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# Increasing digital capabilities of agricultural projects to reduce costs

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## ABSTRACT

This paper provides an overview of the extent of digital transformation in the Republic of Iraq. It contains a discussion of the opportunities and challenges that the economy faces due to digitization and its potential to promote a sustainable economic transformation to achieve the 2030 Agenda for Sustainable Development. By analyzing the experience of implementing these projects, it is possible to identify the economic and accounting actions that can be taken to reduce the costs of digitizing crop production enterprises, as well as identify problems in industrial relations that impede effective digitization and the establishment of a geographic information system for regional agriculture in the Middle Euphrates, Iraq. Based on an assessment of the state of digitization in the Middle Euphrates region of Iraq, key areas for digitization efforts in the agricultural sector were identified. The study revealed the fundamental trends of modern and innovative digital technologies presented by the "Digital Agriculture" management project with special data processing methods and the use of geographic information systems that make it possible to obtain a significant economic impact to reduce and rationalize costs. According to the results obtained, the use of elements of digital technologies in crop production in the Middle Euphrates, Iraq, has a significant economic effect, the replication of which can greatly accelerate the development of the industry. These efforts to unlock Iraq's digital potential will accelerate the achievement of the Sustainable Development Goals.

**Contribution/Originality:** The study identifies the ways of reducing costs by establishing a geographic information system for regional agriculture in the Middle Euphrates, Iraq, and using special data processing methods. These result in a significant economic impact by rationalizing data and reducing costs.

## 1. INTRODUCTION

In the current age, when various information technologies are developing, information systems used in data processing play a large role, which in turn leads to an increase in the efficiency of agricultural enterprises. To carry out the work quickly and accurately, various systematic information systems are being introduced in agricultural operations through a wide range of innovative digital platforms. A methodical information system must meet certain criteria, including information technologies based on innovative models, digital platforms for management and services, and others. Considering the needs of the modern user, the following criteria are indispensable:

1. Reliability. The standard should contain references to letters from ministries and departments, as well as legislation and arbitration practices.
2. Objective orientation and integrity. It must contain a large number of different articles on accounting and taxation.
3. Versatility. A methodical information system must target a large number of users.
4. Availability of viewing materials. The materials used must be written in accessible and understandable language, not contain unnecessary information, be concise and meaningful, and not require much time to read and research.
5. High professional level. The materials used in the information system must be geared towards a professional accountant who uses them in his or her practice for agricultural enterprises.
6. Relevance. Relevance is necessary for the user to assess how meaningful the information is which they receive when implementing innovative digital platforms in agricultural operations.
7. Availability for use. Access to the Internet is assumed, making the standard accessible from any computer.
8. Feedback. If the user notices errors or wants to express gratitude or ideas or offer an article, they need a way to offer feedback to the system developers. Therefore, any modern information system should provide an opportunity for feedback (Al-Shammari, 2008).

The analysis of the development of digital trends in the agricultural sector, such as the use of information technology, sensors, small and big data, controls, and platform solutions, has led to modern and innovative digital technologies provided by the management project "Digital Agriculture."

## 2. LITERATURE REVIEW

Domestic crop production supplies resources to global value chains for the production of products that are subsequently imported at higher prices (Darim, Eisaa, & Lihashm, 2020). This indicates that there are structural imbalances in crop production and other sectors of the agro-industrial complex that require adjustment. It is equally important to ensure rational spatial proportions in the crop-growing industry.

### *2.1. Innovation Factors*

Its insufficient technological level, along with the limited spread of innovations, is a problem for the development of the Iraqi economy as a whole; however, with regard to agriculture, we must discuss overcoming technical and technological backwardness due to the level of productive forces (Hanseth & Lyytinen, 2010; Nagy, 2016). The current technological level of the agro-industrial complex, especially in crop production, does not allow reliance on sustainable development in terms of its economic, environmental, and social criteria.

