

ANALYSIS OF THE INTRODUCTION OF PRECISION FARMING ELEMENTS IN EAST KAZAKHSTAN: PROBLEMS AND PROSPECTS OF DEVELOPMENT

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ABSTRACT:

Agriculture is one of the main sectors of the economy, which provides food security of the country. The development and implementation of modern geoinformation technologies in agricultural production is the basis for transition to precision farming. Application of elements of precision farming system in agricultural enterprises is impossible without high-quality information and technical support.

The purpose of the study is to analyze the use of digital technologies in the farms of the Eastern region of Kazakhstan, identify key factors hindering their implementation and prospects for further development. The information basis for the study was the results of a questionnaire survey of 40.3% of representatives of agricultural enterprises in the Eastern region. The SWOT-analysis, reflecting internal and external factors and conditions for the development of precision farming, was made on the basis of the results. There are: a low level of development of information and communication infrastructure in rural areas (65%), the predominance of small agricultural producers (80 %), insufficiently effective tools of state support, insufficient influence of regional public authorities on the processes of system informatization of agricultural production, weak spread of digital technologies in agriculture.

It is concluded that, despite the relevance and importance of digital technologies in modern agriculture, the digital transformation of agriculture is characterized by a significant lag behind the advanced sectors of the economy, so a unified approach, including a set of measures to stimulate agricultural enterprises to innovative development, government support, a set of differentiated mechanisms for testing and implementing IT technologies, adapted to the conditions of the intra-branch environment is needed.

1. INTRODUCTION

1.1 The current state of agriculture in Kazakhstan

Agriculture plays an important role in the economy of Kazakhstan, as it is one of the main sources of income in agricultural areas and provides jobs for many residents of the country. The agricultural sector is an important supplier of raw materials for other industries, including food, textiles and wood processing (Kalykova, 2020).

In recent years, farmers in Kazakhstan have begun to actively introduce new technologies in agriculture. Some of these include: precision farming devices such as GPS technology that allow farmers to locate crops and control fertilizer and chemical inputs; unmanned aerial vehicles (drones) which are used for data collection, automatic watering and soil conditions control; use of biological methods for pest and plant disease control, such as bacteria and fungi, instead of chemicals; the use of software to manage all farm activities, including recording and analysing production and production data and collecting consumer information. These new technologies not only improve the quality and quantity of agricultural products in Kazakhstan, but also reduce production and energy costs, which also contributes to the country's economic stability (Sologub et al.; 2017). Thus, the introduction of IT technologies increases not only the productivity of agricultural production, but also increases the competitiveness of agricultural products (Yoon et al.; 2020) and (Khanal et al.; 2019). Digitalization in agriculture

creates the conditions for increasing production and increasing the export potential of the country (Charania and Li, 2020).

According to official data, Kazakhstan ranks 50th out of 85 countries by the level of digitalization of the economy in the rating compiled by The Boston Consulting Group (Boston Consulting Group, 2022). Over the years, the trend of stable development of the crop industry has continued. According to the international rating of IFOAM (IFOAM, 2022) of the 123 countries exporting organic products to EU member states, Kazakhstan ranks 9th place, including organic wheat - 4th place, organic oil seeds flax - 6th place. According to preliminary estimates, the direct effect of digitalization of the economy by 2025 will create an added value of 1.7-2.2 trillion tenge (Bureau of National Statistics, 2022).

At the present stage, it can be stated that Kazakhstan has experience in the introduction of IT-technologies in agriculture. Innovative technologies of hybrid breeding, satellite positioning, GIS-systems and systems of monitoring and control of machinery, and quality of work performed, etc. are used (Talimova et al.; 2020).

The most demanded technologies include the following:

- 1 Digital mapping and yield planning
- 2 Differential application of fertilizers
- 3 Crop condition and crop quality monitoring
- 4 Quality monitoring of livestock products and livestock condition
- 5 Electronic database of the production process, etc.

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As part of the digitalization of the agro-industrial complex in East Kazakhstan, the advanced innovative technologies of precision farming, as a rule, are used by large agricultural enterprises. The implementation of digital technologies in the region is influenced by a number of factors: natural and climatic, biological, economic, social, territorial and others. This leads to an imbalance in the territorial and sectoral use of digital technology.

In the medium term, the strategic goal of agricultural production development should be a digital transformation of production and economic relations of economic entities based on the use of a wide sector of information and communication technologies, which is a key factor in improving the competitiveness of the industry in the digitalization of the global and national economy.

