The use of digital technologies in agricultural management

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Abstract. In this article the factors that influence the management of agriculture in the context of sustainable development are listed in this article; the main digital technologies have been identified and a model for the use of digital technologies in agricultural management has been built; indicators for evaluating the effectiveness of the use of digital technologies in agriculture and methods for their calculation are proposed.

1 Introduction

Agricultural management in a sustainable development environment requires the integration of economic, environmental and social aspects to ensure the long-term sustainability of the agro-industrial complex. Sustainable development in agriculture requires a balance between economic, social and environmental aspects of production.

Economic sustainability. To ensure the sustainable development of agriculture, it is necessary to manage finances and business processes in order to ensure economic sustainability. It is important to consider costs and revenues, optimize production processes, improve product quality and develop new markets.

Environmental sustainability. Agriculture must produce products that do not harm the environment, conserve and improve soil and water resources, and minimize the emission of harmful substances into the atmosphere. It is important to apply environment-friendly technologies and methods, to recycle waste and use renewable energy sources.

Social sustainability. Agricultural management should ensure an even distribution of income and social well-being of the population working in agriculture. It is important to take into account the interests of workers and residents of rural areas, to create conditions for the development of small and medium-sized businesses and to support traditional forms of management.

2 Materials and methods

The methodological basis of the article was the scientific works of domestic and foreign scientists in the field of agricultural management. The information base of the study was made up of materials from periodicals and Internet resources, as well as the results of their

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own research. The work uses systematic and integrated approaches, as well as methods of synthesis, generalization and comparison, statistical methods of data processing.

3 Results and Discussion

Agricultural management in terms of sustainable development should consider the following factors:

- Application of ecological production methods. They aim to minimize the harmful impacts on the environment and ensure the conservation of natural resources. For example, the use of biological methods for plant protection can increase the efficiency of water use and reduce atmospheric emissions.
- Application of innovative technologies. The use of new technologies and innovations allows us to increase productivity and production efficiency, improve product quality and reduce the negative impact on the environment [1].
- Application of monitoring and control systems. The monitoring system allows you to monitor the impact on the environment and evaluate the efficiency of production processes. Control over production processes allows you to respond in a timely manner to unforeseen situations and minimize risks.
- Development of social responsibility. Managing agriculture in a sustainable environment requires companies to pay more attention to social issues. For example, it can provide healthy working conditions for employees, participation in social programs, etc.
- Development of international cooperation. Sustainable agricultural development requires a global approach. Interaction between different countries makes it possible to exchange experience and knowledge, jointly solve environmental and economic problems, and create more effective strategies for sustainable development.
- Use of digital technologies. Agricultural management in the context of sustainable development involves the use of modern digital technologies, such as monitoring and production management systems, data analysis systems, resource management systems, etc. This improves the quality and efficiency of production, optimizes the use of resources and reduces the environmental impact [2, 3].

Digital technologies play an important role in the management of agricultural production in the context of sustainable development and include [4]:

- Monitoring and production control systems. These systems automate farming processes such as planting and harvest planning, irrigation and fertilization management, livestock management and diagnosis of animal diseases. They also allow you to analyze production process data to optimize resource usage and improve productivity.
- GPS systems. These systems are used to monitor and manage field work. They allow the determination of the most efficient routes for cultivating fields, reducing fuel and fertilizer costs, and reducing environmental impact [5].
- Data analysis systems. With the help of modern data analysis systems, information can be obtained on soil quality, plant health, food requirements and other aspects that can help improve production processes and resource efficiency.
- Resource management systems. Natural resource management maximizes water and land management that includes an automatic watering system with a fertilizer and pesticide control system.
- Remote sensing. This is technology that provides information on soil cover, vegetation status and other parameters using satellite imagery. This can help in assessing land use, identifying fertilizer and water needs, and assessing potential environmental risks.

- Internet of things. This is a technology that allows the collection of information from various devices in real time. This can help in managing production processes and diagnosing problems [6, 7].
- Blockchain. This technology allows the creation of secure databases that can be used to track food from production to consumption. This can help manage supply chains and ensure transparency in production [8].
- Robotics and automation. The use of robots and automated systems can help reduce labor costs and improve the quality of production.
- Artificial intelligence (AI). Artificial intelligence makes it possible to improve forecasting and decision-making in agriculture. For example, machine learning algorithms can help determine the optimal conditions for growing plants and animals. One of the main applications of AI in agriculture is to increase productivity and quality. The use of AI allows the accurate prediction of weather conditions, determination of the optimal time for sowing, caring for plants and harvesting. AI can also help to automatically determine the condition of the soil and provide fertilizer recommendations. AI can also help reduce agricultural production costs [9]. Automation of data collection, analysis and decision-making processes can reduce the time spent on these tasks, as well as help reduce labor costs. AI can also help optimize the consumption of water and energy, which can also lead to a reduction in costs [10].

