

**ENTROPIC DEVELOPMENT OF UKRAINE'S AGRICULTURAL TRADE
LOGISTICS SYSTEM: DIGITAL TRANSFORMATION, ARTIFICIAL
INTELLIGENCE, AND ADAPTIVE RESILIENCE**

Mariia TEPLIUK, <https://orcid.org/0000-0001-6823-336X>,

Ph.D in Economics, Associate Professor, Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine, maria_6.11@kneu.edu.ua

Article type:
Research Article

Received:
12.03.2026

Accepted:
27.04.2026

Published:
31.05.2026

UDC
339.13:631.1:004.
8:519.876

JEL
Classification:
C45, O39, Q13,
Q57, R41

**Founder and
Publisher:**
Kyiv National
Economic
University named
after Vadym
Hetman

Abstract. This article examines the theoretical and practical aspects of entropy-oriented development of the agricultural trade logistics system in Ukraine in the context of an unpredictable external environment. The relevance of the study stems from the growing level of uncertainty, heightened geopolitical risks, infrastructure constraints and large-scale global economic transformations, which directly affect the efficiency of the agricultural sector and supply chain logistics. In particular, the constant instability of international trade routes, climate variability and the consequences of military actions significantly complicate the functioning of logistics systems and require fundamentally new approaches to management. The aim of the study is to substantiate the impact of entropic processes on the agricultural trade logistics system and to identify key directions for its adaptive transformation under current conditions. The methodological framework is based on a systems approach, which allows the logistics system to be viewed as a complex dynamic structure, as well as on economic and mathematical modelling, analysis and synthesis, and statistical and comparative methods. The results obtained indicate that the agricultural trade logistics system in Ukraine operates under conditions of increased entropy, manifested in the destabilisation of commodity flows, rising costs, the transformation of transport routes and an increase in logistical risks. Particular attention is paid to the system's adaptive capacity, which is expressed in the expansion of multimodal transport solutions and the diversification of export destinations. The study justifies the feasibility of implementing anti-entropy mechanisms, in particular market diversification, the development of multimodal transport, infrastructure modernisation, and the introduction of digital technologies, notably artificial intelligence. The scientific novelty lies in the development of a conceptual model of the entropic development of the logistics system, taking into account transcendental influencing factors. The practical significance of the results lies in their applicability to the development of effective agri-logistics management strategies, enhancing the resilience of logistics processes, and strengthening Ukraine's competitive position in the global agricultural market.

Keywords: agri-trading, logistics system, entropy, transcendence, agricultural sector, multimodal transport, digitalization, competitiveness.

Cite as: Tepluk, M. (2026). Entropic Development of Ukraine's Agricultural Trade Logistics System: Digital Transformation, Artificial Intelligence, and Adaptive Resilience. *Strategy of Economic Development of Ukraine*, 58, 110-121.

<https://doi.org/10.33111/sedu.2026.58.110.121>



Introduction

The current development of Ukraine's agricultural sector is taking place against a backdrop of a highly dynamic external environment, growing global competition, instability in logistics chains, and increasing uncertainty caused by geopolitical, economic, and technological factors. Under such conditions, the agricultural trade logistics system is transforming the influence of entropic processes, manifested in increased chaos in flows, disruption of link stability between system elements, and a decline in the effectiveness of management decisions. Of particular relevance is the study of the entropic development of logistics systems in conditions of so-called environmental transcendence, understood as the system moving beyond the boundaries of traditional operational models due to the influence of complex, weakly formalized, and difficult-to-predict factors. Such factors include the digitalization of the economy, the introduction of artificial intelligence, changes in international trade patterns, and risks associated with military actions and global crises. The agri-trading logistics system, as a complex open system, is characterized by a significant number of interrelated elements (production, storage, transport, export operations) operating under conditions of constant uncertainty. The increase in entropy within such a system necessitates the development of new approaches to its organization and management that ensure adaptability, resilience, and operational efficiency.