The majority of agricultural enterprises in Iraq still belong to the third and fourth technological modes. The third mode of crop production involves the extensive introduction of machinery and mechanization while maintaining large subsistence labor costs. The fourth mode is the "first green revolution," in which, with regard to machinery and equipment, standardized "end-to-end" technological processes are developed with minimal logistical barriers and manual labor (Shenjar, 2016).

At the same time, the opportunities for innovative and technological development of crop production in Iraq (as can be judged by the views of prominent local agricultural economists (Alraawy, 2016; Annual Report, 2016; Talib & Arshad, 2019)) is severely limited by the following factors:

- Poor financial capabilities, low profitability, or the uselessness of a large share of agricultural enterprises, limited funds for technical re-equipment, and, in some cases, a lack of interest in this matter.
- A high degree of risk and dependence on uncontrollable external factors, which leads to a decrease in the attractiveness of investment and a lack of interest from investors in crop production investments.

- Lack of state support, which is necessary for crop production as it is an industry close to the model of perfect competition with minimal economic profit, which does not allow for modernization at its own expense.
- Insufficient development of methodological, organizational, and management tools for the formation of mechanisms for the innovative development of the agro-industrial complex, including crop production.
- Other problems.

### *2.2. Environmental Factors*

Technological development is unimaginable without considering solutions for recent and emerging environmental problems. Therefore, given the current context, an understanding of innovative ways of crop production includes environmental preservation, the use of resource-saving, safe technologies, the minimization of negative impacts on natural fertility, as well as recreational potential (Muqnani & Shabila, 2019; Nagy, 2016).

Some of these factors presuppose a transition to "organic" or "ecological" agriculture, which involves minimal interventions in the natural ecosystem, such as non-mold tillage, use of organic fertilizers, etc. (Abbas, 2010). However, it is currently more a "status" than a collective farming technique. Therefore, traditional agriculture using technical and chemical means will likely remain the main food supplier. However, the proposed greening measures either require high additional costs or entail the risk of low returns and deterioration of financial and economic indicators.

The economic development of agricultural enterprises differs from economic growth. It assumes not only positive dynamics of aggregate economic indicators but also the comprehensive development of productive forces, production, and organizational and economic relations, focused on preserving growth opportunities for future generations and natural soil fertility, solving environmental problems, and social development of the village. This greatly complicates approaches to ensuring and maintaining the economic development of agricultural enterprises.

### *2.3. Introducing Digital Technologies to the Development of Agricultural Enterprises*

The digital transformation of agriculture is largely based on the integrated implementation of several digital technologies within the interrelated concepts of precision farming and smart agriculture. Although individual elements of precision farming have been used for more than 20 years, only now are integrated solutions in the field of sustainable resource-saving crop production being introduced that combine various types of sensors, Internet of Things technologies, automated and unmanned vehicles, robotic production systems, platform technologies for processing large data, and machine learning.

The key task of the digital transformation of agriculture is to extract value from the collected big data about the internal and external environment. The basis for this process is the use of cloud platforms and big data solutions, as well as predictive analytics technologies and decision support systems. By the end of 2020, there were already 75 million agricultural Internet of Things devices in the world, and by 2050, the average farm will generate 4.1 million data points per day (Tech Republic, 2018). Reducing the cost and increasing the accuracy of sensor equipment (field sensors, sensors for monitoring the condition of industrial premises, agricultural equipment and machinery, livestock health monitoring sensors, etc.) will allow a large number of agricultural enterprises to switch to continuous collection and analysis of information and integrate the three levels of monitoring of agricultural systems (ground, air, and space) at the level of individual farms, regions, and countries as a whole (World Social Report, 2021).

The most general concept is that of the digital economy. In 2018, the World Bank defined the digital economy as "a new paradigm of accelerated economic development based on the exchange of real-time data"(Asif & Jolevski, 2019). The World Bank defines digital technologies as "the Internet, mobile phones, and all other means of collecting, storing, analyzing and exchanging information in digital form" (Asif & Jolevski, 2019). At the same time, the digital economy is not limited to the field of information and communication technology (ICT) in the narrow sense (in fact, informatics and communication as an industry), but extends to all economic activities that use digital exchange and data processing (Shchetinina, 2017; Yves, 2015). In other words, the digital economy is not a new sector or industry, but rather a transformation of all ICT-based industries.

