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Establishment of the necessary material and technical base lays the groundwork for the use of innovation in the grain industry

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Article

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Abstract

Here we show for the first time that, solution of pressing problems and further sustainable development of the grain economy is only possible with the necessary material and technical base, allowing the use of modern systems in the agro-industrial complex. The article considers the problems of deficiency of basic plant nutrient elements. On the basis of statistical data, descriptive analysis of the wheat production dynamics has been carried out, state of mineral fertilizers usage in the country is shown. The comparison of mineral fertilizers use in agriculture in Kazakhstan and other countries in the world has been made, from which it is determined that the domestic system of mineral fertilizers application ranks the last positions in the world and lags far behind the foreign countries. The statistical data demonstrate the low wheat yielding ability index, which is directly related to soil depletion. The statistical data coming from official sources and conducted field studies constitute the evidence basis. Purpose – to analyze the current state of mineral fertilizer use in Kazakhstan, justify the need for compulsory fertilizer dressing on all crop lands, elaborate recommendations for solving the existing problems. Methods – general scientific: 1) when analyzing statistical data, the expert evaluation method was used; 2) demonstration plots have been digitized, agrochemical soil analysis has been conducted, optimum rates of phosphorus and nitrogen content have been determined, wheat plantings in plots with different phosphorus and nitrogen content have been performed. Outcomes – problem of soil depletion has been represented, effect of different mineral fertilizers doses on the productivity of wheat has been established. Conclusion – implementation of precision agriculture technology systems is required, thereby the state needs to: 1) introduce a country-wide requirement for compulsory annual submission of agrochemical maps by agricultural producers, for the purpose of croplands status monitoring; 2) construction of new agrochemical laboratories and mineral fertilizer production facilities; 3) initiate the process for relevant personnel training.

1. Introduction

In the 21st century, humanity has faced with the problem of global warming, which aggravates a problem of food security. The increased heat stress usually reduces the agricultural yield since the temperature is a crucial factor affecting crop growth and development (Edreira et al. 2014; Telfer et al 2018; Wang et al 2018; Abdelrahman et al. 2020). The heat stress in plants is usually defined as stress caused by high temperature exposure (high temperature; usually 35°C), running during a period sufficient to cause irreversible damage to growth and developmental (Wang et al. 2012). The mineral fertilization can reduce adverse effects of high temperatures on wheat yield loss [Elia et al. 2018; Asif et al. 2019).

Currently, world population has reached 7.6 billion, and the agricultural area per head of the population is steadily decreasing that creates a severe problem for creating fully sustainable food production systems in order to provide a sufficiency of food for growing population (Guo et al. 2021). There are over 50,000 edible plants in the world. Only three of these, rice, corn, and wheat, provide 60 percent of the world's food energy (Food and Agriculture Organization). According to various expert estimates, world's population will reach 9.7 billion by 2050; thus, a significant increase in wheat yields is needed to ensure a future global food security (Foley et al. 2011; United Nations 2018).

The wheat comprises the bulk of the republic's cultivated lands for cereal crops, 78% of the total area of cereal crops, therefore, the main studies in crop production should be aimed at wheat yield enhancement in order to be able to release the cultivated lands for oil-plants and other technical crops being in increased demand in the immediate market outlets. The wheat is among the most important cereal crops, providing about 20% of the total energy in the human diet (Shewry and Hey 2015).

Currently, Kazakhstan produces up to 15 million tons of wheat annually. The cultural area for wheat is more than 12 million hectares. Kazakhstan is one of the world's leaders in the area of crop land for wheat, but its production is very low.

The use of modern agricultural technology is among the most effective methods of solving the problems of agricultural production development, and the precision farming technology is the most innovative and reputable methods in agricultural sector.

The advanced methods used in agriculture apply the precisely-controlled movement of equipment in the field performed using the global positioning system (GPS). GPS navigation system provides the promptly relevant information pertaining to the location of agricultural engineering and movement in the field. Currently, furnishing of equipment with GPS navigation system is not an expensive and labor-intensive process.

