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## INTEGRATION OF MULTI-CRITERIA DECISION-MAKING MECHANISMS FOR OPTIMIZING AGRICULTURAL EXPORT STRATEGIES

*The aim of the article is to develop and substantiate an integrated approach to selection of an export strategy for agricultural products based on multi-criteria decision-making mechanisms, which allows taking into account the combined impact of economic, logistical, institutional, and risk factors in the process of forming a managerial decision. The methodological basis of the study is formed on the principles of system and process approaches using the concept of multi-criteria decision analysis (MCDA) to structure the task of choosing an export strategy. The AHP, TOPSIS and VIKOR methods are considered as theoretical and methodological guidelines for building the logic of evaluating alternatives without their direct applied use. The study is implemented through the formation of a sequence of decision-making stages: from identifying alternatives to robustness analysis of the decision. The analytical basis is grounded in the generalization of modern scientific approaches and practices of applying multi-criteria methods in the agricultural sector. As a result of the study, an integrated procedural architecture of decision-making regarding selection of an export strategy was formed, which includes five interconnected stages and provides a logically completed cycle of evaluating alternatives. The feasibility of combining AHP with TOPSIS/VIKOR methods to increase the objectivity of ranking export directions, which helps minimize the influence of subjective assessments, is substantiated. The results indicate that the inclusion of the stage of checking the stability of the decision (sensitivity analysis) significantly reduces the risk of choosing an unstable strategy in conditions of changing the weights of the criteria or environmental parameters. It has been practically proven that the proposed approach allows for simultaneous consideration of conflicting factors – price levels, logistics costs, regulatory barriers and risks, which in traditional models are analyzed in isolation. The practical relevance lies in the possibility of direct application of the developed approach at the level of agricultural enterprises, traders and exporters to justify the choice of target markets, logistics routes and forms of contracting. The proposed sequence of actions is reproducible, does not require complex software solutions and can be implemented both in the form of an analytical table and within digital decision support systems.*

*Keywords:* export strategy; agricultural sector; decision optimization; foreign economic activity; logistical factors; export markets; managerial decisions.

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## ІНТЕГРАЦІЯ МЕХАНІЗМІВ БАГАТОКРИТЕРІАЛЬНОГО ПРИЙНЯТТЯ РІШЕНЬ ДЛЯ ОПТИМІЗАЦІЇ СТРАТЕГІЙ ЕКСПОРТУ СІЛЬСЬКОГОСПОДАРСЬКОЇ ПРОДУКЦІЇ

*Метою статті є розроблення та обґрунтування інтегрованого підходу до вибору експортної стратегії сільськогосподарської продукції на основі механізмів багатокритеріального прийняття рішень, що дає змогу враховувати сукупний вплив економічних, логістичних, інституційних і ризикових чинників у процесі формування управлінського рішення. Методологічну основу дослідження сформовано на принципах*

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системного та процесного підходів із використанням концепції багатокритеріального аналізу рішень (MCDA) для структуризації завдання вибору експортної стратегії. Методи АНР, TOPSIS і VIKOR розглянуто як теоретико-методологічні орієнтири для побудови логіки оцінювання альтернатив без їх прямого прикладного застосування. Дослідження реалізовано через формування послідовності етапів прийняття рішень: від ідентифікації альтернатив до аналізу стійкості рішення. Аналітична база ґрунтується на узагальненні сучасних наукових підходів і практик застосування багатокритеріальних методів в аграрному секторі. У результаті дослідження сформовано інтегровану процедурну архітектуру прийняття рішень щодо вибору експортної стратегії, яка включає п'ять взаємопов'язаних етапів і забезпечує логічно завершений цикл оцінювання альтернатив. Обґрунтовано доцільність поєднання методів АНР із TOPSIS/VIKOR для підвищення об'єктивності ранжування експортних напрямів, що сприяє мінімізації впливу суб'єктивних оцінок. Результати свідчать, що включення етапу перевірки стійкості рішення (аналізу чутливості) суттєво знижує ризик вибору нестабільної стратегії в умовах зміни ваг критеріїв або параметрів середовища. Практично доведено, що запропонований підхід дозволяє одночасно враховувати суперечливі чинники – рівень цін, логістичні витрати, регуляторні бар'єри та ризики, які в традиційних моделях аналізуються ізольовано. Практична значущість полягає у можливості безпосереднього застосування розробленого підходу на рівні аграрних підприємств, трейдерів та експортерів для обґрунтування вибору цільових ринків, логістичних маршрутів і форм контракування. Запропонована послідовність дій є відтворюваною, не потребує складних програмних рішень і може бути реалізована як у формі аналітичної таблиці, так і в межах цифрових систем підтримки прийняття рішень.