Traditional logistics management methods are insufficient for processing large volumes of data, forecasting complex scenarios, and optimizing decisions in real time. This, in turn, necessitates the use of innovative tools, in particular neural network technologies, which allow for the modeling of nonlinear processes, account for the multi-factorial nature of the environment, and reduce uncertainty. At the same time, the scientific literature has not sufficiently addressed integrating the entropy approach with neural network models for managing agri-trading logistics systems, nor has it provided a rationale for the mechanisms of their practical implementation in the face of transcendent challenges. This necessitates further research in this area.

Consequently, the problem lies in the need to develop theoretical and methodological foundations and applied tools for managing the entropic development of the agricultural trading logistics system in Ukraine, based on modern neural network technologies in an unpredictable external environment.

Literature Review

Contemporary research into agricultural trading logistics systems is shaped by the intersection of management theories, the economics of the agricultural sector, logistics, and concepts relating to entropy and complex systems. In the context of growing uncertainty and global transformations, the entropic approach to analyzing logistics processes is becoming increasingly relevant. Studies of the agribusiness sector in Ukraine highlight the need to improve the effectiveness of management decisions in logistics processes (Andreichenko & Zhurylo, 2025; Kyryliuk & Liutyi, 2023).

Considerable attention has been paid to the development of infrastructure and financial support for agribusinesses, which forms the basis for the stable functioning of logistics systems (Andriushchenko et al., 2019). At the same time, strategic

management of the agricultural sector is based on analyzing value chains and integrating logistics processes (Hutorov et al., 2018). In the context of military risks and instability, research into changes in transport and logistics routes and cost structures has become significantly more relevant (Kotenko et al., 2021; Kulakova et al., 2023). Entropy, as an economic category, is regarded as a measure of uncertainty, disorganization, and chaos within a system. In logistics systems, it is associated with disruptions to flows, imbalances, and increased risks (Durowoju et al., 2012; Burg, 2023). Research shows that an increase in entropy is a characteristic feature of crisis and transformation periods, particularly in the context of hybrid threats and an unstable institutional environment (Bilokon, 2025).

In this context, the entropic approach enables an assessment of the level of disorganization in logistics systems and the identification of directions for their adaptation. Contemporary research points to the growing role of globalization and glocalization processes in shaping economic systems (Robertson, 1994; Peck & Theodore, 1995), leading to the emergence of transcendent development factors that go beyond the scope of traditional economic models.

The conditions of transcendence manifest through a combination of technological innovations, digitalization, military risks, and global crises, which significantly affect agri-trading logistics systems (Ilchenko, 2025; Korol, 2025). Innovative development in the agricultural sector is increasingly linked to the application of mathematical modeling, big data analysis, and artificial intelligence (Atamanyuk et al., 2023), which enables greater forecasting accuracy and greater effectiveness of logistics solutions. The integration of logistics processes and the use of modern analytical tools have a positive impact on the productivity and resilience of systems (Mackelprang et al., 2014). Neural network approaches are becoming the basis for adaptive management of complex systems under conditions of high uncertainty. An important area of research is ensuring food security and the sustainable development of the agricultural sector (Burkovska et al., 2021; Karimzada, 2020), which involves optimizing logistics processes and reducing supply chain losses.

Sustainable development is also linked to diversifying activities and implementing innovative management models (Denysiuk et al., 2022). Furthermore, research into marketing strategies highlights the need to integrate Ukrainian agricultural producers into global markets (Belkin et al., 2025). Contemporary research highlights the role of stakeholders, the institutional environment, and social responsibility in shaping sustainable economic systems (Kima et al., 2018; Goldsby et al., 2018). The conditions of glocalization require new approaches to business management, focused on responsible consumption and sustainable production (Tepliuk et al., 2023).

An analysis of scientific sources leads to the conclusion that: the agricultural trade logistics system is a complex open system operating under conditions of high uncertainty; the entropy approach is an effective tool for analysing destabilising processes in logistics; the transcendence of the environment necessitates a transition to new management models; innovation, digitalisation and neural network technologies play a key role in ensuring the sustainability of systems; the

development of integrated management models combining entropic and intelligent approaches remains a priority.

