



Article

A Model for Evaluating the Effectiveness of Digital Agrotechnologies in Farming Enterprises

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Abstract: This article develops an econometric model to assess the effectiveness of implementing digital agrotechnologies in farming enterprises. The study analyzed the impact of digital technologies, mobile information systems, water resource monitoring, and agrotechnological investments on agricultural production, using the farming enterprises of the Andijan region as a case study. The research employed regression analysis, the integral index method, and forecasting methods. The results determined that the widespread adoption of digital technologies in farming enterprises has a positive effect on increasing crop yields, promoting the efficient use of water resources, and reducing production costs.

Keywords: Digital economy, farming enterprise, agrotechnology, econometric model, regression analysis, RAI index, digital transformation, mobile platform, forecasting.

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Introduction

Today, the digitalization of agriculture is a key factor in increasing economic efficiency [1], [6]. In global practice, artificial intelligence, IoT technologies, mobile platforms, remote monitoring, and digital management systems are used to optimize agricultural production [4], [8], [9]. In the Republic of Uzbekistan, the digital transformation of the agricultural sector is defined as a priority of state policy [1]. The use of digital technologies in farms enables:

- a reduction in production costs [11];
- the efficient use of water resources [13];
- an increase in crop yields [4];
- rapid operational decision-making [9];
- the expansion of opportunities for automating agrotechnical measures [6].

However, the scientific and methodological foundations for evaluating the effectiveness of digital technologies on farms are not yet sufficiently developed [1], [12]. In particular, assessing the impact of digital agrotechnologies on production outcomes through econometric modeling is a pressing issue [1]. The purpose of this article is to develop an econometric model for evaluating the effectiveness of digital agrotechnologies on farms and to analyze its practical results.

Research Methodology

The study employed economic-statistical analysis, regression analysis, the integral index method, comparative analysis, and forecasting methods [1]. This classification

approach allows for the segmentation of farms by their level of digital development, the creation of flexible organizational-economic mechanisms for each segment, and the targeted application of support measures from the state and private sectors [7]. Furthermore, this index system serves as a crucial scientific and methodological tool for monitoring digital transformation processes in agriculture, assessing their dynamics, and forecasting future development trends [15].

The proposed methodology utilizes the following system of key indicators:

Table 1. Indicator Designations¹.

Designation	Indicator Name	Unit of Measurement
Y	Net Profit	million UZS/ha
RAI	Rural Agrotechnology Index	0-1
Labor	Labor Costs	million UZS/ha
Water	Water Consumption	thousand m ³ /ha
Fert	Fertilizer Costs	million UZS/ha
Invest	Investment in Technology	million UZS
Skill	Farmer's Digital Skills	0-1

These indicators provide the capability for a comprehensive assessment of the economic and technological state of farms [11].

Theoretical Foundations for Assessing the Effectiveness of Digital Agrotechnologies

Digital agrotechnologies are a set of technologies that enable the automation, monitoring, and management of production processes in agriculture [6], [14]. These include:

- GPS and GIS technologies;
- smart irrigation systems;
- mobile information platforms;
- agrotechnical monitoring systems;
- drone technologies;
- analytical systems based on artificial intelligence.

The following criteria are important for evaluating the effectiveness of digital technologies [11]:

1. Economic efficiency;
2. Resource use efficiency;
3. Yield level;
4. Management responsiveness;
5. Quality of information exchange.

Based on these criteria, the level of digital readiness of farms can be determined. This system of indicators forms the logical structure of the research [14]. This is because net profit is taken as the final indicator, and the main economic and technological factors that influence it are expressed systematically [1].

To evaluate the effectiveness of digital transformation, three main criteria are established: economic efficiency, digital efficiency, and investment efficiency.

1. The criterion of economic efficiency.

¹ Compiled by the author

$$E_1 = \frac{Y}{Labor + Fert + Water} \quad (1)$$

The criterion of economic efficiency shows the profit per unit of resources and resource savings.

2. The criterion of digital efficiency.

$$E_2 = \frac{Y}{RAI + Skill} \quad (2)$$

The criterion of digital efficiency shows how profit changes with an increase in the level of digitalization, as well as the actual economic outcome of the technology.

3. The criterion of investment efficiency.

$$E_3 = \frac{Y}{Invest} \quad (3)$$

The investment efficiency criterion allows for the evaluation of the performance level of investments in digital technologies.

The integral assessment indicator is calculated as a composite index that consolidates all factors into a single system.

Composite Efficiency Index

$$CEI = w_1 E_1 + w_2 E_2 + w_3 E_3 \quad (4)$$

Here, is the weight coefficient, which is determined as follows.

We will find the coefficients using regression. In this method, the weight of each indicator (E1, E2, E3) is determined by its impact on net profit. We derive the regression equation as follows:

$$Y = \beta_1 E_1 + \beta_2 E_2 + \beta_3 E_3 \quad (5)$$

Next, we calculate the weights:

$$w_i = \frac{|\beta_i|}{|\beta_1| + |\beta_2| + |\beta_3|} \quad (6)$$

This approach, by relying on real data, minimizes subjective factors and allows for the scientific substantiation of the results [12].

The system of hypotheses developed on this basis comprehensively covers the multifaceted impact of implementing digital technologies, including increasing economic efficiency, optimizing production processes, enhancing resource utilization productivity, ensuring environmental sustainability, and improving the quality of management decisions [6], [11]. These hypotheses are aimed at scientifically evaluating the functional relationships identified through regression and correlation analysis, and their reliability will be verified using statistical methods in the subsequent empirical stage of the research.