1.2 Materials and Methods

In the process of researching issues of implementation and development of precision farming systems in East Kazakhstan different research methods were used: economic-statistical, comparative analysis was used in analyzing the current state and development of agriculture, the degree of use of precision farming systems in agricultural enterprises, evaluating the effectiveness of state support measures; monographic - in determining the existing problems, potential and prospects of development of precision farming systems, factors that constrain.

As of 2022 there are 17,669 registered agricultural enterprises in Kazakhstan, of which 15,317 are active (Bureau of National Statistics, 2022). Including:

- 1 Small business 15,003 enterprises are engaged (up to 100 employees)
- 2 Medium business (from 101 to 250 employees) - 262 units
- 3 Large businesses (more than 250 employees) - 52 units

East Kazakhstan oblast accounts for 1,241 active agricultural formations, which is about 7% of all agricultural formations in the country (Bureau of National Statistics, 2022).

Agricultural formations include the following entities: agricultural agricultural cooperatives, peasant or farmer households, individual entrepreneurs.

In order to study the issues of awareness of digital technologies and their use in rural areas of the region, online questionnaires with questions were sent to more than 1,000 agricultural enterprises. Feedback was given by more than 500 participants these were representatives of agricultural organizations and peasant (farm) households of the East Kazakhstan region.

The geographic location and area of the farm were taken into account when selecting the respondents. The online survey made it possible to analyze the situation of farms and record the number of farms for which digital tools remain inaccessible for various reasons.

2. RESULTS AND DISCUSSION

2.1 Results of the survey of farms

The results of the survey showed that the agricultural sector of the region does not sufficiently use digital trends. In the current research and analysis phase, 75 per cent of farmers indicated that they did not use precision farming technologies on their farms, 10 per cent indicated that they were not familiar with such technologies (Figure 1).

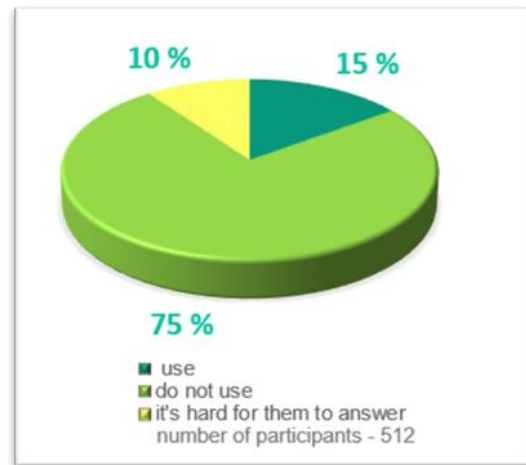


Figure 1. Level of application of digital technologies in farms of East Kazakhstan region.

Meanwhile, of those surveyed who implement digital solutions on their farms, more than one technology is generally used. The most popular survey results were the use of unmanned aerial vehicles to monitor the state of crops and crop quality. Control and tracking technologies based on GPS navigation, with the aim of planning and executing work in time (Figure 2).

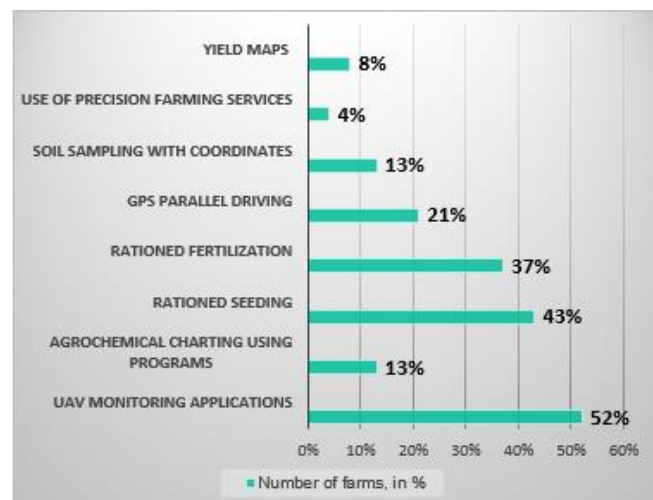


Figure 2. Types of digital technologies used on farms.

Individual farmers (4%) indicated that they use complex solutions for analyzing the condition of fields, including from different manufacturers of technological solutions. Only a few named weather services as an auxiliary - weather stations, weather applications, and soil moisture sensors. The main

reasons that prevent farmers from using digital technology are presented in Figure 3.

In general, the low level of use of information technologies by the overwhelming majority of agricultural producers is a significant barrier to the digital transformation of agriculture.

