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AVALIAÇÃO ECONÔMICA DO PROJETO DE AGRICULTURA DE PRECISÃO NO CAZAQUISTÃO

ECONOMIC ASSESSMENT OF PRECISION AGRICULTURE PROJECT IN KAZAKHSTAN

ЭКОНОМИЧЕСКАЯ ОЦЕНКА ПРОЕКТА ТОЧНОГО ЗЕМЛЕДЕЛИЯ В КАЗАХСТАНЕ

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RESUMO

Os documentos que discutem a eficácia das tecnologias inteligentes na agricultura no Cazaquistão ainda não foram publicados. O tópico não possui diferenças regionais e atrai grande atenção da comunidade acadêmica. Portanto, para tomar decisões sobre o uso de tecnologias digitais, os agricultores devem ser informados sobre sua eficácia e o que devem fazer quando aplicadas. A avaliação econômica e a análise custo-benefício foram usadas para comparar as tecnologias agrícolas tradicionais e digitais na produção de grãos. Os agricultores ricos de países desenvolvidos usam a tecnologia digital de maneira extremamente ampla, reduzindo os custos operacionais para trabalho assalariado e recursos produtivos. Neste estudo, os autores tentaram avaliar a hipótese de significativa eficiência econômica e ambiental na aplicação de ferramentas de tecnologia de precisão. O objetivo deste trabalho é avaliar, do ponto de vista econômico, os resultados da aplicação de elementos de agricultura de precisão que podem contribuir para o estudo da eficácia das tecnologias digitais nos níveis global e local. Este estudo mostra que, com o uso de modernas tecnologias digitais na produção, uma fazenda em determinadas circunstâncias pode aumentar a produção de trigo em pelo menos 25 a 30%. O lucro bruto das tecnologias agrícolas tradicionais foi de US $ 31 por hectare, enquanto o da tecnologia digital foi de US $ 54.

Palavras-chave: *tecnologia agrícola digital, sistema de informações de gerenciamento agrícola, agricultura digital, agronomia de precisão, agricultura de precisão.*

ABSTRACT

The matter of the effectiveness of applying smart technologies in agriculture of the Republic of Kazakhstan will be of interest to the academic community, regardless of territorial affiliation. The relevance of the research is in the need to inform farmers on the efficiency of such technologies and how to use them. Economic valuation, cost-benefit analysis were used to compare traditional and digital agricultural technologies in grain production. Wealthy farmers from developed countries widely use digital technology, reducing operating costs for wage labour and productive resources. In this research, the authors attempted to prove the hypothesis of significant economic and environmental efficiency in the application of precision technologies. The purpose of this paper is to evaluate the results of the application of precision farming tools from an economic standpoint, these results can contribute to the study of the efficiency of digital technologies at the global and local levels. This research displays that with application of modern digital technologies in production, under certain circumstances, a farm can increase wheat yield by at least 25-30%. Gross profit with traditional technologies in agriculture amounted to 31 US dollars per hectare, while application of digital technologies brought 54 US dollars per hectare.

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Keywords: *digital agriculture technologies, farm management information system, digital farming, precision agriculture, precision farming*.

АННОТАЦИЯ

Тема эффективности применения умных технологий в сельском хозяйстве Республики Казахстан будет интересна для академического сообщества вне зависимости от территориальной принадлежности. Актуальность исследования обусловлена необходимостью информирования фермеров о том, насколько такие технологии эффективны, и как их использовать. Экономические оценки, анализ затрат и прибыли был использован для сравнения традиционных и цифровых технологий сельского хозяйства в производстве зерна. Богатые фермеры из развитых стран широко применяют цифровые технологии, сокращая операционные расходы на наемный труд и производственные ресурсы. В этом исследовании авторы сделали попытку доказать гипотезу о значительной экономической и экологической эффективности применения точных технологий. Целью данной работы является оценка с экономической точки зрения результатов применения инструментов точного земледелия, данные результаты могут внести вклад в исследования эффективности цифровых технологий на глобальном и местном уровнях. Это исследование показывает, что с применением современных цифровых технологий в производстве, при определенных обстоятельствах, ферма может увеличить урожай пшеницы как минимум на 25-30%. Валовая прибыль с традиционными технологиями в сельском хозяйстве составила 31 доллар США за гектар, в то время как с применением цифровых технологий – 54 доллара США за гектар.

