

## **ANALYSIS OF METHODS FOR OPTIMIZING THE IMPACT OF AGRO- INNOVATION MANAGEMENT SYSTEMS ON REGIONAL DEVELOPMENT**

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<https://doi.org/10.5281/zenodo.17762021>

**Abstract.** The article analyzes the effectiveness of innovative management mechanisms in the modernization of the agrarian sector through various modeling approaches. The study examines the role of digitalization in agricultural production, the application of statistical and simulation models, financial management systems, and information technologies in enhancing sectoral performance. These modeling frameworks help assess opportunities for ensuring sustainable development of the agrarian sector, optimizing managerial decisions, and improving the efficient use of resources.

**Keywords:** agrarian sector, innovative management, model, agriculture, statistical model, financial block, information technologies, simulation model.

**Introduction.** In the context of modern requirements, econometric modeling of all economic processes has become increasingly relevant, as it enables the identification of future trends and the development of pathways to achieve them. In this regard, the present study aims to develop a methodological framework for modeling the processes that determine the efficiency of agricultural production within the agrarian sector. The goal is to identify the factors influencing agricultural productivity and to outline tasks for improving efficiency based on a comprehensive modeling approach.

The study emphasizes the need to design a model that captures the agricultural production process in its entirety, supports evidence-based decision-making, and allows for the continuous refinement and practical application of scientific ideas. Therefore, the proposed model incorporates a wide range of factors affecting agricultural production—financial investments, environmental conditions, storage and marketing processes—based on correlation analysis and aligned with the objectives of the research. This integrative approach ensures continuity with existing modeling frameworks while addressing the gaps observed in some previous models.

Overall, the development of a simulation model for agricultural production within the agrarian sector involves modeling crop cultivation processes, integrating economic and environmental variables, and incorporating scenario-based management systems that consider regional climate conditions and market

dynamics. By enabling long-term simulation experiments, the model helps identify optimal tactical and strategic solutions for agricultural management, thereby distinguishing this research from previous studies.

**LITERATURE REVIEW.** Research on modernizing innovative management mechanisms in the agricultural sector and modeling their efficiency is based on the experience of scientific schools formed in international economics, innovation management, digital agriculture, agrotechnology, and economic modeling. The theoretical foundations, methodological approaches, and modeling tools of this direction have been enriched with globally developed concepts and empirical studies.

Drucker (2007) interprets innovative management as a key factor determining enterprise competitiveness, emphasizing that integrating innovations into management systems significantly increases efficiency. Christopher & Peck (2012) explore the use of innovative logistics solutions in agricultural supply chains, highlighting how resource circulation and delivery systems can be optimized. These studies provide practical evidence of the importance of innovative management in ensuring agricultural sector stability and improving economic outcomes.

FAO reports (2018–2024) outline the main global trends in agricultural modernization, including digitalization, “smart farming,” agrotechnical monitoring, IoT-based resource management, and the integration of farms through digital platforms.

**METHODOLOGY.** Many models still rely on their legacy code. This reliance originates from past efforts spent on creating the model components, which have continued to work effectively to the present day. As a result, these components are often treated as essential parts of ongoing research by many scholars.

However, this approach is usually written in procedural programming languages, which limits the ability to transition the code to more modern codebases. Furthermore, grammar and software engineering curricula have long shifted to new paradigms that are easier to manage. At the same time, most of the legacy approaches are poorly documented, and access to the source code is often restricted to a small group of developers.

It is important to note that, when combined with long-term constraints on agricultural investment and resources, extending functionality or developing new models becomes nearly impossible. Consequently, maintaining and evolving these models often falls on researchers who are primarily engaged in software development. Studies indicate that the existence of current model structures can

hinder process reuse and substitution. Many models remain limited by data and model structures developed decades ago.

**DISCUSSION.** In agriculture, crop production modeling scenarios can play an important role in systems approaches, providing a strong researcher capability. Crop production modeling has developed extensively over the past 30 years, and a variety of crop production models are now available. However, the tendency to separate the so-called “scientific” and “engineering” approaches to crop production modeling limits the maturity of modeling in the face of existing challenges.

Although pest control decisions are made at the farm level, limited by government regulation and resource availability, pest control models should be developed. Like any economic producer, the farmer’s goal is to maximize profit, which is the income from selling the product on the market after deducting the costs of production. Pest control efficiency is the increase in ZKS, where  $Y(Z)$  represents the yield if there were no pest damage, and  $Z$  represents all inputs of production not related to pest control, such as water, fertilizer, and labor.  $Y$  increases with  $Z$  until  $Y$  approaches its maximum potential yield. Let  $ZU(N, X)$  represent the fraction of yield lost to pest damage, where  $N$  is the initial pest population and  $X$  is the pesticide, and the pest control efficiency is given by [5]:

$$ZKS = [1 - ZU(N, X)] * Y(Z) \quad (1)$$

Pest control affects the quality and quantity of the product. Because the price a farmer receives for the product is equal to  $p$ , which depends on its quality and is expressed as:

$$p = p[q(N, X, Z)] \quad (2)$$

Here  $q$  represents quality as a measure of the actual pest pressure, both as an effective and a pest control method. Studies show that quality is certainly increasing in pest control today, but excessive use of some treatments, such as pesticides, can reduce  $q$ . Thus, the benefit from the efficiency of agricultural production -  $F$  is calculated as follows:

$$F = p[q(N, X, Z)] * \{[1 - ZU(N, X)] * Y(Z)\} \quad (11)$$

where  $C(X)$  and  $K(Z)$  are pest control and other inputs, respectively. For pesticides, for example,  $C(X)$  includes the purchase of pesticides, as well as the rental of equipment, and the hiring and monitoring of trained workers.  $C(X)$  may also include the costs of mitigating or compensating for environmental or health-related damage for which the farmer is responsible. In mathematical optimization terminology,  $F$  is the farmer’s objective function[7]. Of course, these effects can be



considered as components of a vector  $\alpha$ . In this case, the changes in values are not instantaneous, but occur with delays.

**CONCLUSION.** In the agricultural and financial blocks, the components of the scenario block have already been discussed. We are talking about interest and deposit rates, product prices, weather conditions, and as a first assumption, it is assumed that the biomass of crops is fully realized. All prices, possibly with random additions, weather conditions, interest rates are determined as a series of numbers. Weather conditions, as a rule, reflect the yield coefficient for the entire growing season. As for interest rates, they are determined by the market situation, and their possible options are considered in the model. This model allows you to calculate the costs of agricultural production, as well as improve the financial result. Also, the use of modeling results helps to analyze and identify the most priority prospects for agricultural activities, fully satisfy the consumer needs of the population.

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