A model for the use of digital technologies in agricultural management, which can be divided into three stages, is presented in Figure 1.

Staging stage (S1): at this stage, data on factors affecting agricultural production is collected, processed and analyzed.

Analytical stage (S2): At this stage, the optimal digital technologies that can be used in agricultural production are selected and tested. The most critical tasks and problems that can be solved with the help of digital technologies are identified. It is important to test the model using various data by adjusting the parameters and ensuring that the data is accurate and effective.

Operational stage (S3): At this stage, digital technologies are configured and integrated into work processes, as well as the use of the model. To maintain its relevance and effectiveness in the long term, it is important to update and adjust the model regularly.

The model also provides three decision-making points (D1, D2, D3) and an interactive element in the form of return points, because the individual results of the use of digital technologies in agricultural management are regularly coordinated. In the model, the stages and decision points are delineated by dotted lines.

Evaluation of the effectiveness of the use of digital technologies in agriculture can be carried out on the basis of a number of indicators:

- Increasing profitability. Increasing production output and reducing costs can lead to increased profitability in agricultural enterprises. Sales revenue can be increased through enhanced productivity and product quality, decreased production costs, and optimized resource management.
- Increasing labor productivity. Digital technologies make it possible to increase the efficiency of resource use, reduce the time of operation and improve the quality of production, which can lead to an increase in labor productivity. For example, the use of automatic irrigation and fertilizer management systems can increase the crop productivity.
- Cost reduction. Digital technologies can help reduce the cost of producing resources and maintaining equipment. For example, an automatic irrigation system can reduce water consumption and the cost of acquiring and transporting it.
- Increase in output. Digital technologies can increase product output by improving quality, reducing losses in production processes and optimizing the use of resources.