In the strategy for the development of the information society in the Republic of Iraq for the period 2017–2035, the digital economy is understood as "an economic activity in which the main factor of production is digital data; the processing of large volumes and the use of analysis results can significantly increase efficiency, compared to traditional forms of management" (Ali, 2020). The strategy further emphasizes the importance of digital diffusion throughout the economy.

By 2026, the Iraqi market for digital technologies in agriculture is expected to grow five-fold, including through support for startups in the field of agricultural technology (Annual Report, 2020). The most popular solutions include decision support systems, precision farming applications, production management systems, plant and animal health monitoring, unified user interfaces and platforms that integrate various tools for managing an agricultural enterprise – including those based on a cloud environment – automated systems for harvesting and ensuring the activities of livestock farms, and intelligent systems for analysis and supply chain management.

## 3. METHODOLOGY

The objective of this paper is to explore the digital economy of the agro-industrial complex in Iraq, as well as the peculiarities and trends of the development of foreign and Iraqi platform companies. The strategic objective for Iraq's development is to build a digital economy in each region. The implementation of the Information Society Development Strategy and the approved government program "Digital Economy for Iraq" aims to improve the information literacy of the population and develop favorable conditions for the life of Iraqis by improving the quality and availability of goods and services used in the manufacture of modern and innovative digital technologies (Alkarawy, Al-Sultani, Adnan, Al-Ssadi, & Abedi, 2021). The development of the digital economy is one of the main production factors in all spheres of social and economic activity, as well as a prerequisite for increasing the competitiveness of regions. Farms are the main component of the region's economy; agricultural production accounts for 58% of the gross domestic product (GDP) (Shchetinina, 2017). According to Haddad (2012), despite the imposition of sanctions, Iraq can become a model in terms of its level of development.

The process of digitalization (Ali, 2020), involves the division of the economy into three sectors – the primary, secondary, and tertiary – where the primary comprises agriculture and mining, the secondary is the industrial sector, and the tertiary is the service sector. The essence of digitalization as noted by scientists is not so much the growth of the latter sector or the emergence and growth of a new one, the digital economy, as the radical transformation of all three existing sectors. This view of scholars is closely correlated with the views on the concept of post-industrial society, according to which social production was divided along similar lines into three sectors. It must be noted, however, that in the future, compared with the agriculture and industrial sectors, the volume of the service sector will increase significantly (Shahr, 2017).

Ali (2020), who heads Gazprom Neft's directorate for digital transformation, identified the concepts of "digitalization" and "automation," emphasizing that "digitalization, in my understanding, is like automation. That is, we use digital technologies to make the current organizational and production processes more efficient in agricultural complexes."

The idea of building 500 hectares of greenhouses was immediately included in the import substitution program. Later, the list of projects expanded, and in 2018 the Iraqi government announced the implementation of 200 investment projects totaling more than 128 billion dinars, which will contribute significantly to the development of the import substitution program and is innovative. It includes plans to launch a new feed mill, cattle and sheep breeding complexes using high-tech equipment, as well as a plant for processing sunflower, soybean, and rapeseed based on innovative technologies. In addition to attracting investment, the sanctions have had a positive impact on Iraq's foreign trade balance. If earlier the ratio of exports to imports was 35 / 65, now, in contrast, the region exports 65% of the total volume of foreign trade, and acquires 35% of products from abroad (Annual Report, 2016).

## 4. RESULTS AND DISCUSSION

Al Abbasi noted that despite the protracted crisis of agricultural industries in the whole of Iraq and the accompanying decrease in the amount of agricultural land, the central and southern regions enjoy a stable position in Iraq for the production of agricultural crops such as wheat and barley (Al Abbasi, 2014). Education work is of great importance in the regions.

