SCIENTIFIC OPINION

on a Dissertation Thesis Submitted for the Award of the Educational and Scientific Degree "Doctor" in: , Field of Higher Education 3. Social, Economic and Legal Sciences, Professional Field 3.8 Economics, Scientific Speciality Economics and Management (Agriculture)

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Title of the Dissertation Thesis: ECONOMIC ASSESSMENT AND FUTURE PROSPECTS FOR THE USE OF UNMANNED TECHNOLOGIES SUPPORTING ECOLOGICAL ORIENTATION AND PRECISION AGRICULTURE IN BULGARIA

Reviewer: Prof. Nadezhda Blagoeva, PhD, Agricultural University – Plovdiv, Field of Higher Education 3. Social, Economic and Legal Sciences, Professional Field 3.8 Economics, Scientific Speciality Finance, Monetary Circulation, Credit and Insurance, appointed as a member of the Scientific Jury by Order No. RD-16-560/29.04.2026 of the Rector of the Agricultural University – Plovdiv.

1. Relevance of the Research Problem

The topic of the dissertation thesis entitled "Economic Assessment and Future Prospects for the Use of Unmanned Technologies Supporting Ecological Orientation and Precision Agriculture in Bulgaria" is characterized by a high degree of relevance, scientific significance, and practical applicability in the context of the ongoing transformation of the agricultural sector.

In recent years, agriculture has faced numerous challenges related to climate change, the need to increase production efficiency, reduce negative environmental impacts, address rising production costs, and ensure the sustainable management of natural resources. In this context, the implementation of digital technologies and solutions based on the concept of precision agriculture is considered one of the key mechanisms for enhancing the competitiveness and sustainability of agricultural holdings.

Among these innovations, unmanned technologies occupy a particularly important place, as they provide opportunities for real-time data collection, monitoring of agricultural land, assessment of crop conditions, optimization of fertilizer and plant protection product applications, as well as reduction of production costs and the environmental footprint of agricultural activities. The adoption of such technologies is fully aligned with the priorities of the European Union, as outlined in the European Green Deal, the Farm to Fork Strategy, the EU Biodiversity Strategy for 2030, and the new Common Agricultural Policy.

The relevance of the dissertation research is further determined by the need for a comprehensive economic assessment of the effects resulting from the implementation of unmanned technologies in Bulgarian agriculture. Despite the rapid technological development and growing interest in their application, empirical studies examining economic efficiency,

return on investment, adoption factors, and development prospects under the specific conditions of Bulgaria remain limited. This creates a need for scientific research capable of providing a reliable informational basis for decision-making both at the microeconomic level and in the formulation of sectoral policies.

Of particular importance is the fact that the digitalization of agriculture is becoming a key factor in achieving higher resource efficiency, reducing environmental pressure, and adapting agricultural production to contemporary sustainability requirements. In this regard, the study of the economic aspects and future prospects of unmanned technologies possesses not only scientific value but also substantial practical significance for agricultural producers, agribusiness enterprises, and institutions involved in the development of the agricultural sector.

Based on the above considerations, I believe that the selected topic is timely, socially significant, and fully consistent with current trends in the development of precision and sustainable agriculture. This undoubtedly confirms its relevance and justifies the need for an in-depth scientific investigation.

2. Research Objective, Tasks, Hypothesis and Research Methods

The main objective of the dissertation thesis is to conduct an economic assessment of the use of unmanned technologies in precision agriculture in Bulgaria and to analyze their future development prospects within the framework of the European Union's environmental policies and the principles of sustainable development in the agricultural sector.

To achieve this objective, the PhD candidate has formulated seven major **research tasks**, which are presented in a logical sequence. These tasks primarily focus on the analysis of the theoretical and policy prerequisites for the digitalization of agriculture, the economic assessment of the implementation of unmanned technologies, a comparative analysis between conventional and innovative technological solutions, the investigation of farmers' attitudes towards the adoption of such technologies, and the development of future development scenarios.

In order to accomplish the research objective and address the defined research tasks, the author employs a diverse set of research **methods** and analytical approaches. The most notable among them include a systematic literature review, comparative cost analysis, transaction cost analysis, SWOT analysis and scenario modelling, chi-square (χ^2) analysis, a questionnaire survey based on 35 valid responses from agricultural producers, ABCD analysis, backcasting methodology, and other complementary research techniques.