Additionally, a model for a digital agrotechnology index was proposed, which serves to determine the level of digital transformation on farms [15]. This model created a way to comprehensively assess the level of digital technology implementation on farms, the state of their digital infrastructure, and their digital management capabilities.

The evaluation model is expressed as follows:

$$RAI = \sum_{i=1}^n \omega_i \cdot x_i \quad (7)$$

This model is based on the Multi-Criteria Decision-Making (MCDM) approach.

The main advantage of this model is its ability to consolidate indicators with different characteristics into a single integral index. As a result, it becomes possible to compare the digital readiness levels of farms, identify existing challenges, and determine priority areas for development [12]. The integral index value ranges from 0 to 1, and a higher index value indicates a higher level of digital technology implementation on the farm.

Based on this model, the digital development level of farms is classified according to the following criteria:

Table 2. Index for Assessing the Level of Digital Technology Implementation on a Farm².

RAI Value	Digital Development Level
0 - 0.25	Very Low
0.26 - 0.50	Low
0.51 - 0.75	Medium
0.76 - 1	High

This table systematically summarizes the criteria for an integral assessment of the digital technology implementation level in farms, expanding the practical application of the research's methodological framework [15]. The distribution of the Integral Assessment Index (IAI) indicators across various ranges makes it possible to determine the status of farms in the digital transformation process, scientifically classify their stages of development, and evaluate existing disparities.

Specifically, an index value in the lower range signifies underdeveloped digital infrastructure, a low level of technological equipment, and limited digital competencies of human capital [7]. Values in the middle range indicate that digital technologies have been partially implemented and their integration into production processes is being carried out gradually [11].

Conclusion

The research results indicate that the widespread implementation of digital agrotechnologies on farms is a crucial factor in increasing economic efficiency. The results of the econometric analysis confirm that digital technologies have a significant impact on productivity, resource use efficiency, and management quality. Additionally, the developed RAI integral index allows for the assessment of the digital readiness level of farms. In the future, the introduction of artificial intelligence, IoT technologies, and smart monitoring systems on farms will serve to accelerate the digital transformation of agriculture.

REFERENCES

- [1] K. E. Mamatkulov, "Econometric analysis of the impact of water resources and climate factors on agricultural efficiency and the adoption of digital technologies," *American Journal of Research*, vol. 3–4, Mar.–Apr. 2026, doi: 10.5281/zenodo.19661150.
- [2] J. Okello, O. K. Kirui, G. W. Njirani, and Z. M. Gitonga, "Drivers of use of information and communication technologies by farm households: The case of smallholder farmers in Kenya," *Journal of Agricultural Science*, pp. 111–124, 2012.
- [3] C. Okello-Obura, M. K. Minishi-Majanja, L. M. Cloete, and J. R. Ikoja-Odongo, "," *Library*, pp. 31–44, 2009, doi: 10.1515/libr.2009.004.

² Compiled by the author

- [4] B. Cao, P. Zhou, W. Chen, H. Wang, and S. Liu, "Real-time monitoring and early warning of cotton diseases and pests based on agricultural Internet of Things," 2024.
- [5] P. M. Blaikie, "Radio: An effective tool in the present context to serve the rural farming community," 1971.
- [6] B. Bronson, "Smart farming: Including rights holders for responsible agricultural innovation," *Technology Innovation Management Review*, vol. 8, no. 2, 2018, doi: 10.1007/s13593-017-0445-7.
- [7] R. Bukht and R. Heeks, "Development implications of digital economies: Digital economy policy in developing countries," *Centre for Development Informatics, Global Development Institute*, Paper no. 6, 2018.
- [8] M. E. Porter and J. E. Heppelmann, "How smart, connected products are transforming companies," *Business Management*, Oct. 2015.
- [9] T. H. Davenport and D. D. D'Agostino, "Artificial intelligence for the real world," *Harvard Business Review*, Jan. 9, 2018.
- [10] W. B. Diether, C. M. K., and R. V., "Mobile phones and economic development in rural Peru," *Journal of Development Studies*, vol. 48, no. 11, pp. 1617–1628, Nov. 2012.
- [11] N. Wolfert, L. Ge, C. Verdouw, and M.-J. Bogaardt, "Big data in smart farming – A review," *Precision Agriculture*, vol. 153, pp. 69–80, 2017, doi: 10.1016/j.agry.2017.01.023.
- [12] A. Kamilaris, A. Kartakoullis, and F. X. Prenafeta-Boldú, "A review on the practice of big data analysis in agriculture," *Big Data Analytics*, vol. 143, pp. 23–37, 2017, doi: 10.1016/j.compag.2017.09.037.
- [13] F. J. Ferrández-Pastor, J. M. García-Chamizo, M. Nieto-Hidalgo, J. Mora-Martínez, and M. Mora-Pascual, "Developing ubiquitous sensor network platform using Internet of Things: Application in precision agriculture," *Internet of Things, Sensors*, vol. 16, no. 7, p. 1141, 2016, doi: 10.3390/s16071141.
- [14] C. Verdouw, S. Wolfert, B. Tekinerdogan, and M. R. Beulens, "Internet of Things in agriculture," *Smart Agriculture, CAB Reviews*, vol. 11, no. 35, pp. 1–12, 2016, doi: 10.1079/PAVSNR201611035.
- [15] S. Fountas, M. Carli, C. G. Sørensen, Z. Tsiropoulos, B. Cavalaris, A. Vatsanidou, M. Liakos, I. Canavari, J. Wiebensohn, and B. Tisserye, "Farm management information systems: Current situation and future perspectives," *Farm Management Information Systems, Computers and Electronics in Agriculture*, vol. 115, pp. 40–50, 2015, doi: 10.1016/j.compag.2015.05.011.