Thus, there is a need for further research to develop conceptual and applied mechanisms for managing the entropic development of agri-trading logistics systems in the face of transcendental challenges.

Methodology

The study is based on general scientific and specialized research methods that enable a comprehensive analysis of the entropic development of the agricultural trading logistics system in Ukraine. In particular, a systems approach has been applied to treat the logistics system as a complex, open, dynamic structure operating under conditions of uncertainty and transcendent influences. Methods of analysis and synthesis were used to generalize theoretical propositions on entropy, logistics, and the agricultural market, and to identify key factors destabilizing logistics flows. The comparative method enabled the assessment of current trends in agri-trading development in Ukraine in the context of global transformations, as well as the identification of the peculiarities of the logistics system's functioning in crisis conditions.

The research was based on scientific publications by domestic and international authors, analytical reports from international and national organizations, and statistical data on the functioning of the agricultural sector and the logistics infrastructure. To substantiate the applied aspects, methods of economic and mathematical modeling, as well as elements of neural network analysis, were used, which enable the investigation of non-linear processes and the prediction of system behavior under conditions of increasing entropy. The chosen methodological approach integrates the concept of entropy with modern digital analytics tools, enabling the development of an adaptive, robust model for managing the agri-trading logistics system in a transcendent environment.

Identification of previously unresolved aspects of the overall problem. Despite active interest in the topic of glocalization development and stakeholder cooperation within regional ecosystems to support relocating businesses, some aspects remain 'insufficiently explored'. For example, there is a need for a deep understanding of the specific mechanisms of interaction among government bodies, business communities, civil society organizations, and the academic sector within regional ecosystems.

Results

The study found that Ukraine's agricultural trade logistics system is undergoing a profound transformation driven by entropic processes arising from a combination of internal and external factors. Key sources of entropy include military and political instability, disruptions to traditional logistics routes, changes in the structure of global supply and demand, rising transport costs, and climate risks.

An analysis of the structure and dynamics of Ukraine's grain exports shows that, despite high levels of uncertainty, the agricultural sector remains export-oriented and plays a systemic role in the country's economy. At the same time, logistics processes

are becoming increasingly chaotic, as evidenced by shifts in transport channels, longer delivery times, and higher logistics costs. Particular attention is paid to the study of structural shifts in agri-trading logistics. In the pre-war period, sea transport dominated, whereas in 2022–2025, there was a significant shift towards multimodal routes, including rail and road transport. This demonstrates the system's adaptability but also indicates an increase in entropy due to the growing complexity of logistics chains.

Table 1. Impact of Entropy Factors on the Logistics System of Agritrading in Ukraine

Factor group	Specific manifestation	Impact on logistics	Entropy level	Anti-entropy direction
Geopolitical	Military actions, port blockade	Disruption of routes, increased costs	High	Development of alternative transport routes
Infrastructural	Insufficient port and storage capacities	Transportation delays	Medium	Investment in logistics infrastructure
Economic	Price fluctuations, currency risks	Decreased profitability	Medium	Market diversification
Climatic	Changes in crop yields	Instability of supply flows	High	Implementation of innovative agrotechnologies
Technological	Low level of digitalization	Inefficient management processes	Medium	Implementation of AI and neural network systems

Source: compiled by the author

Further analysis has shown that one of the key manifestations of entropy is price disparity. Ukrainian products are sold at lower prices than those of global market leaders, which is linked to logistical risks and costs. Economic and mathematical modeling confirmed that the price of grain depends primarily on global supply and demand factors, whilst domestic logistical parameters have an indirect influence. It has been established that the agri-trading logistics system operates in a state of 'dynamic equilibrium', where adaptive mechanisms offset entropic processes. These mechanisms include:

- diversification of export destinations;
- development of multimodal transport;
- the use of digital technologies;
- integration into global logistics networks.

Thus, the system demonstrates a capacity for self-organization in conditions of transcendence, that is, going beyond the boundaries of traditional models of operation.