**Ключові слова:** експортна стратегія; аграрний сектор; оптимізація рішень; зовнішньоекономічна діяльність; логістичні фактори; експортні ринки; управлінські рішення.

**Problem statement.** The export of agricultural products has long ceased to be a domain in which a strategic decision can be justified solely by price, harvest availability, or the market conditions of a particular destination. Real-world practice demonstrates otherwise: the effectiveness of entering export markets is determined by the simultaneous influence of multiple groups of factors, which often conflict with one another. For instance, a market that is attractive in terms of demand volume may prove problematic from a logistical perspective; a direction with high margins may be unstable due to tariff or non-tariff barriers; and a route with a shorter transportation distance may be less advantageous due to regulatory delays, phytosanitary restrictions, or currency risks. Therefore, the selection of an export strategy in the agricultural sector requires not an intuitive but a structured analytical approach capable of integrating economic, logistical, institutional, and risk-related parameters into a unified evaluation framework.

The practical relevance of such an approach becomes particularly evident under conditions of increased volatility in the global agri-food environment. According to FAO data, the Food Price Index averaged 144.5 points in 2022 [1], representing the highest annual value over the entire observation period and reflecting unprecedented pressure on international food markets. At the same time, the index declined to 125.2 in 2025 and stood at 125.3 in February 2026 [1]. Under such conditions, even short-term decisions regarding export structure, target markets, or delivery channels begin to affect not only commercial performance but also resilience, liquidity, utilization of production infrastructure, and ability to maintain contractual discipline.

Additional complexity arises from the heterogeneity of agricultural products themselves. Cereals, oilseeds, processed products, organic goods, and niche crops differ significantly in their requirements for storage, certification, transportation, traceability of origin, and time sensitivity of delivery. As a result, a universal export strategy proves to be largely ineffective. According to World Bank estimates, a decline in logistical efficiency directly increases trade costs and reduces the competitiveness of exporters, particularly in segments that heavily depend on transport reliability and the speed of border crossing [2]. This implies that an optimal export strategy should not be determined by a single “best” indicator, but rather by a balanced decision in which the structure of criteria corresponds to the specific characteristics of the product, the market, and external constraints.

Against this background, multi-criteria decision-making acquires not only methodological but also practical relevance. It enables a transition from fragmented comparison of individual indicators to a structured decision logic, in which each criterion is assigned a formalized weight and each alternative receives a comprehensive evaluation. Such a formulation of the problem defines the relevance of the present study, which focuses on the integration of multi-criteria decision-making mechanisms into the process of optimizing export strategies for agricultural products.

**Analysis of recent research and publications.** In recent years, the issue of forming export strategies in the agricultural sector has evolved at the intersection of three key research areas: the study of determinants of agricultural export performance, the development of multi-criteria approaches to supporting managerial decision-making in agriculture, and the application of economic-mathematical modeling for strategic forecasting in the agricultural sector. In particular, H. Ngo-Thi-Ngoc and B. Nguyen-Viet [3], based on evidence from Vietnamese enterprises exporting agricultural products, demonstrated that export performance is determined not by a single parameter but by a combination of firm characteristics, marketing strategy, external market conditions, and entry barriers. The study by P. Zandi, M. Rahmani, M. Khanian, and A. Mosavi [4] demonstrated the potential of integrating fuzzy TOPSIS, AHP, and FMEA for risk management in agricultural projects. A significant contribution to the development of this field was made by J. Papathanasiou, N. Ploskas, T. Bournaris, and B. Manos [5], who highlighted the practical relevance of TOPSIS and VIKOR for ranking alternatives within decision support systems aimed at assessing social sustainability in agriculture.