The regions pay great attention to small and medium-sized businesses, including the development of agriculture. In 2019, 3,580 family farms were established in the central and southern regions. Thanks to the support of the Iraqi Ministry of Agriculture, there is a positive trend in the agricultural production of family farms. In 2018, financial support was provided to agricultural enterprises in the region. It should be noted that for the development of agricultural production, special attention must be paid to the formation of a new digital technological basis for the sustainable development of Iraqi agribusiness, increasing the volume of exports of agricultural products, following demand from the Arab Gulf countries, as well as the implementation of the state program for the region "Agricultural Development and Fish Farming" to saturate the local market with high-quality and affordable food products for the population, create efficient and competitive agricultural production, and increase the employment and living standards of rural residents (Annual Report, 2018).

According to the results of an expert survey and estimates by the Iraqi Ministry of Agriculture, the agricultural sector's demand for advanced digital technologies was estimated at 22.2 billion dinars in 2021, with an expected growth of 15.8 times by 2030 to 472.4 billion dinars, as shown in Figure 1.

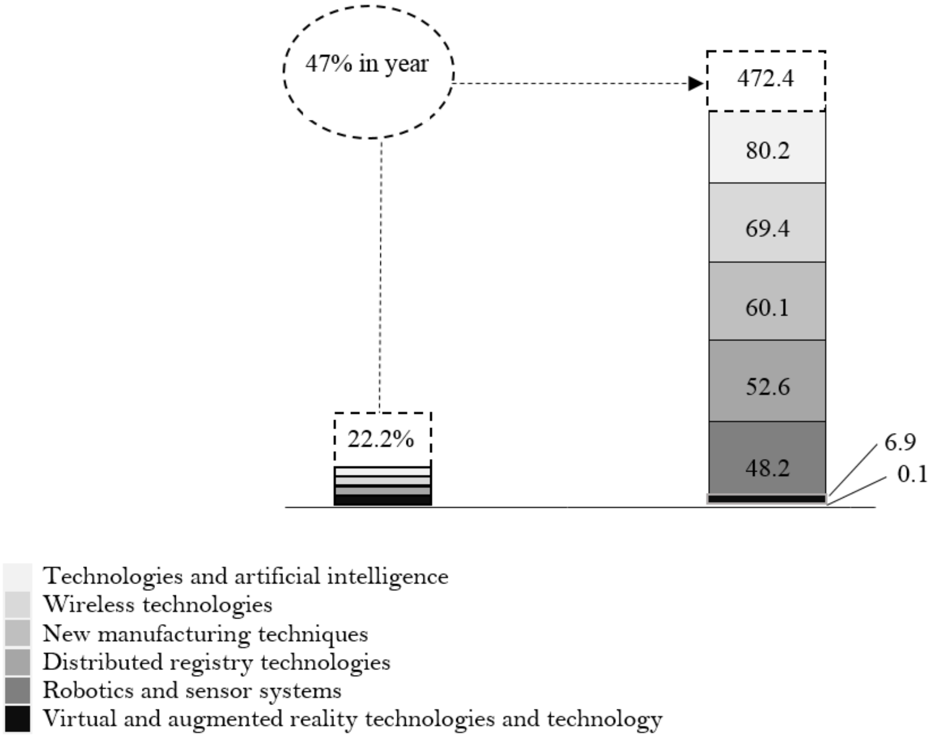



**Figure 1.** Demand for advanced digital technologies in agriculture in 2021 and 2030.

**Source:** Iraqi Ministry of Planning calculations based on expert survey results. Numbers indicate billion dinars.

Among the most demanded advanced digital technologies in agriculture in the future are neurotechnologies and AI, wireless communication technologies, new production technologies, and distributed registry systems, as detailed in Table 1.