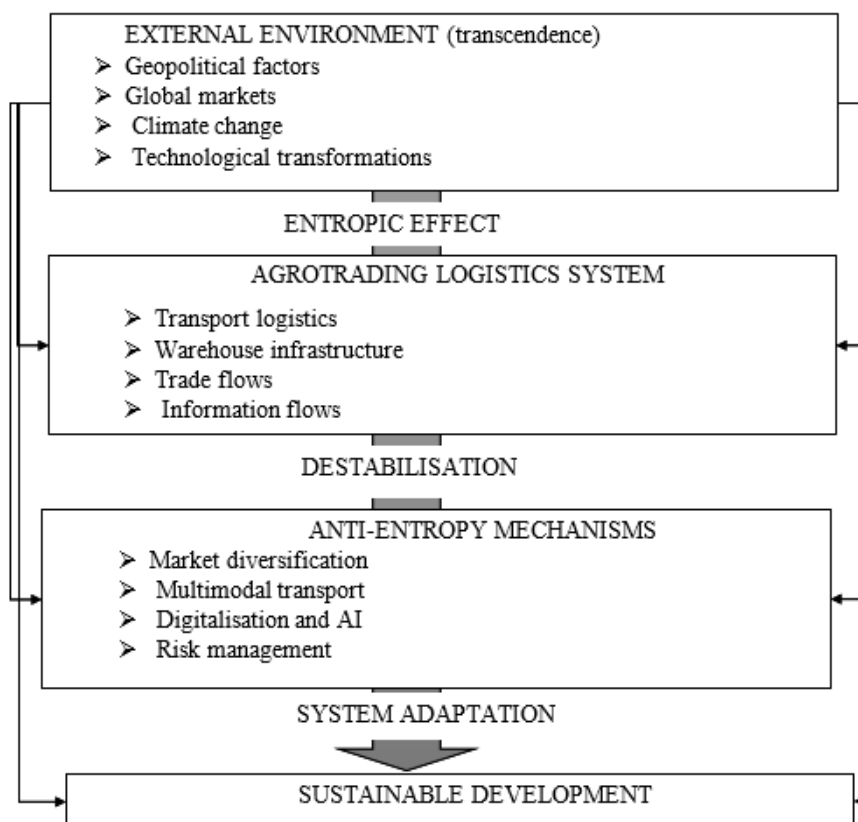


Figure 1. Conceptual model of the entropic development of the agricultural trading logistics system

Source: compiled by the author.

The proposed conceptual framework for the entropic development of the agricultural trading logistics system in Ukraine under conditions of transcendence reflects the multi-level dynamics of interaction between the external environment, the system's internal processes, and management mechanisms. Its structure is based on the logic of transition from destabilizing factors to the formation of an adaptive and sustainable logistics model.

At the top level of the diagram lies a transcendental external environment characterized by high uncertainty, non-linear processes, and factors beyond the scope of traditional economic models. Such factors include geopolitical conflicts, global market transformations, climate change, and technological breakthroughs. Their combined effect creates an environment in which the logistics system cannot operate according to standard algorithms but must adapt to constantly changing parameters.

The second level of the diagram is represented by entropic influence, a generalized category of destabilization. Entropy in this context manifests as increasing chaos in logistics flows, disruption of structural links between system elements, reduced operational predictability, and increased risk levels. In the context of agri-trading, this specifically means instability in exports, changes in supply routes, price volatility, and rising logistics costs.

The third level comprises the agri-trading logistics system itself, including transport, warehousing, trading, and information subsystems. It is at this stage that the external environment's influences are translated into concrete economic outcomes. Disruptions to stability manifest as transport delays, infrastructure overload, inefficient resource use, and reduced product competitiveness.

The next stage is the destabilization phase, a direct consequence of the accumulation of entropic effects. In this phase, the system loses its optimal operational structure, operating costs rise, response speed to changes decreases, and the quality of management decisions deteriorates. For Ukraine, this manifests as the loss of some logistics routes, port blockages, and reduced efficiency in export operations.