Ключевые слова: *цифровые сельскохозяйственные технологии, информационная система управления фермой, цифровое сельское хозяйство, точное земледелие, точное сельское хозяйство.*

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1. INTRODUCTION

Modern agriculture technologies are changing to address farmers' needs for effective production. World practice in applying digital technologies is not so long, accounts only a few decades. Therefore, studies on this subject are relatively new. In Kazakhstan, precision technologies are used only by big companies, and it is not nation spread. State incentives to introduce precision agriculture in combination with digital technologies launched in 2018 for nine model agricultural entities and calculations on its efficiency were made. For this article, we choose three farms with more relevant and complete data.

Informational technologies have been entering into almost every sector of the economy rapidly over the last decades. They came into agriculture as well. Smart farming, farm management information system, digital farming, precision agriculture, and precision farming are the new definitions related to the digital world. Developed and developing countries face these innovations and adopt them carefully (Takhumova *et al.*, 2016). Developed countries apply start-of-art tools in agriculture particularly for cultivation of their main specialized crops. The US largest corn farms have double the precision agriculture adoption rates of all farms: 70-80 % vast of large farms use mapping, about 80 percent use guidance systems, and 30-40 percent use variable rate application (Schimmelpfennig, 2016). Yet this type of technologies even in top countries used selectively. Australian grain growers have readily adopted machine guidance and auto steer, and a majority have access to yield monitoring, but the rate of use of many crops and soil sensors remains comparatively low (Bramley and Ouzman, 2019). Although precision agriculture technology has been available in Australia late period, it has been estimated that only around 3% of Australian grain growers use some form of technology (Price, 2004; Bellon-Maurel and Huyghe, 2017).

When a farm conducts spraying on external landmarks, that is, without navigation systems, up to 4% of the crops remain unprocessed, and another 11% are processed twice. In addition, if on 11% of the area the company receives only a loss from the waste of materials, then the loss from the raw 4% can be much greater. Results of the evaluation of the gross economic effect of precision agriculture tools are still arguable and situational. Overall, precision agriculture technologies can reduce operating costs by preventing farmers from over applying inputs (Schimmelpfennig, 2016; Esenam, 2017; Higgins *et al.,* 2017; Popović *et al.,* 2017, Matyushenko *et al.*, 2018).

The simple analysis of adoption versus non-adoption shows precision agriculture technology adoption positively and significantly associated with higher profitability (Castle *et al.,* 2017; Castle, 2016). Reports for 2016 show those cost savings ranging from USD 13 to more than USD 25 per acre when growers use global positioning systems yield or soil maps in conjunction with auto-steer and variable-rate technology when applying inputs (Crumment, 2017; Ivanova and Merkulova, 2018).

Another economic benefit of using digital technologies was found, like between USD 5-44 per ha, which related to "higher grain and fertilizer prices and depended on levels of soil nutrients in the different zones" (Robertson *et al.,* 2018). In addition, the benefits outweigh the associated costs for cereal farms in excess of 80 ha for the lowest price system to 200 – 300 ha for the more sophisticated systems (Godwin *et al.,* 2003).

In Russia case, investments in 2012 with the minimal cost, including AgGPS EZGuide 250 on parallel driving with AG15 antenna with Omnistar XP correction by calculation were USD 2.919 for each combine and 200 USD additionally for the next months. Therefore, these investments will be paid back in the first year of implementation without including yield growth up to 5-10% (Igoshin, 2012). Additionally, with positive correlation between applying precision agriculture and economic benefits some studies presented controversial results. The small influence was found for US corn producers (Schimmelpfennig, 2016; Deichmann *et al.,* 2016; Schuster, 2017).