The low level of informatization of domestic agricultural enterprises, the weak introduction of digital technologies, a significant technological lag behind the advanced sectors of the economy, is explained by the following reasons:

- depreciation of existing equipment, and high cost of specialized equipment. In the sector of the agro-industrial complex, the issues of updating agricultural equipment continue to be acute. For some types of equipment there is a wear and tear of 40 to 70% (Bureau of National Statistics, 2022). From the point of view of yield growth, about 10-15% of agricultural machinery should be updated annually. So, an old tractor loses more than 15% of the crop, and the new equipment losses are no more than 3-5%. New agricultural equipment helps to reduce energy costs by performing several operations simultaneously and increasing profitability. These include: sowing seeds, cultivation, fertilization.

Due to the current political situation in some countries, there were problems with logistics, which affected the cost of agricultural equipment and machinery of the agricultural park. In addition, the cost of importing: digital technologies, computers, applied information programs and other information and communication technology (ICT) tools. This, of course, has a negative impact on the introduction of new technologies to support the innovative activities of agricultural entities in the market.

- weak internet. It should be noted that most rural farmers have indicated that they have only mobile Internet, which is insufficient to integrate modern technologies more deeply, about 5% have no Internet at all. Studies have shown that only large agricultural holdings have an enterprise website, but with the development of electronic trading in the near future the availability of the site will be characteristic of small enterprises. Almost all agricultural producers have e-mail, while about 10% of farms do not use it to exchange information. The reason for this may be underdeveloped computer literacy of agricultural workers (Figure 3).

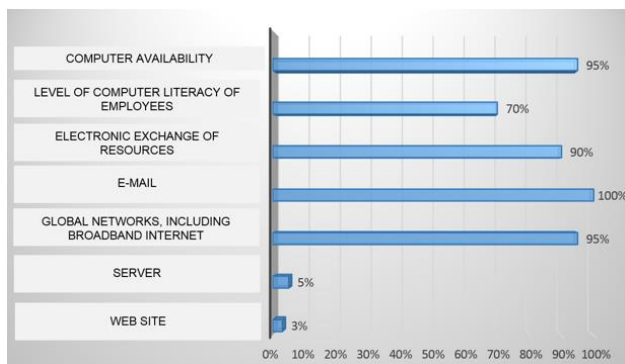


Figure 3. Assessment of factor indicators of digital technology development in rural areas of the region.

- problems of access to market information and lack of awareness of precision farming technologies. Many farmers noted that the source of information is a random search on the Internet, regular analysis of specialized sites noted only 1% of respondents.

- lack of practical experience and lack of qualified specialists in villages.

Thus, the information transformation of agricultural production depends on the level of professional training, intellectual and scientific potential, the level of provision of the industry with personnel. Modern agriculture needs specialists with not only a high level of professional knowledge, but also flexible intelligence, capable of responding quickly to the challenges of external and internal environment in the development of the digital economy. The research has shown that the level of qualification of employees of agricultural enterprises in the Eastern region can be assessed as satisfactory (Figure 4).

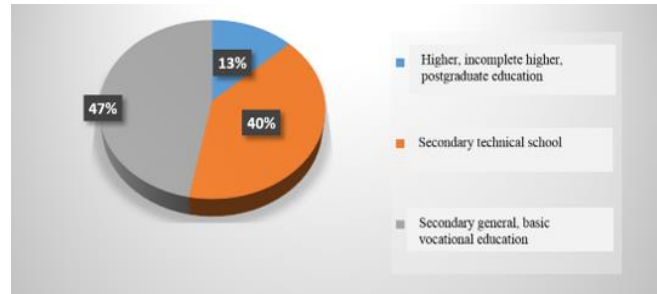


Figure 4. Qualification of agricultural workers in the Eastern region.

Based on the analysis carried out, the reasons preventing the introduction of digital technologies in farms (Figure 5).

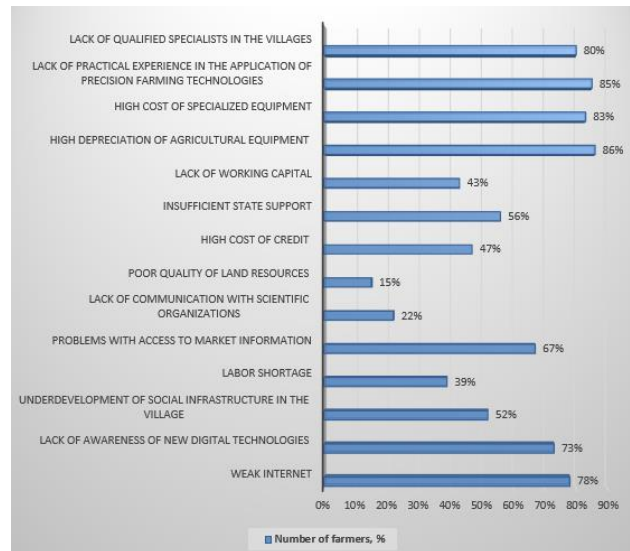


Figure 5. The main reasons holding back the introduction of digital technologies in agricultural enterprises of the region.