According to Food and Agriculture Organization information, average depreciation of the agricultural machinery fleet in Kazakhstan is 70%, and the costs for machinery make the bulk of the grain prime cost. Currently, there is no reliable information about the situation with the agricultural machinery fleet in Kazakhstan, the only source is the Ministry of Agriculture of the Republic of Kazakhstan. Currently, agreement on the industrial assembly of CLAAS German brand machinery in the territory of the Republic of Kazakhstan was signed. It is necessary to encourage the agricultural producers for machinery fleet renewal. The granting of loans for the purchase of agricultural engineering by installments, without interest and overpayment could be one of these incentives.

The agricultural machinery as known as the main instrument of production and a decisive factor in the agricultural development, however, the land is a primary production resource. In this regard, to solve the problems with further increasing agricultural production, information about the soil condition is of paramount importance in addition to solving the problem with the renewal of agricultural machinery fleet.

The collection of soil samples is a first step in monitoring of soil nutritive substances and creation of databases for specific sites. And the monitoring of soil nutrients and creation of database for all farm fields is the first step toward widespread implementation of precision farming technology. Certainly, precision farming technology is not limited to implementation of navigation systems and discriminatory fertilization, this technology includes a vast number of systems for yield enhancement and optimization of harvesting process optimization, however, technology level and consciousness of corn growers is not yet ready for mass adoption of leading-edge systems of precision agriculture, this process takes time, and at this stage it is necessary to start with the creation of the material and technical base for the widespread implementation of main, basic systems of precision agriculture. The implementation of precision farming requires heavy expenses such as the cost of purchasing the necessary equipment, re-formation of manufacturing process, obtaining the necessary information, and training the farm workers, which can be burdensome for agricultural producers (Feder et al. 1985; McBride and Daberkow 2003; McCarthy et al. 2011). Undoubtedly, the amount of these costs depends on the profile of the technology employed, this brings up the issue of the "best" technology solution (Vecchio et al. 2022). At the initial stage of precision farming systems implementation, the "best" technology solution will be associated with the introduction of only fundamental, basic systems of precision farming.

Moreover, behavioral traits, such as farmers' perceptions, may have an effect on implementation of innovation (Aubert et al. 2012). The farmers are more likely to implementation if they believe the innovation is better than existing systems in terms of benefits and time savings (“relative advantage”), or if the innovation demonstrates "ease of use" or being integrated into daily life (Rogers 2003). If the innovation is perceived as difficult to use or understand (“technologic complexity”), adoption will generally be lower (Venkatesh and Davis 1996; Sassenrath et al. 2008). However, institutional context with regard to the policy and socio-cultural dynamics also plays a big part in influencing the implementation of innovation (Edwards-Jones 2006; Robertson et al. 2012; Long et al. 2016). The farmers are likely to adopt this technology if external incentives (such as various institutions and consultation system) will support the technology (Fountas et al. 2005; Edwards-Jones 2006). Actually, the absence of state influence and the lack of communication between the supply and demand parties have proved to be barriers to innovation implementation.

Often the government intervention through subsidies is accused of being politically motivated and of creating opportunistic behavior on the part of officials who control the allocation of subsidies and the divergence of subsidized resources from its intended use (Schmitz et al. 2010).

Moreover, basic element of the former reform in agriculture concerning the transformation of the land tenure from the large state farms to private or cooperative farms through privatization, has not produced the favorable results (Swinnen et al 2009). Macours and Swinnen (2002) argue that under the conditions of free market, a strict distribution of property rights is a principal factor of agricultural production enhancement. Since this criterion has not been observed, and individual property rights have been not clearly defined, farmers have shown weak motivation to invest in land (Swinnen et al. 2009).

The purpose of the study was to show the causes for occurrence of the current situation related to land depletion and lack of necessary soil maintenance, demonstrate the effectiveness of discriminatory application of mineral fertilizers, justify the need to create the necessary material and technical base for the soil monitoring and further phased implementation of basic systems of precision agriculture.

2. Materials And Methods

The dialectical method of economic processes analysis and fundamental provisions of economic theory on the problem of research form the basis of theoretical and methodological background of research. The methodology used in the first part of the study is highly descriptive; it is necessary for analysis and comprehensive understanding of the problem under study.