Precision agriculture tools such as variable rate of fertilizer application were not profitable in wheat and barley, sometimes profitable in corn, and profitable in sugar beet. Profitability correlated closely with the per acre gross revenue earning potential of the crops grown (Swinton and Lowenberg-DeBoer, 2001). Farm size, the shape of the field, and other factors are indicated to be valuable for the economic impact of operations adopted digital technologies (Paraforos *et al.,* 2016; Paraforos *et al.,* 2017; Skvortsov *et al.,* 2018; Shamshiri *et al.,* 2018).

Hired labour costs are 60 to 70 percent lower with any of the three precision agriculture technologies on small corn farms (140-400 cropland acres), while hired labour costs are higher on large farms that have adopted precision mapping and guidance (Schimmelpfennig, 2016). Research projects in Colorado, Kansas, and Nebraska showed the greatest return occurs in the most irregularly shaped fields. The payback is less than one year all the way up to around 120 acres in size. In the case of small, square fields, the payback is 2.38 years (Smith *et al.,* 2013). The application of precision technology in agriculture depends on experience of farmers, size of their business the most (Castle *et al.,* 2016).The use of Internet of things spreads not only on open space soil based crops but also in greenhouses. A not very expensive device, which needed three-tier open source software platform at local, edge, and cloud planes, was proposed for greenhouse cultivation (Řezník *et al.,* 2016; Zamora-Izquierdo *et al.,* 2019).

Information strategy with site-specific information to determine the economically optimal uniform rate of lime provides an average increase in the annual return of $14.38 ha in Indiana. (Bongiovanni and Lowenberg-DeBoer, 2000).

Consideration of the factors, which contribute to the stabilisation and growth of efficiency in grain production, will make it possible to develop a well-specified set of actions, which are aimed at solving the problems of the branch development. A serious limitation to precision nutrient management in Kazakhstan is the availability of fertilizers to farmers. Fertilizer supplies to farmers in Kazakhstan are inadequate even for P, which is mined in Kazakhstan with more exports of P fertilizer exceeding 3 billion US$ annually (Carrer *et al.,* 2017; Lindblom *et al.,* 2017; Waltz, 2017; Daum *et al.,* 2018; Pierce, 2018).

In order to ensure efficient agricultural production (in response to the changing natural conditions, to expectations and demands of consumers, as well as to the requirements of the state concerning ecological agricultural production), farmers must run their farms and do their business not only in accordance with agrotechnical requirements. They must also apply state-of-the-art digital technologies. In the course of utilisation of state-of-the-art digital technologies, it is always necessary to comply with a certain logistics chain. That is, it is necessary to know how to start and how to complete planting and harvesting of the agricultural crops. In accordance with the numerous studies, crop yields are the most important factor, which determines the profitability of grain production. As a rule, the greater crop yields, the lower costs of production/prime costs and labour costs per 1 metric tonne of the products and, respectively, the higher profitability of these products.

Precision farming in grain production consisted of several stages:

– selection of fields with relatively uniform soil fertility and compilation the electronic fields map;

– accurate pre-sowing tillage, sowing, differential fertilizer, and plant protection products;

– identification of the state of crops, yield forecast, and grain quality based on remote monitoring systems.

The aim of this paper is to evaluate from an economic perspective the results of implementation precision farming elements, which can contribute to the studies on digital technologies efficiency globally, and locally. Papers discussing the efficiency of smart technologies in agriculture with Kazakhstani cases were not published yet. Therefore, in respect of making decisions concerning the application of digital technologies, farmers need to be informed how it is effective and what they should do while applying them.

Wealthy farmers over the world have been applying digital technologies more and more, cutting operation expanses on hired labour and production recourses. In this study, we tried to evaluate the hypothesis of significant economic and environmental efficiency of application the precision technologies tools (Friedrich *et al.,* 2016; Kudari and Patil, 2017).

2. MATERIALS AND METHODS

In Kazakhstan state project called Digital Kazakhstan was formed for the period 2018-2022, which considered agriculture as one of the five directions for implementation. According to this project in 2019, the information on the food chain, livestock, planting from the farm to retail will be collected for transparency monitoring. In 2020, the entire electronic platform e-Agro trade for food will be designed. Finally, for 2022 National Project on spatial data infrastructure is planned (Digitalization of economy branches, 2018). In 2018, precision agriculture was applied for nine pilot farms. We selected three farms with more representative data for the purpose of this study in order to evaluate how effective digital technologies in agriculture of Kazakhstan.