A key element of the scheme is anti-entropy mechanisms, which serve a compensatory function and aim to restore the system's equilibrium. These include:

- diversification of sales markets and logistics routes;
- the development of multimodal transport;
- the modernization of transport and warehousing infrastructure;
- the introduction of digital technologies, including artificial intelligence and neural network systems;
- the improvement of risk management systems.

Appropriate tools enable reducing the impact of entropic factors and increasing the system's flexibility. At the final stage, the adaptation and sustainable development of the logistics system take shape through the effective implementation of anti-entropic measures. Adaptation manifests itself in the system's ability to quickly restructure in response to environmental changes whilst maintaining functionality and economic efficiency. In the long term, this ensures the sustainable development of agri-trading, enhances Ukraine's competitiveness in the global market, and facilitates integration into global logistics networks.

Thus, the proposed scheme reflects the cyclical nature of the interaction between entropy and anti-entropy, where innovation, managerial decisions, and a strategic vision for the development of the logistics system play a key role. Its practical significance lies in its potential use as a conceptual framework for developing effective models for managing agri-logistics in conditions of transcendental uncertainty

Discussion

The findings of this study confirm that the development of the agricultural trade logistics system in Ukraine is taking place against a backdrop of significantly

intensified entropic processes, both natural and artificial in origin. A comparison with contemporary scientific approaches leads to the conclusion that entropy acts not only as a destabilizing factor but also as a catalyst for structural change in logistics systems.

In particular, the research findings are consistent with the position of most authors who view entropy as a tool for assessing disruptions in supply chains. In the context of Ukrainian agri-trading, this manifests itself in changes to logistics routes and the structure of exports. At the same time, unlike classical models, which assume entropy has an exclusively negative impact, this study demonstrates its dualistic nature: alongside destruction, it also stimulates adaptive processes and innovative change. The analysis has shown that the transcendence of the environment, manifested through uncontrollable external influences (war, global crises, climate change), significantly complicates traditional approaches to logistics management, which confirms the need to transition from linear management models to non-linear, adaptive, and digitalized systems, a point also emphasized in the research.

At the same time, the results obtained indicate certain limitations. In particular, the economic-mathematical models showed a relatively low coefficient of determination, which indicates the complexity of accounting for all factors influencing pricing and the functioning of logistics systems. This confirms the thesis regarding the multidimensionality of entropic processes and the need to expand the research toolkit further, particularly through the use of neural network models and big data analysis. An important aspect of the discussion is the effectiveness of anti-entropy mechanisms. The study found that traditional tools (infrastructure development, market diversification) remain relevant, but their effectiveness increases significantly when digital technologies are integrated, confirming the current trend towards intelligent logistics systems.

Thus, the question of the optimal combination of classical and innovative approaches to logistics management in conditions of entropy remains a matter of debate. Further research should focus on developing hybrid models that combine economic, mathematical, and neural network methods of analysis.

Conclusions

As a result of this study, theoretical, methodological, and practical principles have been formulated regarding the entropic development of the agricultural trading logistics system in Ukraine under conditions of transcendence. It has been established that the modern agricultural trading logistics system is characterized by a high level of entropy, manifested in increased uncertainty, destabilized logistics flows, and heightened risks. The main sources of entropy are geopolitical, economic, infrastructural, climatic, and technological factors. It has been demonstrated that the transcendence of the external environment shapes a new reality for logistics systems, in which traditional management approaches lose their effectiveness. Under these conditions, Ukraine's logistics system demonstrates an ability to adapt through changes in transport routes, the development of multimodal transport, and the diversification of export destinations.

It is substantiated that a reduction in the entropy of the logistics system is possible through the implementation of a set of anti-entropy measures, including:

- modernization of transport and warehouse infrastructure;
- diversification of logistics routes and sales markets;
- introduction of digital technologies and artificial intelligence systems;
- the development of flexible management and risk management models.