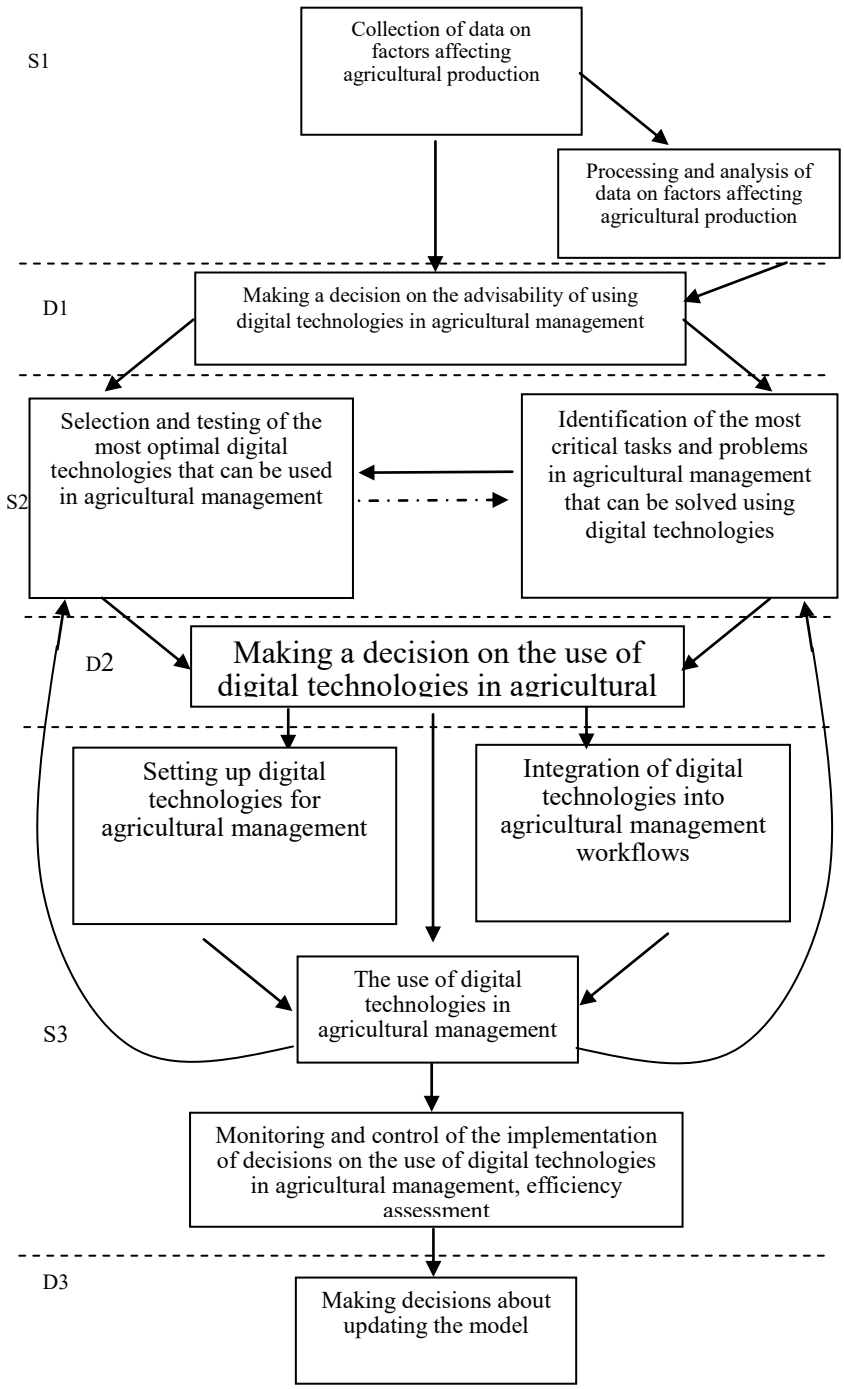

Fig. 1. Model of digital technologies application in agriculture management.

- Reducing the negative impact on the environment. Digital technologies can help reduce the negative impacts on the environment by reducing emissions and pollution, optimizing the use of water resources and reducing energy consumption. For example,

the use of fertilizer management systems minimizes fertilizer costs and reduces their negative impacts on the environment.

- Increasing competitiveness. The introduction of digital technologies can increase the competitiveness of agricultural enterprises by increasing their productivity, reducing costs and improving product quality. For example, the use of plant growth monitoring systems allows the determination of the optimal conditions for growth, which in turn improves the quality of the products.
- Payback period of investments. It is shown over what period of time the investments spent on the use of digital technologies will be fully recovered from the available benefits. The shorter the payback period, the more effective will be the use of digital technologies in agriculture.
- Share of automated processes. This allows for increase labor productivity and reduction labor costs, as well as to improve the accuracy and speed of data processing and process management in agriculture.
- Improving the availability of information. Digital technologies can improve the availability of information about the state and production processes, and it can allow for better management decisions.
- Improvement in working conditions. This factor assesses improvements in working conditions by the use of digital technologies. For example, the use of automatic irrigation and fertilizer management systems reduces the need for manual labor and it improves working conditions.

The recommended methods for calculating the efficiency indicators for the use of digital technologies in agriculture are presented in Table 1.

Table 1. Methods for calculating indicators for assessing the use of digital technologies in agriculture.

No.	Indicator	Method of calculation
1	Profits increase	Effectiveness = (sales revenue – the costs of implementation of digital technologies/ the costs of implementation of digital technologies) x 100%
2	Increase in labor productivity	Effectiveness = (labor productivity after the implementation of technology / labor productivity before the implementation of technology) x 100%
3	Cost reduction	Effectiveness = (costs before the implementation of technology - costs after the implementation of technology)/costs before technology implementation) x 100%
4	Increasing yield	Effectiveness = (the number of products using digital technologies - the number of products without the use of digital technologies) / the number of products without the use of digital technologies) x 100%
5	Reducing the negative impact on the environment	Effectiveness = (amount of emissions/ pollution before the implementation of technology - the number of emissions / pollution after the implementation of technology) / the amount of emissions/pollution before the implementation of the technology) x 100%
6	Increasing competitiveness	Effectiveness = (the level of competitiveness with the use of digital technologies - the level of competitiveness without the use of digital technologies) / the level of competitiveness without the use of digital technologies) x 100%
7	Payback period of investments	Payback period = investments in the implementation of digital technologies / annual cash flow that is acquired as a result of the use of digital technologies in one year, less the costs of their use and maintenance
8	Share of automated processes	Share of automated processes = (the number of automated processes after the implementation of digital technologies / total number of processes) x 100%
9	Improving the availability of information	Level of information availability = (the number of employees who gained access to information after the implementation of digital technologies / total number of employees) x 100%
10	Improving working conditions	Index of improvement of working conditions = (number of employees who improved working conditions after the implementation of digital technologies / total number of employees) x 100%

To assess the effectiveness of digital technologies in agriculture, a combination of these indicators can be used depending on the goals and objectives of the agricultural enterprise.

4 Conclusion

Digitalization is becoming increasingly important in modern agricultural management as it offers a range of benefits that can improve efficiency, productivity, and sustainability. By implementing digital technologies, agricultural managers can gain access to real-time data and analytics, which can help them make more informed decisions about crop management, resource allocation, and supply chain management.

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