In this study, we collected soil analysis, field history, and space maps, cost analysis and made calculations on how much expenses and profit were made for one ha of land with smart agriculture technologies. In the course of implementation of this project, investigations were based on the principles of the systematic and integrated approach, of the economic analysis, and of the comparative analysis. We have begun our study of farms from the study of history of their fields during 10-year period in order to find answers to the following questions: which agricultural crops have been planted by the relevant farm during this period of time and what are volumes of the mineral fertilisers, which were introduced to these fields. All these data have been collected in order to determine the efficiency of the application of the mineral fertilisers by relevant farms, as well as in order to determine degree of influence of these fertilisers upon the crop yields of the cultivated crop. In addition to the study of history of the relevant fields in the course of development of agricultural production, we have calculated all expenses, which are connected with production of the agricultural crop. Particularly, such calculations for the wheat and rape were made in accordance with the technological flow chart.

Before submission of our recommendations to farms we have conducted analysis of agrochemical properties of soils from 1(one) ha in order to determine level of content of those forms of nitrogen, phosphorus, and potassium, which are accessible for nutrition of crops, as well as in order to ensure further calculation of the relevant rates of application of fertilisers. Following the analysis, which we have performed, we have calculated, how much monetary funds any farm must spend (investments in acquisition of agricultural equipment, mineral fertilisers, herbicides and fungicides, seed treatment, equipping of the specialised machines and vehicles) in order to ensure that this farm will generate profits from each cultivated hectare in accordance with the technology of the bitmap precision agriculture.

We have been performed our study with the help of field methods; that is, we have obtained all the data on the basis of primary data collection.

This pilot project was duly developed and performed by the interdisciplinary research group (27 scientists of Saken Seifullin Kazakh Agrotechnical University) in cooperation with the Competences Centre of the National Chamber of Entrepreneurs of the Republic of Kazakhstan in accordance with the instructions of the Ministry of Agriculture of the Republic of Kazakhstan. The main goal of this project was formulated as follows: approbation and introduction of digital technologies on the basis of 9 pilot farms in Akmola, Karaganda, Kostanay, and North Kazakhstan regions with subsequent dissemination of successful experiences among farmers of the Republic of Kazakhstan.

Since the beginning of the implementation of this pilot project, a group of scientists has carried out a broad range of activities, which are required for the introduction of precision farming technologies. Electronic maps of fields were developed for each pilot area. A training stage for farm specialists concerning the application of these technologies was organised and carried out. Audit of technical fleets of the pilot farm was carried out along with the provision of pieces of advice concerning the acquisition of special equipment for precision farming. Electronic agrochemical cartograms of the pilot fields were developed. Calculations in respect of application of the required rate of fertilisers were made. We have also developed electronic maps with respect to the following factors: weed infestation of crops; degree of their infection with plant diseases, pest colonisation of plants. These electronic maps were submitted to the relevant farms. Therefore, these farms have succeeded in performance of local treatments, as well as in suppression of diseases at the early stages of their development.

In order to determine degree of efficiency of the precision farming technologies from the economic point of view, in 2018 we performed economic calculations on the basis of the data, which were collected from three farms in Akmola, Karaganda, and Kostanay regions: "Akmola Phoenix" JSC, "Naydorovskoye" LLP and “Troyana" LLP. In the course of our calculations, we have used the method of timing, observation, and data analysis with the help of Excel software.

In order to optimise expenses of farms in the course of cultivation of various agricultural crops along with the relevant decrease in the costs of production in the branch of crop cultivation, we have calculated expenses in respect of each of these farms and have conducted an analysis of their possibilities. As a rule, various systems of criteria are used in the course of calculation of the economic efficiency in grain production. As concerns food cereals, it is usual to calculate the following parameters: crop yields (1); costs of production per one centner of the product (2); labour costs per one centner (3); profits per one hectare (4); the level of profitability (5).