A distinct strand of research is represented by review studies that systematize the application of multi-criteria methods in agriculture. Thus, B. Cicciù, F. Schramm, and V. B. Schramm [6] conducted a literature review in 2022 on the use of MCDM/MCDA methods for assessing agricultural sustainability, demonstrating a growing interest in these tools as well as a high frequency of application of AHP, TOPSIS, and other methods in agricultural management tasks. Further development of this methodology has been observed in studies focused on digitalization and precision farming. In particular, N. N. K. Krisnawijaya, B. Tekinerdogan, C. Catal, and R. van der Tol [7] proposed an MCDA-based approach for selecting data analytics platforms in precision farming.

Alongside international studies, an important place is occupied by the works of Ukrainian scholars who substantiate the application of economic-mathematical

modeling and analytical tools in the strategic management of the agricultural sector. O. Dudnyk [8] considers economic-mathematical modeling as a tool for forecasting the implementation of development strategies in the agricultural sector, while S. Stepenko and I. Lazarenko [9] examine it as an instrument of analytical decision support in agriculture. V. I. Kyfyak [10], in turn, emphasizes the determinants of strategic decision-making in agribusiness in the context of adaptation to climatic and economic challenges.

In this context, the present study builds, on the one hand, on research that substantiates the multi-factor nature of agricultural exports, and, on the other hand, on contemporary studies applying MCDM in agriculture, which demonstrate the effectiveness of AHP, TOPSIS, VIKOR, and their integrations for complex managerial decision-making. At the same time, it extends the existing body of knowledge in a more applied direction, as it focuses not on general sustainability or the digital infrastructure of agricultural production, but on the development of a practical mechanism for optimizing export strategies of agricultural products.

The purpose of the study is to develop and substantiate an integrated approach to the selection of an export strategy for agricultural products based on multi-criteria decision-making mechanisms, which allows for taking into account the combined impact of economic, logistical, institutional, and risk-related factors in the process of managerial decision-making.

**Main results of the study.** The problem of selecting an export strategy in the agricultural sector has long been described primarily through the categories of comparative advantage, market conditions, and operational efficiency [3]. However, although this approach has been useful for explaining general trade behavior, it proves insufficient at the level of a specific managerial decision. When an enterprise must determine where to export its products, in what product form, through which channel, by which mode of transport, with what contracting horizon, and with what degree of adaptation to market requirements, it is in fact confronted with a multi-criteria problem. For example, since 2022, there has been a clear trend of reorientation of Moldova's agricultural exports from traditional CIS markets to alternative destinations, particularly the EU and the Middle East. Specifically, the share of apple exports to CIS countries decreased from 72% in 2024 to 54% in 2025, while the share of certain EU markets (e.g., Romania) increased to 37% [11]. Thus, at the core of the multi-criteria problem lies not merely the ranking of alternatives, but the need to simultaneously balance the objectives of profitability, resilience, turnover speed, regulatory compliance, and risk minimization.

It is precisely in this context that multi-criteria decision-making mechanisms acquire practical relevance. Their key advantage lies in enabling the formal comparison of alternatives that cannot be adequately evaluated on the basis of a single indicator. The classical criterion of "selling price" is often misleading when it conceals additional costs related to certification, insurance, cold storage, or an increased likelihood of delays. Similarly, demand volume in a target market does not guarantee the feasibility of market entry if access is constrained by complex sanitary regulations or intense competition from local or regional suppliers.