**Table 1.** Forecast of changes in demand for advanced digital technologies in agriculture.

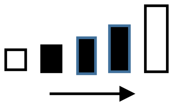
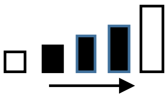
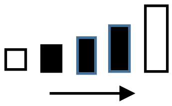
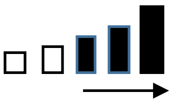
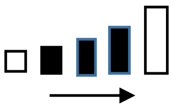
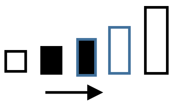
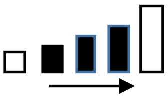
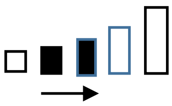
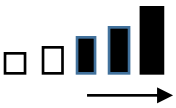
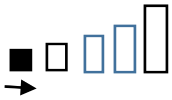
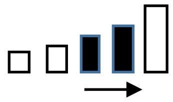
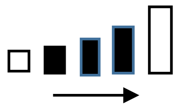
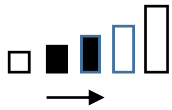
| Technology | Change in demand | Expert substantiation |
|---|---|---|
| Technologies and artificial intelligence | | |
| Computer vision |  | Computer vision-based systems are beginning to be widely used to monitor the condition of crops and animals, control the use of equipment and the work of employees, and control the quality of products. |
| Recommender systems and intelligent decision support systems |  | Intelligent decision support systems are used to perform the tasks of predicting yields and choosing the optimal strategy for growing crops, adjusting fattening, and caring for animals. |
| Distributed registry technologies | | |
| Data organization and synchronization technologies |  | Already being implemented, public information systems built on "consensus participation processes" (CPP) technology and platforms that give farmers access to active participation in industry processes, ensuring high transparency in tenders and purchases, as well as allowing them to put their own products for sale online. |
| Technologies for ensuring data integrity and consistency (Consensus) |  | Distributed ledger technologies make it possible to verify the origin of products and provide consumers with free access to reliable information about agricultural products. |
| Technologies for creating and executing decentralized applications and smart contracts |  | Smart contracts greatly simplify the process of insuring crops for farmers and interacting with insurers about damages. |
| New manufacturing techniques group | | |
| Digital design, mathematical modeling, and product or product life cycle management (Smart design) |  | Digital design, mathematical modeling, and product or product life cycle management (Smart design). |
| Manipulators and manipulation technologies |  | Manipulation technologies will be increasingly used in the automation of agricultural processes (Crop processing, harvesting, livestock care). |
| Robotics and sensor systems group | | |
| Sensors and digital components for human-machine interaction |  | The development of this area will be associated with smart greenhouse systems, which, due to deep automation, will be able to ensure an increase in the quality of interaction with a person. |
| Technologies of sensorimotor coordination and spatial positioning |  | Two areas of application are actively developing – the transfer from manual control mode of agricultural means to remote control and taking into account the features of the trajectories of movement of the working elements of the robotic complex in the physical environment. |

**Table 1.** Continued.

| **Technology** | **Change in demand** | **Expert substantiation** |
|---|---|---|
| Wireless technologies group | | |
| WAN (Wide area network) |  | The use of WAN networks based on 5G licensed spectrum networks is not critical for the digitalization of agriculture. |
| PAN (Personal area network) |  | Some automation processes are implemented on PAN technologies (For example, a system for monitoring and recording the state of animal health using non-contact sensors). |
| Virtual and augmented reality technologies group | | |
| Platform solutions for users: content creation and distribution editors |  | The growth in demand for solutions will be associated with the rapid development of farmer marketplaces, the integration of virtual reality and augmented reality VR / AR elements into which will become an effective marketing tool to attract new customers. |
| Graphics output technologies |  | Pilot projects in the field, including using VR glasses on dairy farms to create favorable conditions for cows and improve their well-being, have had a positive impact on the quantity and quality of milk produced. |

**Source:** Ministry of Agriculture report based on expert survey data.

We cannot ignore the fact that today's digital technologies are changing the way businesses are run, especially the business of the agricultural sector, so we must consider the different areas of digitization that are prevalent in modern agricultural business, and the feasibility of using digital technologies. Thus, one of the aims of increasing the economic potential of local agricultural enterprises is digital transformation, that is, building a customer-oriented strategy and improving the tools for interaction with them, as agricultural enterprises will find it difficult to survive and ensure their presence in a new competitive market without innovative technologies. The central and southern region of Iraq has a large capacity to increase the efficiency of agricultural production through the introduction of digital technologies in areas such as crops, animal husbandry, cattle breeding, and others, thus creating additional job opportunities and improving the economic climate. The tasks of digital transformation should also be noted:

- Monitoring systems.
- Digitalization of workflow.
- Digital platform.
- Product traceability.