The data concerning the application of mineral fertilisers, concerning seed application rate, as well as data on the profitability of production with the help of traditional agro-technology, as well as in accordance with new agro-technology have been entered to Excel forms. These forms were used in the course of development the following matrixes: "Matrixes of application of mineral fertilisers with the help of traditional technology, as well as with the help of precision farming technology", "Matrixes for calculation of the seed application rate", and "Forecast matrix of profitability".

The "Forecast matrix of profitability" with the help of its main parameters presents economic calculations of expenses ("Indirect expenses for wheat production" and "Direct expenses in accordance with the flow process chart for wheat production"). In addition, this Matrix presents "Calculations of sums for the purchase of seeds, fertilisers, and herbicides (in the case of planning the crop yields at the level of 10 centner/hectare)". Results of all calculations have been compiled in the relevant table "Calculation of the income section of the company budget". This Table includes the following items of income: parameters "Crop yields", "Gross production", "Refraction", "Gross collection, taking into consideration refraction", "Costs of production", and "Gross profits". Calculations of the "income item" were made in accordance with the actual planted acreage in hectares, as well as in tenge per one hectare. Table 1 presents crop yields of wheat in three (3) pilot farms in 2018.

As we can see, average crop yields of wheat on 3 pilot areas have increased following the introduction of certain components of precision farming. The average crop yields were approximately equal to 30 centner/hectare. Therefore, it is possible to draw a logical conclusion that introduction of components of digital technologies into the production of wheat is equal to not less than 5 centner/hectare. In addition, introduction of the technology of precision farming has demonstrated that it is possible to save 9% of fuel and lubricant materials at the expense of utilisation of the system of parallel driving, as well as it is possible to save 27% of mineral fertilisers and 31% of pesticides at the expense of their differentiated application (Akhmetshin *et al.*, 2018).

3. RESULTS AND DISCUSSION:

We assumed that precision agriculture affects positively on operational results of production. In accordance with our calculations, gross profits on the relevant areas (in the conditions of three pilot farms) have achieved the level of 54 US Dollars per one hectare in the course of production of wheat with the help of digital technologies. Similar investigations were carried out by other scientists. The application of digital technologies can be an efficient method of farming under certain circumstances. Certain agricultural crops, for example, fruits and vegetables cannot be fully subject to digitalisation, robotization, and automation, not least because of the complexity of these technologies and lack of qualified human resources in rural areas (Vasconez *et al.,* 2018; Vogt, 2017). The efficiency of digital technologies is also connected with the minimisation of the resources, which are used in the course of production. For instance, reducing the quantity of agrochemicals required. It could also reduce costs, risk of crop damage and excess herbicide residue, as well as potentially reduce environmental impact (Partel *et al.,* 2019).

In our research, we have studied wheat. It turned out that digital technologies are applicable to the production of this crop, and these technologies can result in an increase in the economic efficiency of production. Within the framework of this project, we have developed electronic maps of fields of the relevant farms. These electronic maps were used as the cartographic base for performance of the agricultural chemical survey (Figures 1-3). Taking into account orientation of this project to precision farming, this agricultural chemical survey has been carried out with the help of GPS receivers in order to ensure soil sampling in accordance with the grid sheet survey (coordinate referencing). For the first time, grid of sampling of soils from the elementary plots was approbated provided that area of each elementary plot is equal to one hectare instead of the previously accepted areas in the Republic of Kazakhstan, which were equal to 75 hectares on the rainfed lands and 10 hectares on the irrigated lands (Kingwell and Pannell, 2005; Swinton and Lowenberg-DeBoer, 1998). On the basis of the agrochemical survey, which we have performed, as well as on the basis of integration of the data of the agrochemical analysis of soils, we have developed agrochemical cartograms of availability of soils with humus and movable forms of nutrients (Figures 4-5). In accordance with the results obtained, it was established that there were substantial losses of humus within the entire surveyed area of arable soils as compared with the similar virgin lands virgin lands. There is no doubt that this fact exerts influence upon the crop yields of cultivated crops. There is a lack of a considerable extent of those forms of nitrogen and phosphorus, which are accessible for nutrition in the soils of the surveyed fields. Therefore, the set of actions, which are aimed at increase of the humus content, must include the following actions: application of organic fertilizers; introduction of perennial grasses into the succession of crops; green manuring, etc. At the same time, increase of level of the efficient of soil fertility is possible in the case of application of mineral fertilisers. On the basis in the methodology of calculation of rates of fertilisers, which was developed by Professor V.G. Chernenok (Saken Seifullin Kazakh Agrotechnical University), we have calculated rates of fertilisers, which contribute to increasing rate the content of the movable phosphorus and content of the nitrate-nitrogen up to optimal levels.