The idea of a multi-criteria approach in export management lies not merely in accounting for a greater number of factors. Its essence consists in the transition from

an unstructured set of considerations to a transparent procedure in which criteria are selected in accordance with the strategic objective, normalized, weighted, and subsequently integrated into a unified decision model. For agricultural exports, this is of fundamental importance, as the criteria involved are often heterogeneous in nature. Some of them are quantitative and directly measurable, such as production cost, logistics costs, delivery time, average contract price, market capacity, and exchange rate volatility. Others are qualitative and expert-based, including the complexity of customs administration, the predictability of regulatory policy, the stringency of phytosanitary requirements, the reliability of intermediaries, and the sensitivity of demand to changes in quality standards.

In this sense, a multi-criteria model is not merely an evaluation method but an instrument for integrating heterogeneous information. It enables the transformation of fragmented market observations into a coherent decision system in which each criterion occupies a functionally defined position. For enterprises operating with bulk commodities, the emphasis typically shifts toward logistics, demand scale, and the stability of procurement channels. In contrast, for exporters of more highly processed products, greater importance is assigned to quality requirements, pre-sale adaptation, certification, branding, and long-term contractual reliability. Thus, the same model should not be mechanically applied to all product groups. Its value lies in its flexibility, that is, in its ability to adjust the structure of criteria and the system of weights depending on product characteristics and the strategic horizon.

In the scientific literature, multi-criteria methods, including AHP, TOPSIS, VIKOR, ELECTRE, and PROMETHEE, have long been used to evaluate complex alternatives in logistics, agricultural management, supplier selection, and international marketing. However, in the export practice of agricultural products, the problem often lies not in the absence of methods per se, but in the fragmented nature of their application. Some approaches perform well at the stage of determining criteria weights but are less adaptable to the ranking of alternatives. Others effectively structure and rank options but are sensitive to the normalization method or the structure of input data. As a result, the most promising approach is not an isolated but an integrated decision-making architecture, in which different methods perform distinct functions.

**For agricultural exports, such an architecture is particularly well-suited.** For example, the AHP method allows structuring the problem in the form of a hierarchy “goal – criteria – alternatives” and deriving consistent weights based on expert pairwise comparisons [5]. Subsequently, TOPSIS or VIKOR can be used to rank target markets, logistical routes, or contracting models according to their proximity to an ideal solution [4; 5]. In this combination, the first method is responsible for determining the relative importance of criteria, while the second performs the final comparison of alternatives. This reduces the risk of subjective choice, where decisions are effectively made intuitively and analytical tools are only applied ex post to justify them.

The practical relevance of integrating multi-criteria mechanisms becomes particularly evident in situations where an enterprise faces several potentially attractive export directions, none of which is unequivocally dominant. In such cases, decision-making is often constrained by conflicting criteria. One market may offer a higher price but be more complex in terms of certification requirements. Another may have

a lower margin but provide faster turnover and lower logistical risks. A third may offer prospects for long-term market positioning but require substantial initial investments in product adaptation. In this context, the multi-criteria approach does not seek to impose a universally correct solution, but rather to demonstrate under which configuration of objectives a particular alternative becomes rational.

To systematize the practice of selection, Table 1 presents a basic structure of criteria that directly influence the formation of export strategies for agricultural products.

**Table 1. Criteria influencing the formation of export strategies for agricultural products, based on [3; 8–10]**

No.	Criteria Group	Criterion Description	Example of Practical Application in Export Decision
1	Economic	Selling price, gross margin, adaptation costs, customs and logistics costs	Choosing between a market with a higher price and a market with lower associated costs
2	Logistical	Delivery time, route availability, transshipment stability, risk of delays	Assessing the feasibility of exporting via port, rail, or multimodal channels
3	Regulatory	Phytosanitary requirements, certification, quotas, customs procedures	Determining the actual complexity of market entry and compliance costs
4	Market	Demand capacity, level of competition, purchasing power of importers, price volatility	Choosing between a mass market with high competition and a niche segment
5	Risk	Currency risk, political instability, contractual risks, risk of changes in trade rules	Accounting for the probability of margin loss or supply disruption
6	Strategic	Potential for long-term market positioning, diversification effect, scalability	Selecting a market not only for a current transaction but for strategic expansion

