequal bargaining positions, and strategic risks.                       | Rules for agricultural-data ownership, access agreements, encryption, and control of data exchange.                  |
| Technological dependence             | Dependence on global suppliers of platforms, equipment, software, and services.                                 | High costs, risk of service blocking, and limitations on digital sovereignty.                 | Development of national platforms, open standards, supplier diversification, and support for local AgTech companies. |
| Financial barriers                   | High cost of sensors, machinery, analytical platforms, and staff training.                                      | Digital divide between large and small producers and unequal access to technological effects. | Grants, leasing, cooperative use of machinery, tax incentives, and public digitalization programmes.                 |
| Infrastructure unevenness            | Insufficient mobile coverage and high-speed internet in rural areas.  | Limited operation of IoT, drones, cloud services, and platforms in remote territories.        | Development of rural broadband, public-private projects, and prioritization of agricultural territories.             |
| Energy vulnerability                 | Dependence of digital services, servers, warehouses, and equipment on uninterrupted electricity supply.         | Failures in data management, logistics, storage, and the cold chain.                          | Backup power, renewable energy on farms, and energy-efficient data solutions.  |
| Human-resource shortage              | Insufficient digital competencies of farmers and managers.  | Low use of technological potential and errors in data and decisions.                          | Training, advisory services, digital agricultural schools, and partnerships with universities and IT businesses.     |
| Environmental consequences           | Production of electronic equipment, e-waste, and data-centre energy consumption.                                | Transfer of environmental burden to digital infrastructure.                                   | Equipment life-cycle management, reuse, recycling, and green data centres.   |

*Source: compiled by the author based on Vakulenko, Yuntao, and Smetan (2024), Tsykunov (2025), GRAIN (2025), and Propozytsiia (2021, 2024).*

$$FS_{dig} = f(P, L, T, Q, R; I), \quad (1)$$

where  $FS_{dig}$  denotes the digital-innovation contribution to food security; the productivity effect (P) reflects the influence of technologies on production volumes and production stability; the loss-reduction effect (L) characterizes the reduction of losses in storage, logistics, and processing; the transaction effect (T) shows the reduction of market-interaction costs and the facilitation of market access; the quality-and-safety effect (Q) reflects traceability, certification, and safety control; the risk component (R) covers cyber, infrastructure, human-resource, energy, and regulatory threats; and the institutional environment (I) moderates the strength and direction of the influence of these blocks.

According to this logic, digitalization has a positive effect only when the growth of P, L, T, and Q outweighs the negative influence of the risk components R, while the institutional environment I ensures technology accessibility, data standardization, information protection, and the development of digital competencies. In other words, technological potential by itself does not guarantee food security; it requires

appropriate infrastructure, financing, human capital, and regulatory support (Table 4).

The proposed system of indicators can be used as a basis for applied monitoring of the digital transformation of the agricultural sector at the national, regional, or corporate level. The advantage of the proposed system is that it is not limited to the number of implemented technologies but focuses on their outcome for food security. This makes it possible to assess not the fact of digitalization itself but its capacity to ensure the productivity, accessibility, stability, quality, and resilience of the agri-food system.

### Conclusions

**Table 4**

**Indicators for Assessing the Impact of Agricultural-Sector Digitalization on Food Security**

| <b>Model block</b>            | <b>Content of the block</b>  | <b>Possible monitoring indicators</b>  |
|-------------------------------|--|--|
| P - productivity              | Impact of technologies on production volumes and production stability. | Crop yields; share of area under precision agriculture; number of farms using drones, sensors, GPS/GIS; yield deviation between seasons.   |
| L - losses                    | Reduction of losses in storage, logistics, and processing.             | Share of products passing through a controlled cold chain; post-harvest losses; share of warehouses with sensor monitoring; average delivery time.   |
| T - transaction costs         | Reduction of market-interaction costs and access to financing.         | Share of transactions through digital platforms; average contracting time; number of farmers connected to digital marketplaces; share of digital payments; amount of financing through agri-fintech.                   |
| Q - quality and safety        | Verification of product origin and circulation conditions.             | Share of batches with digital traceability; number of electronic certificates; time needed to recall an unsafe batch; share of enterprises with digital HACCP integration.   |
| R - risks                     | Cyber, infrastructure, human-resource, energy, and regulatory risks.   | Number of cyber incidents; share of farms with data backups; internet coverage of agricultural territories; share of staff with digital training; cybersecurity expenditures.  |
| I - institutional environment | Conditions that strengthen or limit the technological effect.          | Availability of public AgTech support programmes; agricultural-data standards; public-private digital-infrastructure projects; access to grants and leasing; community participation in digital agricultural projects. |

*Source: developed by the author.*

The article substantiates that innovative technologies and the digital transformation of the agricultural sector are independent determinants of food security and influence not only production processes but also storage, logistics, market interaction, financing, quality control, and risk management. Their contribution is manifested through changes in yield parameters, supply stability, transparency, and trust in products.