In accordance with the electronic maps, which were developed in the course of this project, the following facts were established: there is strong degradation of soils within the fields of the pilot farms, while content of micronutrients in these soils is not sufficient in order to ensure growth of crops within the fields of the pilot commercial farms (Figures 1-5). In accordance with the analysis of soils, it was established that the introduction of both phosphorus and nitrogen is insufficient practically in all commercial farm units (except for "Troyana" LLP). This fact exerts essential influence upon the level of crop yields of these commercial farm units. In the course of investigations of the main agrochemical characteristics of soils on the fields of these commercial farms, we have determined optimal rates of application of fertilisers and calculated relevant effects from the proposed recommendations.

Soils in Kazakhstan should respond to precision agriculture because many soils are degraded, and soil fertility is often low as fertilizer application in Kazakhstan has declined over the last 30 years. Micronutrients may be important in Kazakhstan soils as nutrient deficiencies may be occurring given soil degradation, low fertilizer use, and low humus content (Franzen, 2008; Pierce, 2018).

In Table 2, performance expectations of wheat production have been modelled with consideration of the conducted research and economic evaluation. According to our calculations, the optimal area, from which the introduction of precision farming technology should be started, is not less than 2 thousand ha. The comparison of two technologies and their economic efficiency is represented below. The average yield in three areas with the use of tradition technology is 1.2 tons per hectare, while if to take the minimum increment of 0.5 tons per hectare when introducing digital technologies, yield can reach 1.7 tons per hectare. With the price of USD 131.5 per 1 ha profit from an area of 2 thousand hectares is USD 54 per hectare. Therefore, it is noticeable that the use of precision farming technology not only improves crop yield but also increases gross profit from its trading even taking into account refraction.

In the case of the introduction of digital technologies, the farm will need additional investments in the amounts of USD 37 per one hectare. In addition to these investments, they will need outsourcing services with respect to consultations and technical support. In order to ensure wide dissemination of technologies of the precision farming among farmers, it is very important to organise relevant training, introductory courses in respect of digital technologies and technologies of the precision farming on the basis of the specific pilot commercial farm units, which would be capable to of demonstrating their successful experiences.

In addition to this training, the first stage of the introduction of digital technologies will be possible in the case of governmental support and partial indemnification of farmers' expenses in connection with these technologies. For those farmers, who plan introduction of the precision farming, it is necessary to envisage the following actions, which will require additional expenses: agrochemical analysis (revealing of the easy-hydrolysable nitrogen and movable phosphorus); acquisition of mineral fertilisers, installation of the system, which will ensure differentiated application of fertilisers and parallel driving, device for application of the main rate of fertilisers, expense for crop protection products, consultancy servicing.

4. CONCLUSIONS:

Therefore, in the course of organisation the productive activities, it is necessary to comply with certain requirements. The most important requirement is very simple: timely performance of all works and activities, which are envisaged by the relevant technologies, including compliance with the agro technical requirement beginning from the preparation of soil for the future sowing of cereal crops and up to their harvesting. In order to comply with this requirement, it is necessary to have certain production resources, material, and technical resources and labour resources, which must be in rational proportions depending on the crop yields of various crops, as well as depending on the accepted technologies of their production. Therefore, it is necessary to study the procedure of implementation of the plan in respect of all agro technical actions (1); determine the efficiency of all such actions (additional yield per one centner) (2). Then it would be necessary to calculate the influence of each such action upon the level of crop yields (3) and upon the gross production (4) of the relevant crop.