Digital technologies in agriculture contribute to the creation of complex automated production and logistics chains that cover wholesale and retail businesses, supply logistics, and the marketing of agricultural products in a single organizational and economic mechanism with adaptive management. Today, the tasks of quantitative, but also qualitative, transformations of the industry come to the fore. This is because the industry is competitive, not only in the domestic market but also in the global market. It should be noted that a significant contribution to the development of a digital platform for the Iraqi agricultural sector was made by the Scientific and Educational Center of the Iraqi Ministry of Agriculture, which was created because of the National Science Project. The Scientific and Educational Center is distinguished as a line of innovations in the agro-industrial complex and as a platform dealing with the digitization of agriculture. This platform is designed for the agricultural sector of the whole country. The Scientific and Educational Center established within the Iraqi Ministry of Agriculture will specialize in the development of biotechnologies for the agro-industrial complex.

Therefore, it must be clarified that geographical information systems (GIS) can be used to create a project. The user of GIS has the ability to create a project, that is, a data system in a specific field (or department), presented in different layers, to request and receive information, to plan certain actions on this basis, and to evaluate their results.

For some tasks, for example, the authorities can also require the identification of land use, "AgroGIS." When developing GIS for the Middle Euphrates region, it is important to correct errors and distortions in the data related to agricultural land received from the federal authorities. For instance, the Fadak farm under study contained only 20.1 harvests in terms of reference units, extending the harvest time by 1.5–2.0 compared to the norm, that is, by up to 10 days, leading to a loss of 1% of the crop in a third of the area.

Even before the use of GIS, the farm made certain attempts to rationalize harvest schedules, taking into account individual differences in harvest times in different areas; however, without the use of digital technologies, this did not produce any practical result. Having accessed "AgroGIS," it became possible to draw up harvest tables, taking into account comprehensive information about the maturity of the grain, which had a significant productive and economic effect, as shown in Table 2.

**Table 2.** The effect of rationalizing grain harvesting schedules for a limited fleet of combines in accordance with vegetation indices.

| Data | Without rationalization | | | | After rationalization | | |
|---|---|---|---|---|---|---|---|
| | Average losses, percent | Maximum possible collection | Actual collection | Losses | Average losses, percent | Actual collection | Losses |
| First 33% (Cleaning within 1-4 days) | 0 | 17583 | 0 | 17583 | 0 | 17583 | 0 |
| Next 33% of the area (Cleaning within 4-7 days) | 5.1 | 17583 | 896.7 | 16686.3 | 2.0 | 17231.3 | 351.7 |
| The last 33% of the area (Cleaning within 8-10 days) | 7.5 | 17583 | 1318.7 | 16264.3 | 5.1 | 16686 | 897 |
| Total | - | 52749 | 2315.4 | 32950.6 | - | 33917.3 | 1248.7 |

From the above table, it can be noted that although it does not completely eliminate losses (and requires full savings with combines), the rationalization of the harvest schedule and the use of combines, taking into account the actual differences in the aging reversal index of plants, made it possible to shape the time of harvest by considering the actual stages of maturity, consequently reducing the total grain losses by 1910 (up to 2150 tons).

Taking the average market value of the grain at 750,000 Iraqi dinars (IQD) per ton at the prices of the corresponding year, it is possible to determine the economic impact in the form of additional revenue from the sale of agricultural products in the amount of 191.0 tons x 7.5 thousand dinars = 1432 thousand dinars. At the same time, access to data on 3,700 hectares of land is required at a rate of 76 dinars (providing access to the PSRI index), therefore, the economic impact of investment in the use of GIS amounted to 4.50 dinars gained for each 1 Iraqi dinar (IQD) spent.