Four main channels through which innovative agrotechnologies influence food security are systematized: increasing production volumes, reducing food losses, lowering transaction costs, and strengthening quality and safety control. This typology makes it possible to evaluate digitalization not as a set of separate tools but as a functional mechanism for strengthening the reliability, accessibility, stability, and quality of food products.

The developed structural-functional model shows that the digital transformation of the agri-food chain is formed at three levels: production, supply, and regulation. Together with the two-way exchange of “data - decisions”, these levels create a closed circuit of digital management and make it possible to move from reactive risk response to proactive planning.

It is determined that the risks of digitalization - cyber threats, confidentiality of agricultural data, technological dependence, financial barriers, infrastructure

unevenness, energy vulnerability, human-resource shortages, and the environmental consequences of digital infrastructure - may reduce the positive effect of technological modernization. Therefore, digital agri-food policy should be not only innovation-oriented but also risk-oriented.

The practical significance of the proposed provisions lies in the possibility of using them to develop agricultural-sector digitalization programmes, national and regional food-security strategies, monitoring systems for AgTech projects, and mechanisms to support small and medium-sized producers of agricultural products. Further research should focus on empirical measurement of the proposed indicators, comparison of the digital maturity of agricultural regions, and assessment of the impact of digitalization on the resilience of food chains under global and wartime shocks.

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### **Андрощук І.О. Цифровізація та інноваційні технології розвитку аграрного сектору в системі продовольчої безпеки**

**Мета.** Метою статті є теоретичне обґрунтування та систематизація впливу інноваційних технологій і цифрової трансформації аграрного сектору на формування продовольчої безпеки, а також визначення каналів, ризиків та управлінських умов, за яких цифровізація перетворюється з технологічного процесу на чинник стійкості агропродовольчих систем.

**Методологія.** Методологічна основа дослідження включає системний, структурно-функціональний, процесний, ризик-орієнтований та інституційний підходи. У статті застосовано методи теоретичного узагальнення, порівняльного аналізу, типологізації, структурно-логічного моделювання, формалізації та індикаторного підходу.

**Висновки.** У статті продемонстровано, що цифрова трансформація аграрного сектору впливає на продовольчу безпеку через чотири основні канали: збільшення обсягів виробництва, зменшення втрат продовольства, зниження транзакційних витрат і посилення контролю якості й безпеки продукції. Обґрунтовано структурно-функціональну модель цифрової трансформації агропродовольчого ланцюга, у якій виробництво, постачання та регулювання пов'язані двостороннім обміном даними та управлінськими рішеннями.

**Оригінальність.** Наукова новизна полягає у поглибленій теоретичній інтерпретації цифровізації аграрного сектору як багаторівневого детермінанта продовольчої безпеки, розробленні авторської типології інноваційних агротехнологій за каналами їх впливу на складові продовольчої безпеки та формалізації інтегрованих взаємозв'язків між технологічними, ринковими, якісними та ризиковими параметрами агропродовольчої системи.

**Практична цінність.** Практичне значення результатів полягає у можливості їх використання під час розроблення національної та регіональної агропродовольчої політики, програм цифровізації сільського господарства, стратегій підтримки сільськогосподарських виробників, інвестиційних проєктів у секторі AgTech, а також систем моніторингу ризиків, пов'язаних з кібербезпекою, сільськогосподарськими даними, інфраструктурою та людськими ресурсами.

**Ключові слова:** продовольча безпека, аграрний сектор, цифрова трансформація, інноваційні технології, точне землеробство, AgTech, біотехнології, цифрові платформи, простежуваність, кібербезпека.

Андрощук Ілона Олександрівна – кандидат економічних наук, доцент, доцент кафедри економіки, менеджменту та комерційної діяльності Центральноукраїнського національного технічного університету (e-mail: [androschukio@kntu.kr.ua](mailto:androschukio@kntu.kr.ua), ORCID ID: <https://orcid.org/0000-0002-2232-8061>).  
Androschuk Ilona Oleksandrivna – Ph.D. (Econ.), Assoc. Prof., Associate Professor of the Department of economics, management and commercial activities of the Central Ukrainian National Technical University.

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