The practical significance of the results lies in the possibility of using the proposed conceptual model to formulate strategies for the development of agri-trading, improve the efficiency of logistics processes, and enhance Ukraine's competitiveness in global agricultural markets. Prospects for further research include the increased use of neural network technologies for forecasting the behavior of logistics systems, assessing entropy processes, and developing intelligent decision-support systems in agri-trading.

Author Declarations

The author is responsible for all stages of the research, including conceptualization, methodology, analysis, and manuscript preparation.

Conflict of Interest

The author declares that there are no conflicts of interest regarding the publication of this paper.

Funding

Competition for grants of the President of Ukraine to support scientific research and development for doctoral students, "Entropic development of the logistics system of agro-trading in Ukraine under conditions of transcendence," No. 2025.04/0001.

Data Availability

The theoretical and legal sources used in the study are publicly available and listed in the references.

Use of AI Tools

During the preparation of this manuscript, artificial intelligence tools (Grammarly) were used for supportive language editing. The author reviewed all outputs and bears full responsibility for the scientific quality, accuracy, and academic integrity of the article.

References

- Adisa, T. A. (2024). Industry 5.0: From digitisation to digitalisation. *Y HRM 5.0: Unpacking the digitalisation of human resource management* (pp. 1–9). Palgrave
- Andreichenko, A., & Zhurylo, S. (2025). Decision-making in agribusiness management. *Scientific Bulletin of the Odessa National Economic University*, 2(327), 65–72. <https://doi.org/10.32680/2409-9260-2025-2-327-65-72>
- Andriushchenko, K., Ishchenko, M., Sahaidak, M., Tepliuk, M., & Domina, O. (2019). Prerequisites for the creation of financial and credit infrastructure of support for agricultural enterprises in Ukraine. *Banks and Bank Systems*, 14(2), 63–75. [https://doi.org/10.21511/bbs.14\(2\).2019.06](https://doi.org/10.21511/bbs.14(2).2019.06)
- Atamanyuk, I., Havrysh, V., Nitsenko, V., Diachenko, O., Tepliuk, M., Chebakova, T., & Trofimova, H. (2023). Forecasting of winter wheat yield: A mathematical model and field experiments. *Agriculture*, 13(1), 41. <https://doi.org/10.3390/agriculture13010041>