The population needs in wheat are determined on the basis of physiological norms of food consumption, recounted in accordance with the conversion factors of basic food into the primary product, Table 1., 2.

Table 1
Physiological standards of foodstuffs consumption applied in the Republic of Kazakhstan

No.	Wheat product group	Kilogram per year
1	Wheat flour of premium quality and 1st grade	9
2	Rye-bread	25
3	Mixed grain bread	42
4	Wheat bread	28
5	Noodle products	2.4

Source: Order of the Minister of National Economy of the Republic of Kazakhstan dated December 9, 2016 No. 503 “On approval of scientifically founded physiological norms of foodstuffs consumption”.

Table 2
Conversion factors of basic food to primary product applied in the Republic of Kazakhstan

Name of primary product	Name of final product	Conversion factors of final product to primary product
Wheat	Flour	1.24
Flour	Wheat bread, rye-bread, mixed grain bread and other	0.718
	Noodle products	1.03
Source: Agency for Strategic planning and reforms of the Republic of Kazakhstan Bureau of National statistics (further – ASPR of the of the RK of BNS)		

The information on the use of types of mineral fertilizers per total area of agricultural land provided by the Food and Agriculture Organization of the United Nations of Kazakhstan (further - FAO) on its statistical portal, but the source does not provide data on the total use of mineral fertilizers (nutrient nitrogen N + phosphorus oxide P_2O_5 + nutrient potassium K_2O), therefore, an indicator was calculated by adding the data.

The share of the fertilized area from the cultivated is calculated on the basis of information of the ASPR of the of the RK of BNS by correlating the indicators. *Share of fertilized area from the cultivated = cultivated land of wheat fertilized with mineral fertilizers / total acres of wheat* * 100.

Field tests with precision fertilization have been conducted by Saken Seyfullin Kazakh Agro Technical University (further – S. Seifullin KATU) in the subordinate agricultural production of the North Kazakhstan Agricultural Experimental Station in 2018–2020. In the crop rotation, spring wheat has followed the fallow forecrop. The initial content of fertilizers in the soil was as follows: N-NO_3–23.7 mg/kg of soil, P_2O_5–20.7 mg/kg of soil. Three rates of increased phosphorus fertilizers were applied (*ammophos*) in doses of phosphorus content (*P*) – 60 kg of active agent/ ha, 90 kg of active agent/ ha, 150 kg of active agent/ ha (*P60, P90, P150*). The effect of fertilization has been evaluated in comparison with check – *P0*(without fertilizers). The area of each experimental plot was 150 m^2.

The deficit and t required dose of phosphate fertilizer is calculated by the formula:

$$\mathrm{Frkgofactiveagent/ha} = (\mathrm{Popt} - \mathrm{Pact}) \times 10 \tag{1}$$

where Fr – fertilizer rate, Popt – optimum content of P_2O_5 in the soil, Pact – actual content of P_2O_5 in the soil, 10 – kg of active agent of fertilizers per 1 mg of P_2O_5 deficit in the soil.

This formula was developed by scientists of S. Seifullin KATU as a result of conducting twenty years of research conducted in long-term stationary multivariant experiments on dark-chestnut soils and ordinary black soil of the main grain-growing regions of Kazakhstan, in this regard, we consider the use of this formula to be the most appropriate method of calculation.

The northern region of Kazakhstan is mainly characterized by ordinary and southern black soils, loamy and middle loamy by grain-size distribution.

The parameters of meteorological conditions (average air temperature, °C and amount of precipitation, mm, have been recorded by meteorological station located in the experimental field:

1) Characteristics of climatic conditions, 2019 –amount of precipitation for the entire vegetation period (May - August) was 191.6 mm with the average annual rate of 196.5 mm. In May, amount of precipitation was 44.8 mm, while the average annual rate was 27.4 mm, in June – 48.1 mm with an average annual norm of 42.9 mm, in July 59.3 mm with an average annual rate of 60.6 mm, in August 39.4 mm with an average annual norm of 45.6 mm. The average daily air temperature in May was 1.5 degrees below the long-term average, in June it was 1.6 degrees higher, in July and August it was 0.7 degrees higher.