It is possible to separate three big groups among the factors of cultivation efficiency of cereal crops: agro technical, technical, as well as organisational and economic factors. As concerns, the first group, utilisation of the prospective varieties and hybrids and application of the scientifically substantiated systems of farming, are the most important factors as of today. Application of the progressive systems and machine is the most important factor in the second group, while a combination of marketing and governmental regulation is the most important factor in the third group.

In accordance with our calculations, “Akmola Phoenix" JSC, "Naydorovskoye" LLP, and “Troyana" LLP can increase their gross profits with the help of digital technologies from USD 31 up to USD 54 per one hectare of wheat.

If these farms are guided by all recommendations, which were submitted for them by the experts in the sphere of digitalisation, then they can increase the crop yields of wheat by 25-35 % in perspective. At the same time, they can increase such parameters as income and profits.

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Table 1*. Crop yields of the spring wheat in 2018, centner/hectare*

Farms	Cultivated area, hectare	Average crop yields in the region, centner/hectare	Crop yields on the pilot field, centner/hectare	Growth rate, centner/hectare
Akmola region				
"Akmola-Phoenix" JSC	500	12.9	18.0	+5.1
Karaganda region				
"Naydorovskoye" LLP	250	11.6	50.2	+38.6
Kostanay region				
"Troyana" LLP	400	13.7	22.0	+8.3

Table 2*. The calculated rate of wheat production in traditional and precision farming technologies*

Parameters	Per one ha in physical terms		Per one ha in monetary terms	
	Traditional technology	Application of digital technologies	Traditional technology	Application of digital technologies
Crop yields, 12 c/ha	12	17	-	-
Gross collection/croppage, ton	1.2	1.7	158	210
Refraction, 10%, ton	0.12	0.17	-	-
Gross collection, taking into consideration tret/refaction, ton	1.08	1.53	142	201
Costs of production, USD			111	148
Additional costs for precision farming, USD			-	37
Gross profits, USD			31	54

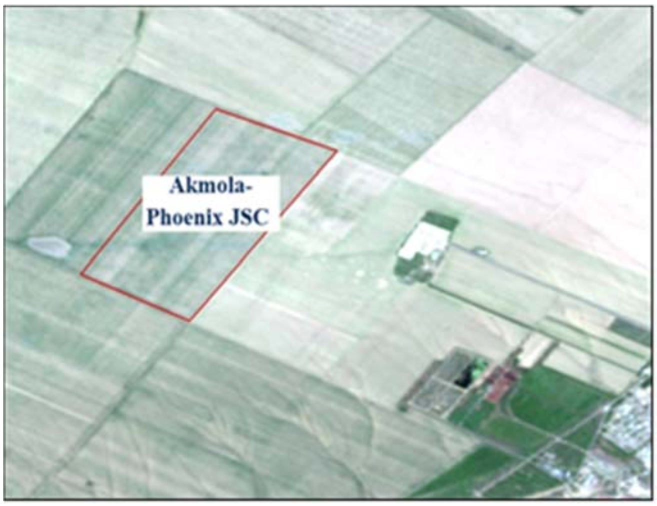

Figure 1. *The electronic map of field within the pilot area of "Akmola Phoenix" JSC, 500 hectares*

Figure 2. *The electronic map of field within the pilot area "Naydorovskoye"LLP, 250 hectares*