The **research hypothesis** advanced and substantiated throughout the dissertation is that the implementation of unmanned technologies creates favorable conditions for improving economic efficiency, sustainability, and resource optimization in crop production, while the extent of their adoption is determined by a combination of economic, institutional, and technological factors.

3. Presentation and Visualization of the Research Results

The dissertation thesis is structured in a logical and coherent manner. It consists of an introduction, four chapters, a conclusion, recommendations, and a list of references. The individual chapters are relatively well balanced in terms of content and scope, with a somewhat greater emphasis placed on the third chapter, which contains the empirical research findings.

To enhance the presentation and visualization of the research results, the author has included 24 figures and 27 tables. These graphical and tabular elements contribute not only to the effective illustration of the research findings but also facilitate the reader's understanding of the dissertation content. The thesis comprises a substantial volume of 193 pages.

The essence of the dissertation research is concisely presented in the abstract, where the author systematically and clearly summarizes the principal aspects of the study. The abstract consists of 43 pages and has been prepared in full compliance with the established requirements regarding its structure and content.

It includes all mandatory components and presents, in a logical sequence, the relevance of the research topic, the object and subject of the study, the formulated research hypothesis, the research objective and tasks, the applied methodology, the structure of the dissertation, a summary of the scientific and applied scientific contributions, as well as a list of the author's publications related to the dissertation research.

4. Discussion of the Research Results and Literature Used

In the introductory part of the dissertation, the author consistently presents the relevance of the research topic and formulates a clear research objective, supported by an appropriately defined set of research tasks. The object and subject of the study, as well as the research methods employed, are accurately specified. This methodological framework enables the author to convincingly substantiate the research hypothesis throughout the dissertation.

The first chapter is theoretical in nature and is devoted to the conceptual and regulatory foundations of unmanned technologies in agriculture. It examines the essence of sustainable agriculture as an economic and technological system, as well as the concepts of innovation, digitalization, precision agriculture, smart farming, and unmanned technologies, together with their application in modern agricultural practices. A comprehensive review of the relevant scientific literature is provided, allowing the author to identify a research gap that the dissertation successfully addresses.

The second chapter presents the research methodology and establishes the overall research design of the dissertation. The methodological framework is clearly articulated and appropriately aligned with the research objective and the formulated research tasks.

The third chapter contains the empirical component of the study. It examines the economic, social, and environmental dimensions of the implementation of unmanned technologies in agriculture. The results of the survey conducted among agricultural producers

are analyzed in detail, and the main empirical findings are systematically summarized and interpreted.

The fourth chapter focuses on strategic perspectives and implementation models for the adoption of unmanned technologies in Bulgarian agriculture. Particular attention is given to future development scenarios and policy implications related to the wider diffusion of these technologies within the sector.

The comprehensive quantitative and qualitative analysis of the research problem has enabled the PhD candidate to formulate well-grounded conclusions and practical recommendations regarding the sustainable implementation of unmanned technologies in Bulgarian agriculture.

In preparing the dissertation, the author reviewed and utilized 163 bibliographic sources, all of which are appropriately cited in accordance with the requirements of the APA referencing style. The cited sources are exclusively presented in the Latin alphabet and are directly relevant to the subject matter of the dissertation, demonstrating a thorough engagement with the contemporary scientific literature in the field.

5. Contributions of the Dissertation Thesis

The submitted dissertation represents a completed and comprehensive scientific study in which the research objective formulated at the outset has been successfully achieved and the research hypothesis has been convincingly substantiated. The author identifies five scientific-theoretical contributions and six applied scientific contributions, all of which I fully acknowledge and consider to be the original work of the PhD candidate.

Scientific Contributions

• An integrated conceptual framework has been developed for analyzing the implementation of unmanned technologies in agriculture, combining economic, production, environmental, social, and institutional factors.

• The theoretical understanding of the role of the institutional environment in the adoption of innovations within the agricultural sector has been enriched through the application of concepts derived from institutional economics.

• It has been demonstrated that the adoption of unmanned technologies does not follow a universal pattern but rather constitutes a differentiated process that depends on the structural characteristics of agricultural holdings, including farm size, degree of mechanization, investment capacity, and organizational readiness.