2) Characteristics of climatic conditions, 2020–161.2 mm of precipitation fell during the whole vegetation period (May - August). In may, precipitation was 28.1 mm, in June 35.9 mm, in July 75.6 mm, in August 21.6 mm. The average daily air temperature in May was 5.2 degrees above the long-term average, in June 2.1 degrees below, in July 1.4 degrees above, in August 2.6 degrees above.

Planning of experiment:

1) In spring 2018, location for the breakdown of demonstration plots was determined on the basis of analysis of fertilizer application and evaluation of methods for determining the doses of mineral fertilizers;

2) In the springtime of 2019, soil sampling was performed and the wheat was sown on demonstration plots with different doses of phosphorus fertilizers;

3) In the spring period of 2020, soil samples were taken and analyzed for the content of mobile phosphorus in the soil at the demonstration sites. At the fifth demonstration plot the phosphorus content was brought to optimum level by applying an additional 80 kg of active agent of *ammophos*. The wheat planting has been performed.

3. Results And Discussion

3.1. Dynamics of wheat production and mineral fertilizer use in Kazakhstan, descriptive analysis

The agriculture is an industry where Kazakhstan has a competitive advantage, which consists in massive availability of agricultural land (Table 3). Kazakhstan takes the ninth largest country in the world, with an area of 2,724,900 square kilometers. At that, area of agricultural lands is 110,971.8 thousand hectares, which is equivalent to 1 million 109,718 thousand square kilometers, and accounts for 41% of the entire country's territory, which stipulates the considerable production potential of the republic, especially under conditions of global challenges and rapidly growing world population.

Table 3
Categories of agricultural lands with a breakdown by regions of Kazakhstan*

Agricultural lands	Unit of measure	Croplands	Total agricultural lands
In Kazakhstan	Ths. ha	26 120.5	110 971.8
	Ths. km^2	261 205	1 109 718
Structure of agricultural lands	%	24	100
* Information submitted as of November 01, 2021. Source: Committee of Land Administration of the Ministry of Agriculture of the Republic of Kazakhstan			

The regional specialization of the regions growing wheat in the country is as follows: As can be seen from Table 4, the main regions growing wheat are Akmolinskaya (31,1% of seeds in the republic is accounted for by this region), Kostanaiskaya (share – 29,9%) and North Kazakhstan (share – 18,6%) regions. The total specific weight of these regions is 79.6%, or three-quarters of all crops.

Table 4

Specialization* of regions growing wheat

Regions	Cultivated lands on average for 2015–2020, ths. ha	Share, %
Akmolinsk	3 693.3	31.1
Kostanaisk	3 543.4	29.9
North Kazakhstan	2 210.7	18.6
Karaganda	619.5	5.2
Pavlodar	508.1	4.3
East Kazakhstan	374.8	3.2
Aktobe	284.9	2.4
Turkestan	183.2	1.5
West Kazakhstan	180.2	1.5
Almaty	132.6	1.1
Zhambyl	121.8	1.0
Other	12.54	0.1
Republic of Kazakhstan	11 865.2	100.0
* specialization was determined through the ranking of cultivated lands. Source: ASPR of the of the RK of BNS		

The need for wheat per head of population is presented in Table 5 and calculated by using the conversion factors applied in the Tables 1,2.

Table 5
Provision of the population with wheat in accordance with consumption rates

Name	Unit of measure	2016	2017	2018	2019	2020
Population size	Ths. people.	17 918	18 157	18 396	18 632	18 833
Need (wheat) – 195 kg per capita per year	Ths. tons	3 494	3 541	3 587	3 633	3 672
Bulk yield	Ths. tons	14 985	14 803	13 944	11 452	14 258
Meeting the demands through domestic production	%	429	418	389	315	388
Source: Own calculations based on the methodology of ASPR of the of the RK of BNS						

In 2020, meeting the population's demand for wheat through domestic production was 388% and decreased slightly, by 41% compared to the same indicator in 2016. The decrease is due to an increase in population by 915 thousand people and a decrease in gross yield by 727 thousand tons during the analyzed period. The annual indicators for meeting the population's demand for wheat through domestic production show a fourfold overproduction of wheat in the country.