- Bazaluk, O., Postnikova, M., Halko, S., Kvitka, S., Mikhailov, E., Kovalov, O., Suprun, O., Miroshnyk, O., & Nitsenko, V. (2022). Energy saving in electromechanical grain cleaning systems. *Applied Sciences*, 12(3), 1418. <https://doi.org/10.3390/app12031418>
- BDO in Ukraine. (2025). *Oilseed market of Ukraine 2025: Analysis, trends, and development forecast*. <https://www.bdo.ua/en-gb/insights-1/information-materials/2025/oilseed-market-ukraine-2025-trends-analysis-forecast>
- Belkin, I., Trapaidze, S., Bondarenko, V., Omelianenko, O., & Cherniavskiy, I. (2025). Sustainable marketing of Ukrainian agricultural enterprises to enter global grain markets. *European Journal of Sustainable Development*, 14(2), 490. <https://doi.org/10.14207/ejsd.2025.v14n2p490>
- Bilokon, M. (2025). Entropy as a challenge to the institutional sustainability of public administration in the conditions of hybrid threats. *Pressing Problems of Public Administration*, 1(66), 179–195. <https://doi.org/10.26565/1684-8489-2025-1-08>
- Burg, A. (2023). Entropy in the logistics world: Applying Boltzmann's equation to modern logistics. *Transvirtual*. <https://www.transvirtual.com/blog/entropy-in-the-logistics-world/>
- Burkovska, A., Shebanina, O., Lunkina, T., & Burkovska, A. (2021). Ensuring food security in the context of the sustainable development of agriculture. *Management Theory and Studies for Rural Business and Infrastructure Development*, 43(3), 337–345. <https://doi.org/10.15544/mts.2021.30>
- Decker, E. A., Rose, D. J., & Stewart, D. A. (2014). Processing of oats and the impact of processing operations on nutrition and health benefits. *British Journal of Nutrition*, 112, S58–S64. <https://doi.org/10.1017/S000711451400227X>
- Denysiuk, O., Svitlyshyn, I., Tsaruk, I., Vikarchuk, O., & Dankevych, A. (2022). Diversification in the enterprises' activities for sustainable development in the agricultural sector. *Rivista di Studi sulla Sostenibilità*, 12(2), 85–102. <https://doi.org/10.3280/RISS2022-002007>
- Dibrova, A., & Stepasiuk, L. (2023). Economic value and economic attractiveness of oats in the context of the development of a niche production. *Economics and Business Management*, 14(3), 53–65. [https://doi.org/10.31548/economics14\(3\).2023.045](https://doi.org/10.31548/economics14(3).2023.045)
- Durowoju, O. A., Chan, H. K., & Wang, X. (2012). Entropy assessment of supply chain disruption. *Journal of Manufacturing Technology Management*, 23(8), 998–1014. <https://doi.org/10.1108/17410381211276844>
- Goldsby, M. G., Kuratko, D. F., Bishop, J. W., Kreiser, P. M., & Hornsby, J. S. (2018). Social proactiveness and innovation: The impact of stakeholder salience on corporate entrepreneurship. *Journal of Small Business Strategy*, 28(2), 1–15.
- Gonzalez-Bueno, J., García, F., Garcés-Baustista, J., Oliver, J., & Tamošiūnienė, R. (2024). A multi-objective credibilistic approach to portfolio optimization: Balancing return, risk, and liquidity in emerging and developed markets. *Intellectual Economics*, 18(2), 284–307. <https://doi.org/10.13165/IE-24-18-2-03>
- Holopainen-Mantila, U., Linderborg, K. M., Piironen, V., Sontag-Strohm, T., & Nordlund, E. (2023). Oats. In *ICC handbook of 21st century cereal science and technology* (pp. 173–180). <https://doi.org/10.1016/B978-0-323-95295-8.00018-6>
- Hutorov, A., Lupenko, Y., Yermolenko, O., & Dorokhov, O. (2018). Strategic management of the agrarian sector of economy based on the analysis of value chains. *Bulletin of the Transilvania University of Brasov*, 11(60/2), 101–114. https://webbut.unitbv.ro/index.php/Series_II/article/view/693/627

- Ilchenko, S. V. (2025). Indicative model of the eco-adaptive modernization of Ukraine's transport and logistic network. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, 6, 246–259. <https://doi.org/10.33271/nvngu/2025-6/246>
- Jablonskis, A. (2014). Explications and interpretations of logistic activity. *Intellectual Economics*, 8(1), 47–58. <https://doi.org/10.13165/IE-14-8-1-07>
- Karimzada, M. V. (2020). Features of ensuring food security. In *Economic and Social Development: Book of Proceedings* (pp. 2–4). <https://www.proquest.com>
- Kim, H. J. (2016). Opportunities and challenges of alternative specialty crops: The global picture. *HortScience*, 51(11), 1316–1319. <https://doi.org/10.21273/HORTSCI10659-16>
- Klein, J. (2022). Oatly wants farmers to plant more oats: Here's how it's helping. Trellis. <https://www.greenbiz.com/article/oatly-wants-farmers-plant-more-oats-heres-how-its-helping>
- Korol, D. (2025). Grain market: How Ukraine maintains its export positions despite the war. BDO in Ukraine. <https://www.bdo.ua>
- Kotenko, S., Nitsenko, V., Hanzhurenko, I., Vasylyuk, M., Lavrushchenko, Y., & Kucher, I. (2021). The economic crisis as a factor in changing the structure of multimodal transportation routes. *Financial and Credit Activity: Problems of Theory and Practice*, 6(41), 277–284. <https://doi.org/10.18371/fcaptop.v6i41.251454>
- Kulakova, S., Kalemбет, A., & Podkopova, D. (2023). Features of the formation of logistics expenses of enterprises under military conditions. *Financial and Credit Systems: Prospects for Development*, 1(8), 22–29. <https://doi.org/10.26565/2786-4995-2023-1-03>
- Kyiv School of Economics. (2025). *AgroDigest Ukraine*. https://kse.ua/AgroDigest_Ukraine_January_2025.pdf
- Kyryliuk, I., & Liutyi, O. (2023). Features of management in the agricultural business of Ukraine. *Bulletin of the Cherkasy Bohdan Khmelnytsky National University. Economic Sciences*, 27(3–4), 68–83. <https://doi.org/10.31651/2076-5843-2023-3-4-68-83>
- Mackelprang, A. W., Robinson, J. L., Bernardes, E., & Webb, G. S. (2014). The relationship between strategic supply chain integration and performance. *Journal of Business Logistics*, 35(1), 71–96.
- Peck, J., & Theodore, N. (1995). Business goes local: Dissecting the 'business agenda' in Manchester. *International Journal of Urban and Regional Research*, 19(1), 55–78.
- Robertson, R. (1994). Glocalization: A new trend of globalization. *Journal of International Communication*, 1(1), 33–52.
- Tepliuk, M., Sahaidak, M., Petrishyna, T., Fokina-Mezentseva, K., Fomenko, B., & Vasyliiev, I. (2023). Managing responsible consumption and sustainable production enterprises in glocalization conditions. *Acta Innovations*, 48(6). <https://doi.org/10.32933/ActaInnovations.48.6>