It is also possible to clarify the needs of Fadak farm in terms of material and technical resources and thus implement a seeding campaign according to GIS data, which makes it possible to determine the exact boundaries of the fields.

For many subsidiaries in the Middle Euphrates region, the problem of inaccurate knowledge of the size and boundaries of the cultivated areas is characteristic, resulting in excessive consumption of fuel, seeds, and fertilizers ("non-existent hectare costs"), incomplete use of arable land, and a lack of harvest. In 2021, the Fadak farm planned a 3,000-hectare seeding campaign using GIS data, which made it possible to obtain the economic impact detailed in Table 3.

**Table 3.** Economic impact of planning sowing operations using geographic information systems on Fadak farm.

| No. | Data | Total |
|---|---|---|
| 1 | Additional revenue from the sale of grain grown on plots of land that did not previously participate in the processing, one thousand dinars | 1210 |
| 2 | Additional costs for processing previously unused areas, thousand dinars | (740) |
| 3 | Savings on fuel and lubricants by accurately determining the size of the cultivated areas in thousands of dinars | 190 |
| 4 | Savings on other expenses (Including wages), thousand dinars | 130 |
| 5 | Total resource savings, thousand dinars | 650 |
| 6 | Total effect, thousand dinars | 998 |
| 7 | Expenses associated with use of geographic information systems (At a rate of 100 dinars per hectare), thousand dinars | 160 |

To date, generalized quantitative evaluations of the economic efficiency of digital technologies in crop production have not been presented in the literature; only a few positive effects are known. In this regard, the authors have analyzed the impact of the introduction of digital technologies on the cultivation cost of wheat and barley, as well as the investment efficiency in their use by certain private companies, as shown in Table 4.

From the data in Table 3, it can be seen that the use of two technologies – GIS and drone crop control – has made it possible to reduce the costs of such items as "remuneration for labor with accruals" and "raw materials, materials, and components" (due to clarification of the scope of work using the real boundaries of the fields). In addition, due to yield programming, the yield is slightly increased. As a result, the total expenditures of the agricultural enterprise decreased by 6518 thousand IQD, taking into account the cost of introducing digital technologies.

Planned pre-season costs were calculated in accordance with current standards and on-farm costing practices. Thus, the cost of planting 1 ton of wheat was 5945.3 IQD, and the farm's total costs were about 111.253 million IQD. Due to the introduction of digital technologies for precision agriculture, the actual costs across several categories decreased by 6.878 million IQD.

**Table 4.** The effect of the introduction of digital technologies on the cost of growing wheat (with an average of more than two agricultural enterprises for the Middle Euphrates region for the year 2021).

| Cost elements | Primary option (Before using digital technologies) | | After the implementation of the project | | Savings | |
|---|---|---|---|---|---|---|
| | For the entire production volume, thousand IQD | For 1 ton of wheat, IQD | For the entire production volume, thousand IQD | For 1 ton of wheat, IQD. | For the entire production volume, thousand IQD | For 1 ton of wheat, IQD. |
| Rent, leasing of equipment | 7326 | 366.3 | 7326 | 333 | 0 | 33.3 |
| Remuneration for labor with accruals | 25237 | 1261.8 | 24119 | 1096.3 | 1118 | 165.5 |
| Raw materials, materials, components | 68289 | 3797 | 62529 | 2843 | 5760 | 954.6 |
| Incl. seeds | 24255 | 1427 | 23980 | 1090 | 275 | 337 |
| Pesticides | 19034 | 1119.6 | 13670 | 622 | 5364 | 498.6 |
| Fertilizers | 25000 | 1250 | 24879 | 1131 | 121 | 119 |
| Taxes included in the cost of agricultural products | 2045 | 102.2 | 2045 | 93 | 0 | 9.2 |
| Depreciation deductions | 8356 | 418 | 8356 | 380 | 0 | 38 |
| Initial costs | 111253 | 5945.3 | 104375 | 4745.3 | 6878 | 1200 |
| Engineering services | 0 | 0 | 360 | 33 | -360 | -33 |
| Total costs | 111253 | 5945.3 | 104735 | 4778.3 | 6518 | 1167 |

At the same time, a total of 104375 thousand IQD was spent on the use of digital technologies. Thus, the efficiency of investments exceeded 700% (as a result of a decrease in costs in absolute terms and an increase in returns). The cost of producing one ton of commercial wheat decreased by 1200 IQD.