Figure 1. shows the yield indicators and the share of fertilized area from the cultivated land by wheat for 2009-2020s in Kazakhstan. The period under review shows the consistently low yields of wheat, while the share of fertilized area from cultivated land shows a marked increase from 4–22.5%. Therefore, there is no correlation between two indicators.

At that, conducted agrochemical analyses of soils suggest that soil fertility in Kazakhstan is different on every hectare, and soils are disparate. The mineral fertilizers are applied irrationally, without the use of methods of discriminatory application of mineral fertilizers. The applied volumes of mineral fertilizers do not meet the scientific demand of plants for mineral fertilizers.

Figure 2. shows the use of mineral fertilizers (nutrient nitrogen N + phosphorus oxide P2O5 + nutrient potassium K2O) per total area of croplands in different countries. One of the lowest values was in Kazakhstan – 2.9 kg/ha for the total area of croplands. In Canada, 105 kg/ha is used for the total area of croplands.

Figure 3. shows the production volumes of nitrogen (N) and phosphate (P) fertilizers at the specialized facilities from 2010 to 2020.

According to analytical data, annual scientific demand for mineral fertilizers for the entire croplands of the republic is 2.5 million tons in gross weight (nitrogen 1.2 million tons, phosphate 1.3 million tons, potash 0.03 million tons) or 1.0 million tons in active ingredient. The Kazakhstani producers can provide only 40% of domestic scientific demand.

The data presented for the annual scientific demand for mineral fertilizers is not entirely correct, and represents the summary data. Any selected methodology for calculating the scientific demand of croplands in mineral fertilizers cannot be reliable since there is no reliable information about the soils condition at present.

3.2. Field tests

According to the results of many years of research conducted by scientists of the S. Seifullin KATU, it has been established that the crucial role in the formation of yields is played by: mineral nitrogen content before wheat plantings – N-NO3 in the 0–40 cm layer, mobile phosphorus in the 0–20 cm layer, its ratio and water availability.

In 2019, agrochemical monitoring was conducted at the demonstration plots, the results of which are presented in Tables 6 and 7.

The content of nitrate nitrogen in the 0–40 cm layer was high – 23.7 mg/kg of soil, which is quite acceptable for a fallow forecrop, refer to Table 6.

Table 6
Content of nitrate nitrogen in demonstration plots, mg/kg of soil

Number of plot	Applied, kg of active agent	Soil layer	N-NO3, mg/kg of soil
1	*P0*(without fertilizers)	0–20	29.9
		20–40	17.4
		0–40 (average)	23.7

According to the experimental evidence presented in Table 7, phosphorus content in the check of the experiment was low – 20.7 mg per kg of soil.

Table 7
Content of mobile phosphorus in the 0–20 cm layer in demonstration plots, mg/kg of soil

Number of plot	Applied, kg of active agent	P2O5, mg/kg of soil
1	*P0*(without fertilizers)	20.7
2	*P60*	27.1
3	*P90*	31.6
4	*P150*[1]	32.6
5	*P150*[2]	33.8

Based on the experimental evidence obtained by scientists of the S. Seifullin KATU over the multi-year period of experiments, in all years the highest yield of spring wheat was formed with the same content of P2O5 in the soil – 35 mg/kg. The slight increase in mobile phosphorus content over 35 mg/kg had no effect on yield, but above 40 mg/kg has sharply reduced it. Based on the optimal level of P2O5 in the soil – 35 mg/kg, optimal amount was determined for the fertilizer needed for the experimental plot – *P150*.

According to the obtained yield, presented in Table 8, application of phosphorus fertilizers at the rate of *P60*, *P90* and *P150*, has increased wheat grain yields to 33.2 dt/ha, 34.2 dt/ha and 38.1 dt/ha, respectively.