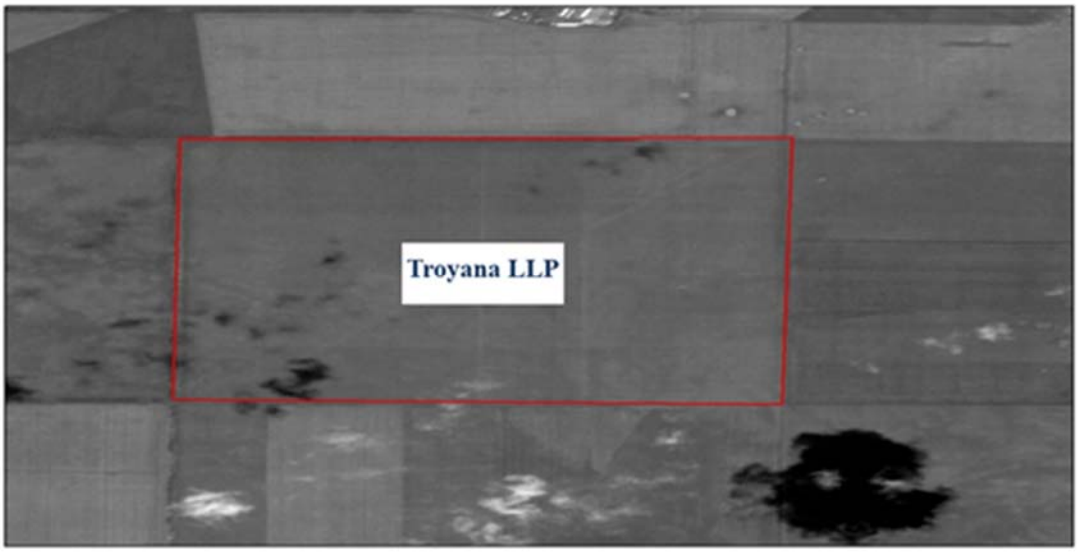

Figure 3. *The electronic map of field within the pilot area of «Troyana» LLP, 400 hectares*

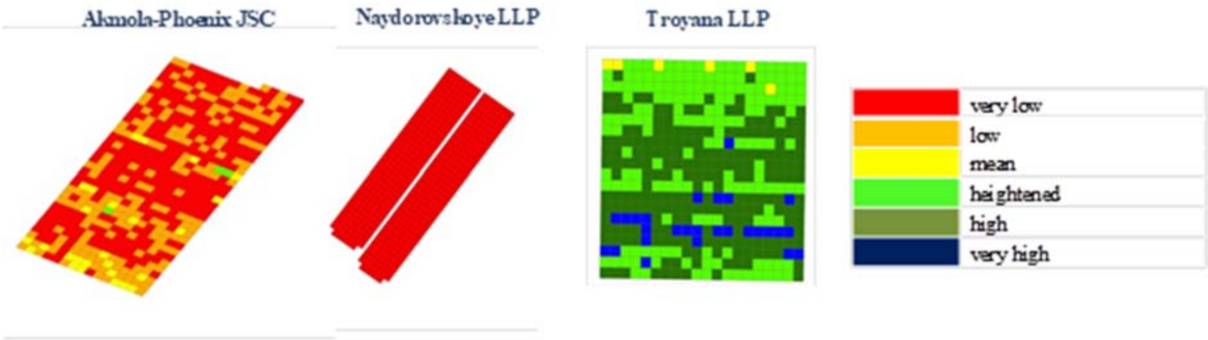

Figure 4. *Agrochemical cartogram of the easy-hydrolysable nitrogen'scontent, mg/kg*

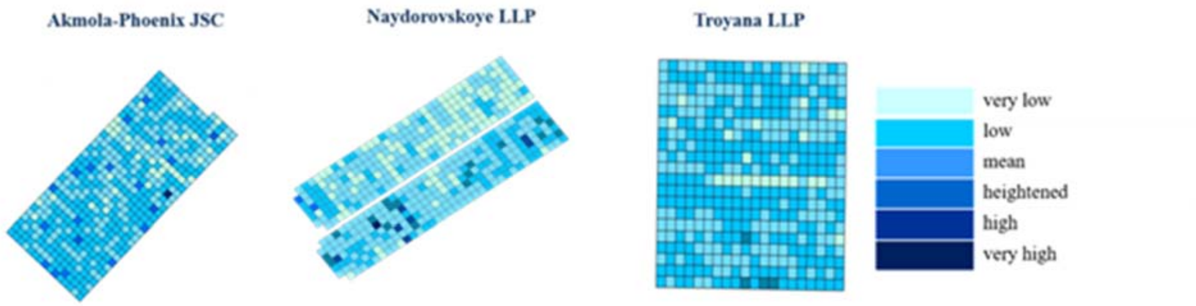

Figure 5. *Agrochemical plan/cartogram of the content of the movable phosphorus, mg/kg*