Similar data on the economic impact of digital technologies on agricultural enterprises were also obtained for barley, as shown in Table 5.

**Table 5.** The effect of introducing digital technologies on the cost of barley cultivation (an average of more than 4 agricultural companies in the Middle Euphrates, 2021).

| Cost elements | Primary option (Before using digital technologies) | | After the implementation of the project | | Saving | |
|---|---|---|---|---|---|---|
| | For the entire production volume, thousand IQD | For 1 ton of barley, IQD | For the entire production volume, thousand IQD | For 1 ton of barley, IQD. | For the entire production volume, thousand IQD | For 1 ton of barley, IQD. |
| Rent, leasing of equipment | 4195 | 322.7 | 4195 | 299.6 | 0 | 23.1 |
| Remuneration for labor with accruals | 20159 | 1550.7 | 19067 | 1361.9 | 1092 | 188.8 |
| Raw materials, materials, components | 34124 | 2624.9 | 29090 | 2077.8 | 5034 | 547.1 |
| Incl. seeds | 10386 | 798.9 | 9162 | 654.4 | 1224 | 144.5 |
| Pesticides | 9868 | 759.1 | 7280 | 520 | 2588 | 239.1 |
| Fertilizers | 13870 | 1066.9 | 12648 | 903.4 | 1222 | 163.5 |
| Taxes included in the cost of agricultural products | 543 | 41.7 | 543 | 38.7 | 0 | 3 |
| Depreciation deductions | 5310 | 404.4 | 5310 | 379.2 | 0 | 25.2 |
| Initial costs | 64331 | 4944.4 | 58205 | 4157.2 | 6126 | 787.2 |
| Engineering services | 0 | 0 | 280 | 29 | -280 | -29 |
| Total costs | 64331 | 4944.4 | 58485 | 4186.2 | 5846 | 758.2 |

When growing barley, as can be seen from the data in Table 4, a 9% decrease in the total costs of the agricultural project was achieved compared to the plan developed according to the experience of previous years, while the programming of the crop increased the harvest per hectare. Thus, in comparison to the previously accumulated experience, through the introduction of the most popular digital technologies of precision agriculture, elements of crop programming can reduce costs by 7-11%, increase yields, and reduce the negative impact on the environment through the rational use of mineral fertilizers and pesticides.

## 5. CONCLUSION

This study has investigated the main trends of introducing digital technologies in crop production in Iraq. These include the creation of a regional geographic information system for agricultural enterprises and crop monitoring using drones. The area offers opportunities for the remote monitoring of farmland, the planning and control of work in the fields, and elements of crop programming. The use of GIS makes it possible to obtain a significant economic effect (4-6 dinars of cost reduction per 1 dinar of costs) through the clarification of field boundaries, rationalization of work planning, a complete assessment of the condition of crops, and forecasting of returns.

Crop monitoring using drones and the subsequent programming of crops using the results obtained, methods used by several agricultural institutions in the Middle Euphrates, Iraq, when growing grains (wheat and barley), can reduce total costs by 7-11%, in addition to reducing the environmental load and managing harvests more efficiently. Thus, the use of elements of digital technologies in crop production in the Middle Euphrates has a significant economic impact, and if this use becomes widespread, it can significantly accelerate the development of the industry.

The immediate prospects for the introduction of digital technologies depend on the identification of the most effective technologies at the initial stage, the formation of organizational and methodological foundations for their implementation, and the scientific development of the main directions for the introduction of digital technologies in the industry.

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