Table 8
Spring wheat yield at the demonstration plots, 2019

No. of plot	Applied, kg of active agent	Bunker weight, dt/ha	Content of impurities, %	Moisture, %	Refraction, %	Yields taking into account refraction, dt/ha	P2O5, mg/kg
1	*P0*(without fertilizers)	26.5	0.16	18.5	4.66	25.3	20.7
2	*P60*	34.7	0.14	18.3	4.44	33.2	27.1
3	*P90*	35.7	0.14	18.1	4.24	34.2	31.6
4	*P150*[1]	36.7	0.16	18.2	4.36	35.1	32.6
5	*P150*[2]	39.7	0.14	17.8	3.92	38.1	33.8

Table 9 shows that the wheat had a good natural weight within 776–780 g/l, protein content has fallen within the limit of 14.17–15.45%, which corresponds to the worldwide standard. The content of gluten has increased from 20.2 to 31.8%. There is a clear relationship between the quality of spring wheat grain and the content of mobile phosphorus in the soil. With a low phosphorus content, content of gluten was very low, despite the good nitrogen supply.

Table 9
Quality of spring wheat by plots, 2019

No. of plot	Applied, kg of active agent	P2O5 mg/kg	Natural weight, g/l	Protein, %	Crude gluten		Falling number, s
					Content, %	FDM	
1	*P0*(without fertilizers)	20.7	777	14.17	20.2	47.3	464.7
2	*P60*	27.1	776	14.47	26.72	34.4	459.7
4–5	*P150*	33.0	780	15.45	31.8	42.2	491.5

In the spring period, 2020, soil samples have been taken at all demonstration plots, with its subsequent analysis for the content of mobile phosphorus in the soil. In the fifth demonstration plot, phosphorus content was brought to an optimal level by applying additional 80 kg of active agent of *ammophos*. The accounting for the effects of fertilizers applied in 2019 was provided for the remaining demonstration plots. The results of the analysis are presented in Table 10.

Table 10
Content of mobile phosphorus in the demonstration plots in the layer 0–20 cm during the waiting period, 2020, mg/kg of soil

No. of plot	Applied, kg of active agent	P2O5
1	*P0*	17,3
2	*P60*– afteraction	22,5
3	*P90*– afteraction	25,5
4	*P150*[1]– afteraction	31,2
5*	*P150*[2]– afteraction + *P80*	36,0
* additionally applied 80 kg of active agent of *ammophos*.		

According to the data presented in Table 11, yield of spring wheat in the fifth demonstration plot was 34.1 dt/ha, in afteraction on the fourth demonstration plot 31.1 dt/ha, in afteraction on the first demonstration plot (without fertilizer) – 18.4 dt/ha.

Table 11
Output yield of spring wheat in the demonstration plots, 2020

No. of plot	Applied, kg of active agent	Bunker weight, dt/ha	Content of impurities, %	Moisture, %	Refraction, %	Yields taking into account refraction, dt/ha	P2O5, mg/kg
1	*P0*(without fertilizers)	18,2	0,6	12,3	1,1	18,4	17,3
2	*P60*–afteraction	24,4	0,5	12,1	1,4	24,7	22,5
3	*P90*–afteraction	26,41	0,8	11,5	1,7	26,9	25,5
4	*P150*^{1}–afteraction	30,57	0,6	11,6	1,8	31,1	31,2
5*	*P150*^{2}–afteraction + *P80*	33,44	0,5	11,6	1,9	34,1	36,0
* additionally applied 80 kg of active agent of *ammophos.*							

In Kazakhstan, there are no grain producers using the full range of precision farming systems, including the discriminatory application of fertilizers. There are only pilot projects on the basis of several organizations subordinate to the Ministry of Agriculture. The most grain-producing countries have long been using the precision farming systems and get the high yields.

Kazakhstan lags far behind other countries in the use of mineral fertilizers, resulting in low yields. The high cost of imported mineral fertilizers and the lack of industrial capacity for production of mineral fertilizers to meet the needs of the domestic market are among the reasons of this situation.