**ЕНТРОПІЙНИЙ РОЗВИТОК ЛОГІСТИЧНОЇ СИСТЕМИ
АГРОТРЕЙДИНГУ УКРАЇНИ: ЦИФРОВА ТРАНСФОРМАЦІЯ,
ШТУЧНИЙ ІНТЕЛЕКТ ТА АДАПТИВНА СТІЙКІСТЬ**

ТЕПЛЯЮК Марія Анатоліївна, <https://orcid.org/0000-0001-6823-336X>,
канд. екон. наук, доцент, Київський національний економічний університет
імені Вадима Гетьмана, Київ, Україна, maria_6.11@kneu.edu.ua

Анотація. У статті досліджено теоретичні та прикладні аспекти ентропійного розвитку логістичної системи агротрейдингу в Україні в умовах трансцендентності зовнішнього середовища. Актуальність теми зумовлена зростанням рівня невизначеності, посиленням геополітичних ризиків, інфраструктурними обмеженнями та масштабними глобальними економічними трансформаціями, які безпосередньо впливають на ефективність функціонування аграрного сектору та логістичних ланцюгів постачання. Метою дослідження є обґрунтування впливу ентропійних процесів на логістичну систему агротрейдингу та визначення ключових напрямів її адаптивної трансформації в сучасних умовах. Методологічну основу становлять системний підхід, що дозволяє розглядати логістичну систему як складну динамічну структуру, а також методи економіко-математичного моделювання, аналізу і синтезу, статистичні та порівняльні методи. У результаті встановлено, що логістична система агротрейдингу України функціонує в умовах підвищеної ентропії, яка проявляється у дестабілізації товарних потоків, зростанні витрат, трансформації транспортних маршрутів і підвищенні логістичних ризиків. У дослідженні обґрунтовано доцільність застосування антиентропійних механізмів, серед яких ключовими є диверсифікація ринків збуту, розвиток мультимодальних перевезень, модернізація інфраструктури та впровадження цифрових технологій, включаючи інструменти штучного інтелекту. Наукова новизна полягає у формуванні концептуальної моделі ентропійного розвитку логістичної системи з урахуванням трансцендентних факторів впливу. Практична цінність результатів дослідження полягає у можливості їх використання для розробки ефективних стратегій управління агрологістикою, підвищення стійкості логістичних процесів та зміцнення конкурентних позицій України на світовому аграрному ринку.

Ключові слова: агротрейдинг, логістична система, ентропія, трансцендентність, аграрний сектор, мультимодальні перевезення, цифровізація, конкурентоспроможність.