Such a structure demonstrates that an export strategy in the agricultural sector is a multidimensional construct. It is not limited to the decision of whether to export or not, nor is it confined to the choice of a destination country. Rather, it involves a configuration of interrelated decisions, including the selection of the product, market, delivery channel, partnership format, and risk management regime. Therefore, the integration of multi-criteria decision-making mechanisms serves as a methodological foundation for the transition from situational exporting to purposeful strategic management of export activities.

To ensure that the multi-criteria approach does not remain merely an analytical declaration, it must be translated into an operational model suitable for practical use by enterprises or export-oriented cooperatives. In the agricultural sector, such a model should account for the specific features of decision-making under conditions of incomplete information, varying data quality, seasonality, cost fluctuations, and differing importance of criteria across product groups. For this reason, the integrated model is appropriately structured as a sequence of five logically interconnected stages: (1) identification of alternatives, (2) formation of the criteria system, (3) determina-

tion of criteria weights, (4) evaluation of alternatives, and (5) robustness analysis of the decision (Table 2).

*Table 2. Methodological sequence of multi-criteria evaluation of export strategies for agricultural products, developed by the author*

No.	Model Stage	Description	Methodological Tool	Practical Outcome
1	Identification of alternatives	Identification of feasible export options by market, product form, route, and contracting model	Expert selection, analysis of contractual practices	Shortlist of comparable strategies
2	Formation of the criteria system	Definition of a set of indicators without content duplication	Content analysis, expert structuring	Working criteria matrix
3	Determination of criteria weights	Pairwise comparison of the importance of criteria	AHP	System of weights aligned with the strategic objective
4	Evaluation of alternatives	Normalization of indicators and comparison of strategies	TOPSIS or VIKOR	Ranking of alternatives and selection of the priority strategy
5	Robustness analysis of the decision	Sensitivity analysis to changes in weights and selected parameters	Scenario modeling	Identification of the stability boundaries of the selected strategy

The proposed sequence ensures a structured and reproducible decision-making process in the context of export strategy selection.

**The first stage involves a clear definition of the alternatives.** In the practice of agricultural exports, an alternative is not merely a destination country. It is often a combination of “market – product form – logistical channel – contracting model.” For example, for a maize producer, alternatives may include exporting through a trader to Mediterranean port markets, direct rail deliveries to Central European countries, or supplying markets with higher traceability requirements but offering a price premium. For producers of apple concentrate or sunflower oil, the range of alternatives is even more diverse, as the influence of packaging, compliance with technical regulations, contractual discipline, and the need for reputational capital becomes significantly more pronounced.

**At the second stage, the criteria system is formed.** At this point, it is essential to avoid two extremes: excessive simplification and model overloading. If too few criteria are used, the model loses sensitivity to real-world constraints; if too many are included, the risk of redundancy and lack of transparency in evaluation increases. For practical application, it is advisable to limit the model to 6–8 key criteria, structured in such a way as to avoid overlap [6]. For agricultural exports, the most justified criteria include expected profitability, logistical resilience, turnover speed, complexity of regulatory entry, level of market risk, scalability potential, and strategic diversification

[6]. When dealing with products sensitive to storage conditions or transportation requirements, an additional criterion of temporal reliability of the logistics chain may be introduced.

**At the third stage, criteria weights are determined.** It is at this point that the integration of multi-criteria decision-making mechanisms acquires methodological depth. The most appropriate approach is the use of AHP as a tool for pairwise comparison of criteria [4]. Its value lies in the fact that it requires experts not merely to identify important criteria, but to consistently assess their relative importance. This is particularly important for export strategy, as the weight of the same indicator may vary depending on the strategic context. If an enterprise operates under liquidity preservation conditions, greater weight is assigned to turnover speed and payment discipline. Conversely, if the enterprise is oriented toward long-term market positioning, greater importance is given to demand stability, scalability, and institutional predictability.