• A theoretical framework for a hybrid model of technological integration has been developed, whereby unmanned technologies are combined with conventional mechanization, ensuring a balance between innovation, economic efficiency, and manageable risk.

• The theoretical understanding of the relationship between precision agriculture and unmanned technologies has been expanded by considering the latter not as standalone

solutions, but as components of a broader digital ecosystem for agricultural production management.

Applied Scientific Contributions

• An original assessment tool has been developed to evaluate the applicability of unmanned technologies at the farm level, enabling a comparative analysis of technological alternatives through the integration of economic, environmental, social, and institutional criteria.

• A decision matrix for selecting technological solutions according to farm type has been created, providing a differentiated approach to the implementation of unmanned technologies based on farm scale, available resources, and organizational capacity.

• A scenario-based model for the development of unmanned technologies in Bulgarian agriculture has been designed, incorporating four alternative scenarios that reflect different combinations of institutional support, economic viability, and technological readiness.

• An empirical analysis of farmers' attitudes, perceived barriers, and investment readiness has been conducted, providing a realistic basis for assessing the adoption process and identifying key constraints.

• A model for evaluating the economic efficiency of implementing unmanned technologies has been developed through an analysis of costs and the potential for their optimization within agricultural production.

• Practical recommendations for the sustainable implementation of unmanned technologies have been formulated at three levels institutional, sectoral, and farm level, which can be utilized in the development of public policies and managerial decision-making processes.

6. Critical Remarks and Questions

I consider the submitted dissertation thesis entitled *"Economic Assessment and Future Prospects for the Use of Unmanned Technologies Supporting Ecological Orientation and Precision Agriculture in Bulgaria"* to be a comprehensive scientific study characterized by a high degree of relevance and a clearly expressed practical orientation. The research addresses an important issue related to the development of precision agriculture in Bulgaria and has been prepared in accordance with the established academic standards and regulatory requirements for the award of the educational and scientific degree of Doctor.

The dissertation is distinguished by a solid theoretical foundation, an appropriately selected and correctly applied methodological framework, as well as clearly formulated research objectives, tasks, and findings. The research problem has been examined systematically and in sufficient depth, resulting in significant achievements of both scientific and practical value.

The PhD candidate demonstrates the ability to conduct independent scientific research, to process and analyze empirical data, and to formulate well-founded conclusions and

recommendations. This provides sufficient grounds for concluding that Dafinka Grozdanova possesses the necessary academic preparation, research competence, and professional expertise required for the successful completion of a doctoral dissertation at the expected academic level.

In this regard, I do not formulate any substantial critical remarks concerning the dissertation thesis. However, I would like to address the following questions to the PhD candidate:

• To what extent does the economic efficiency of unmanned technologies depend on the size of the agricultural holding, and is there a threshold below which investments in such technologies become economically unjustifiable?

• In your opinion, what are the principal barriers to the large-scale adoption of unmanned technologies in Bulgarian agriculture?

7. Publications and Citations

On the subject matter of the dissertation, the author has published three scientific articles and one conference paper. In one of these publications, the PhD candidate is the first author, while the remaining publications have been prepared in co-authorship. These publications demonstrate not only the scientific relevance and visibility of the author's research but also the fact that the obtained results have already undergone scholarly scrutiny and evaluation within the academic community.

The presented publications account for a total of 41 points, exceeding the minimum requirement of 30 points established by the applicable legislation for the award of the educational and scientific degree of Doctor.

CONCLUSION

Based on the research methods employed by the PhD candidate, the properly designed and conducted empirical investigations, the analyses performed, and the conclusions and recommendations formulated, I am of the opinion that the submitted dissertation thesis fully complies with the requirements of the Academic Staff Development Act of the Republic of Bulgaria and the Regulations for its implementation at the Agricultural University – Plovdiv. Therefore, I evaluate the dissertation positively.

In view of the above, I respectfully recommend that the esteemed Scientific Jury also vote positively and award Dafinka Vasileva Grozdanova the educational and scientific degree of **Doctor** in the scientific speciality **"Economics and Management (Agriculture)"**.

Date: 31 May 2026
Plovdiv