Thus, an analysis of the introduction and application of precision farming technologies in the region’s agricultural holdings has shown that they have not yet been developed and are being implemented only by individual farms. Nevertheless, agricultural enterprises in the region have come to realize in practice that digitalization of the industry is necessary to ensure competitiveness and environmentally sustainable development of agricultural production. Ninety per cent of farmers indicated that they were ready to learn about new technologies and to acquire new skills in applying digital technologies to their farms.

It should be noted that the agricultural sector is largely dependent on natural factors and biological traits of living organisms (Adnan et al.; 2019). At the same time, competition, pandemics, and global processes are pushing for the active application of digital solutions, which have found application in other industries and have provided leadership to individual companies.

To date, large agricultural formations of the steppe zone of East Kazakhstan region, specializing in export oilseeds, introduce elements of digital technology, there is a tendency of growth in their number.

For example, in the LLP "Experimental farm of oilseeds" over the past 2 years, based on the use of remote sensing data and unmanned aerial vehicles, monitoring of crops was conducted, based on the application of computer technology and the results of agrochemical analysis of soils were created electronic maps of fields and soil maps to assess soil quality, given the use of digital technology and the use of polyhydroxylated fullereneols for processing crops in farms, a significant increase (8,51 %) in the yield of high-quality plant products - soybeans was provided (Rakhymberdina et al.; 2021), which proves the advantages of using precision farming elements in agriculture. Monitoring of agricultural land in the farm "Mayak" located in the Pavlodar region using available online applications, software, UAVs allowed to assess the potential of multi-level use of remote sensing in agriculture (Rakhymberdina et al.; 2022).

It is quite realistic to predict that by 2025 the majority of agricultural enterprises in the region will use information technology, digital solutions.

The digital financial integration of government services, which has been a catalyst for change in the financial ecosystem, also contributes to this. These include:

1. Online provision of public services to agricultural producers
2. The process of subsidizing the agro-industrial complex is automated
3. The created network of personal offices on electronic resources in which economic entities can apply for state subsidies, leasing and land acquisition
4. An automated system of the State land cadastre is used, allowing access to a single land database with characteristics on the current state of the site and the nature of its operation, etc.

2.2 Prospects for the development and implementation of digital technologies in agriculture

Despite the overall positive trend in the implementation of the program of digitalization of agriculture in the region, there are a number of problems that require rapid solutions. The development of digital technologies in the agricultural sector is constrained by both economic and social and other factors. Therefore, a comprehensive solution is required to solve these problems, highlighting the role of digitalization in them.

The factors constraining the development of digitalization of agriculture in the region include:

1. Lack of interest on the part of agricultural producers in the results of the digitalization program. Most farmers are not interested in digitalization due to their reluctance to

move away from the current system of farming, mastering and adopting new technologies, etc. The introduction of innovative products in agricultural production is accompanied by the risk associated with the recoupment of expensive equipment and software.

2. The almost zero provision of farms with specialists in the field of digitalization and the weak level of training of the available personnel. The majority of employees of agroformations have agronomic, technical education and training, without even basic competencies in the field of information technology. This problem determines the shortage of qualified specialists, which significantly hampers the development and implementation of modern digital technologies in agriculture.

3. Important source data required by agricultural enterprises for agricultural production are mostly fragmented and unstructured. Based on the above, it is required to create a single base, which would aggregate the necessary information, and in the future - the entire information space. It is necessary to improve agrochemical analysis of soils to determine vital macro-elements, phytosanitary situation, the system of operational real-time provision of accurate weather data and forecasting, land resources, the state of agricultural land, etc. to agrarians.

The most preferred tool for analyzing the development of precision agriculture in the region is the SWOT analysis - a universal method of strategic planning, used to evaluate the phenomena and factors that affect the course of a particular process.

All phenomena and factors, to some extent related to the digitalization of the agricultural industry, are divided into 4 categories: strengths (Strengths), weaknesses (Weaknesses), opportunities (Opportunities), threats (Threats) (Table 1).