**The fourth stage involves the final ranking of alternatives.** For this purpose, the use of TOPSIS is appropriate, as it allows for assessing the extent to which each alternative approaches an ideal solution and moves away from the worst-case scenario [4; 5]. In the practice of agricultural exports, this is particularly useful, as no strategy is ever ideal across all criteria. One alternative may offer the highest profitability but be weaker in terms of logistical resilience. Another may perform better in terms of turnover speed but be less advantageous in terms of scalability potential. TOPSIS does not eliminate these trade-offs; rather, it makes them transparent and transforms them into a measurable distance from an ideal solution [4; 5].

For practical illustration, one can model a scenario involving a choice among three export strategies for a hypothetical producer of grain and oilseed products. The first strategy targets a large market with high capacity but unstable logistics. The second focuses on a closer regional market with a lower price, but faster turnover and lower operational risks. The third targets a niche segment with a quality premium, but with stringent certification requirements and the need for prior product adaptation. If the evaluation is conducted based on criteria such as profitability, turnover speed, logistical reliability, regulatory complexity, risk level, and scalability potential, it becomes evident that the most appropriate strategy depends on the enterprise's objective function. For an exporter constrained by working capital, the option with faster turnover and lower risks is likely to be preferred. For an enterprise capable of investing in compliance and certification, the niche premium strategy may prove more attractive.

The final stage of the integrated multi-criteria approach is the robustness analysis of the obtained decision, which makes it possible to assess its sensitivity to changes in key model parameters. In practice, the results of ranking alternatives obtained using TOPSIS or VIKOR may significantly depend on the structure of criteria weights, the normalization method, or variations in input data [5–7]. Therefore, without an additional verification step, there is a risk of selecting a formally optimal but unstable decision.

The analytical procedure for robustness analysis involves varying the criteria weights within permissible ranges corresponding to changes in the enterprise's strategic priorities or external operating conditions. In particular, for agricultural exports, it is advisable to model scenarios in which the significance of logistical constraints increases, regulatory requirements become more stringent, or market price volatility

intensifies. Within each such scenario, the aggregate scores of alternatives are recalculated, and the stability of their positions in the final ranking is assessed.

If a slight change in criteria weights leads to a change in the leading alternative, this indicates low robustness of the decision and the need for its further justification or diversification of the export strategy. Conversely, the stability of a given alternative's position across different scenarios confirms its validity as a strategic priority. Thus, the robustness analysis stage performs the function of a "reliability filter," allowing the distinction between situationally optimal decisions and those that maintain effectiveness under changing conditions.

**Conclusions.** Thus, within the framework of the first research objective, it has been established that the selection of an export strategy for agricultural products has a distinctly multi-criteria nature, as the effectiveness of the decision is determined not by a single indicator but by a combination of economic, logistical, regulatory, market, and risk-related parameters. It has been demonstrated that the use of isolated criteria, primarily price or demand volume, oversimplifies the real managerial context and increases the likelihood of strategic error. On this basis, the feasibility of integrating multi-criteria decision-making mechanisms as an analytical foundation for optimizing the export behavior of agricultural enterprises has been substantiated.

Within the framework of the second research objective, a methodological sequence for the multi-criteria evaluation of export strategies for agricultural products has been proposed, integrating the identification of alternatives, selection of criteria, determination of their weights, and final ranking of strategies. It has been substantiated that the most practical approach is the combination of AHP as a tool for determining criteria weights and TOPSIS as a mechanism for the final ranking of alternatives. It has been demonstrated that such a model not only formalizes the decision-making process but also provides a transparent logic for comparing alternatives characterized by different types of advantages and constraints.

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