FORECASTING AND OPTIMIZING THE EFFECTIVENESS OF INNOVATIVE TECHNOLOGIES IN DEHKAN FARMS

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Annotation: *This study is aimed at developing a model for assessing, forecasting, and optimizing the economic efficiency of the implementation of digital transformation and innovative technologies in dehkan farms of the Republic of Karakalpakstan. The research results provide practical recommendations for increasing the efficiency of agricultural production, rational use of resources, and the widespread introduction of innovative technologies.*

Keywords: *Karakalpakstan, dekhkan economy, digital transformation, innovative technologies, economic efficiency, optimization model.*

Introduction: The Republic of Karakalpakstan, as an agricultural region, has diverse climatic and geostable conditions, and dehkan farms play an important role in the country's food security and economic stability [1]. In recent years, there has been a growing need for the introduction of digital technologies and innovative solutions into agricultural production, since traditional methods do not give sufficient results in increasing efficiency and optimal use of resources[2].

The introduction of digital transformation and smart technologies will allow not only to increase productivity, but also to reduce production costs, efficient use of resources, and quick adaptation to market demands[3]. From this point of view, the creation of a model for forecasting and optimizing

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innovative technologies in dehkan farms of Karakalpakstan is considered a relevant scientific and practical issue [4].

The purpose of this study is to develop a model for assessing, forecasting, and optimizing the economic efficiency of the implementation of digital transformation and innovative solutions in dehkan farms in the region[5]. The research results serve as a practical basis for the formation of local agricultural policy, the widespread introduction of innovative technologies, and ensuring sustainable economic development [6].

Literature review: In recent years, domestic and foreign research on the implementation of digital technologies, IoT systems, smart irrigation, and sensor monitoring solutions in agriculture has been expanding. Local authors empirically analyzed the impact of digital transformation on productivity, costs, and resource utilization efficiency[8]. In international literature, economic results in the agricultural sector through digital technologies - increasing yields, reducing costs, and optimizing management - have been studied with well-founded methodological approaches[9]. Based on these scientific works, the development of a model for economic assessment and optimization of digital transformation processes in the conditions of Karakalpakstan is relevant[10].

Research Methodology: The study used a comprehensive methodological approach aimed at assessing the process of digital transformation in dehkan farms of Karakalpakstan and determining the economic efficiency of the introduction of innovative technologies. First of all, the existing scientific literature, regulatory legal acts, and international experience were systematically analyzed. Empirical data were collected on the basis of regional statistics, surveys of dehkan farms, and production indicators.

In the analysis process, comparative-statistical methods, regression models, and economic-mathematical optimization approaches were used. The effectiveness of the implementation of digital technologies was assessed

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according to such key indicators as production costs, productivity, water and energy consumption. For the forecasting process, time series analysis, the ARIMA model, and scenario-based forecasting methods were used.

The optimization model was formed on the basis of mathematical functions aimed at achieving the maximum economic result under conditions of limited production resources. The research results made it possible to determine the most optimal parameters for the introduction of innovative technologies for dehkan farms.

Results and discussion: The research results showed that the introduction of digital technologies in the dehkan farms of Karakalpakstan has a significant impact on production efficiency. Increased yields, reduced water and energy consumption, and reduced production costs were noted in farms using IoT monitoring systems, smart irrigation, and touch networks. The difference between sectors where digital technologies are implemented and traditional farms is statistically significant, which confirms the economic advantage of innovative transformation. The following table shows an analytical comparison based on empirical results.

Table 1

Analytical comparison of traditional dehkan farms with the introduction of digital technologies

Indicators	Traditional farms	Farms with the introduction of digital technologies	Difference (%)
Yield (t/ha)	2.8.	3.7.	+32.1
Water consumption (m3/ha)	6,800	4800	-29.4.
Energy use (kWh/ha)	410	320	-22.0
Production costs (thousand soums/ha)	5,400	4200	-2.2

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Net profit (thousand sum/ha)	21.00	3100	+47.6

The results of the table show that in farms where digital technologies have been introduced, a decrease in resource consumption is observed along with an increase in yields. A sharp decrease in water and energy consumption led to a decrease in production costs, resulting in a significant increase in net profit. This confirms the economic efficiency of the digital transformation process in dehkan farms.

During the discussion, it was revealed that economic results are directly related to the correct choice of resource-saving technologies, improving the quality of maintenance, and the availability of digital infrastructure. It was also determined that for the widespread introduction of innovative technologies, it is necessary to strengthen personnel training, technical support, and investment mechanisms. These factors are considered as the main economic conditions ensuring the stability of the transformation process.

Conclusion: The research results showed that the introduction of digital technologies in dehkan farms of the Republic of Karakalpakstan is an important factor in increasing the economic efficiency of agricultural production. It has been established that IoT systems, intelligent irrigation, and sensor monitoring technologies lead to a significant increase in yields, a reduction in resource consumption, and a decrease in production costs. This confirms that digital transformation not only optimizes production processes, but also strengthens the financial stability of dehkan farms.

Analysis shows that the effectiveness of digital technologies is directly related to their correct selection, the maintenance system, the level of infrastructure development, and the qualifications of personnel. Therefore, for the digital transformation process to be sustainable and effective, along with technological modernization, it is necessary to strengthen institutional support,

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professional development programs, investment incentives, and technical infrastructure.

In general, the research results empirically prove the economic advantages of introducing innovative and digital technologies in the dekhkan farms of Karakalpakstan and serve as the basis for the development of scientific and practical recommendations for their widespread implementation.

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