STRENGTHS	WEAKNESSES
- large areas of fertile arable land with the highest potential for soil fertility in the country; - high energy- and resource-saving potential for the development of precision farming; - availability of digital maps of fields of the region	- low solvency of peasant (farm) farms; - weak service structure and absence of local dealerships for digitalization of agriculture services, actual digital services monopoly
OPPORTUNITIES	THREATS
- sustainability of farming, levelling the risk of crop failure and the cost of crop insurance; - growth of crop production and export potential	- reduction of labor productivity in the industry and competitiveness of crop production; - reduction in the productivity of agrocenoses due to the general transition to soil-producing oilseeds and the decline in the fertility of arable soils

Table 1. SWOT-analysis of the conditions for the development of precision agriculture in the Eastern region of Kazakhstan.

Another element of the application of digital technologies in agriculture are various applications for farmers, which are aimed at solving the problems of process management in off-

line and on-line modes. Today, the market of goods and services offers a wide range of specialized software applications for agriculture: ExactFarming (Russia), OneSoil (Ukraine), Egistic (Kazakhstan), GIS Panorama AGRO (Russia), Cropio (Ukraine), Scoutpro (USA), Farmathand (Canada), Pessl Instruments (Austria), etc. They are designed for agro-managers of crop farms, managing the farm with the use of precision farming technologies (Toguzova et al. 2022).

On the territory of East Kazakhstan the most popular applications: ExactFarming (Exactfarming, 2022), OneSoil (OneSoil, 2022), Cropwise (Cropwis Operations, 2022), Egistic (Egistic, 2022). According to the survey, more than 50% of farmers have heard and know about applications, their tasks and opportunities, and only about 10% use digital assistants.

Thus, in order to eliminate or mitigate the constraints on the development of precision digital farming, we believe that a number of measures are appropriate:

1. Increase of farmers' interest and motivation to introduce digital technologies through co-financing of expenditures in the form of state subsidies, introduction of incentives, reduction of taxes.
2. 2 Involvement of scientists, specialists from universities, scientific centers and laboratories for cooperation in the field of digital technologies, conducting joint research. Adaptation, testing, analysis, certification and follow-up monitoring, control and counselling of digital technologies on farms should be carried out.
3. Conducting detailed studies to assess the effectiveness of digitalization of the technological processes of agriculture in the region at the level of competitive agricultural formations with the implementation of specific calculations of costs, benefits, results (economic, technological, environmental, etc.).
4. Cooperation with foreign partners, joint activities with companies specializing in digital technologies, to develop modern information technologies for the agricultural sector of the region. Study their experiences in the field of agricultural digitalization and agriculture, in particular, identifying and adapting appropriate and accessible platforms for the region, attracting and transferring international practices and technologies.
5. Holding of training seminars, round tables for farmers to familiarize themselves with the new digital technologies used in agriculture

CONCLUSIONS

In general, the conducted research led to the conclusion that the agricultural sector has entered an active phase of the introduction of digital technologies in production and management, but there is a lag of the domestic agricultural sector from developed foreign countries.

The rate of digitalization in agricultural enterprises is influenced by their production size. Larger farms have a higher degree of digitalization development compared to smaller enterprises. This is explained not only by different financial opportunities, which is the main influencing factor, but also by a number of objective reasons related to the lack of need for the use of digital technologies at a low level of production. At the same time, with the constant improvement of digital technologies used in agriculture, their accessibility is increasing, the user mechanism is simplified, their cost is reduced, which means that

the number of agricultural enterprises using "digital" is guaranteed to increase.

Precision farming requires careful and fast data analysis, hence, BigData processing technologies and artificial intelligence will inevitably develop agriculture (Defourny et al. 2019). The application of big data analytics in smart farming technologies is stimulating great prospects in innovation information management, as the results of research shows. The extent of the need to use new digital technologies has increased significantly and many farmers in the regions need to adopt information and communication technologies to remain competitive.

Today, farmers are facing new educational challenges. It is no longer enough for a farmer to be a good agronomist or machine operator. Precision farming requires new technological knowledge and skills, and continuous professional development. Until now, agriculture, not only in Kazakhstan, but all over the world, has not been the most attractive sector of the economy, primarily because of the high risks associated with difficulties in forecasting, long production cycles, low added value of products. However, with the development of technology and the emergence of new digital capabilities and data analysis of the agricultural sector, the level of identifying patterns for more accurate and therefore - effective forecasting, which will increase the yields and profitability of agriculture in the region, increasing productivity, reducing material costs, as well as more efficient allocation of funds and preservation of the environment.

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