If we compare the average yield of wheat with Canada, which has the same climatic conditions for grain production as Kazakhstan and actively uses the precision farming technology, it equals to 31 dt/ha, which is two and a half times higher than the yields in Kazakhstan. This comparison is not correct since the grain production in Kazakhstan is in degradation, and large volumes of production are conditioned by the large amount of croplands. Currently, use of modern precision farming systems, particularly the use of discriminatory application of fertilizers turns to be possible. Even for the use of basic systems of precision farming technology, it is necessary to have the appropriate material and technical base, which is not available in Kazakhstan.

The conducted analysis has showed that the statistical data does not reflect the real condition of croplands in Kazakhstan, and the ongoing research and experiments demonstrate the problem of extreme soil depletion and confirm the feasibility of mineral fertilization. 30 years of continuous use of croplands and lack of necessary soil maintenance, including the use of mineral fertilizers, has resulted in soil depletion. With a view to ensuring the soil fertility recovery, it is necessary to apply the prodigious amount of mineral fertilizers. Currently, more than 75%, and a year earlier more than 85%, of croplands in Kazakhstan have been not fertilized. The most part of production has been associated with ancient methods based on the “sown-harvested” principle.

This situation was caused by the low ethical values in society, resulting in negative consequences for the development of industry.

The high level of corruption had an adverse impact on the land distribution process. As a result, new landlords have been not professional farmers and had no special knowledge about the agriculture; most of them were the former Communist elites who used their position to enrich themselves (Spoor 1999; Toleubayev et al. 2010).

The same situation has occurred with the personnel in agriculture, starting with the senior executives, most of them were not professionals and did not have the specialized knowledge necessary to choose the right model of development of industry and efficient use of budgetary funds.

Very often, a change of Ministers of Agriculture was followed by a change of owners of major agricultural establishments. The regulatory legal acts issued by the Ministers of Agriculture and regulating the distribution of subsidies have issued according to the needs and existing material and technical base of the privileged owners of major agricultural enterprises, who were in one way or another associated with public servants. The subsidies did not always reach small producers; Ministry's budgetary funds often ran out.

The unsteady situation has resulted in high risks faced by grain producers, and based on the circumstances, making the greatest profit in the short, or at best in the medium term, has become the main goal of the owners of croplands. The state of uncertainty was a major factor in the lack of concern among the grain producers to invest in the renovation of material and technical base and to look after their land.

It is evident that the government intervention seems to be advisable to support the agricultural development, however, this is only possible through viable, accountable, and transparent policy.

4. Conclusion

To bring agriculture in Kazakhstan to the competitive level and implementation of modern systems of precision agriculture, a comprehensive approach is required.

The most part of croplands in Kazakhstan has not been treated with mineral fertilization for a very long time, in this regard, it is recommended to oblige grain producers to apply the mineral fertilizers in the minimum rates established by the state on all croplands.

The continuous growth of prices for imported fertilizers is composed of a broad range of reasons, which include the unscrupulous intermediaries in the supply chain of fertilizers, high prices for energy sources in countries being the major fertilizer producers, and transportation costs. In this regard, we consider it necessary to introduce a ban on the export of mineral fertilizers, as well as allocate the funds for construction of new enterprises for the production of mineral fertilizers, in this case, it is advisable to keep enterprises in state ownership.

In order to perform the monitoring of croplands by the state, it is necessary to introduce a requirement for grain producers to submit the compulsory annual agrochemical maps of fields to the relevant state authorities, on the principle aimed at bringing the requirement to the rate of 1 sample – 1 hectare.

To bring the requirements of agrochemical maps of fields to the rate of 1 sample – 1 hectare, it is necessary to reallocate the part of the financial aid to agriculture for the construction of new agrochemical laboratories, which services will be available in all grain-growing regions. Its activity will be accountable to subordinate organizations of the Ministry of Agriculture of the Republic of Kazakhstan

In order to start the work of agrochemical laboratories, it is necessary to start training the appropriate personnel. Initially, accelerated grant-based continuing education programs for advanced training should be developed at the relevant universities and/or research institutes, with the requirement of compulsory subsequent conclusion of employment agreement for established periods of workout under the grant-based training.

In cases of non-compliance with the requirements of the Ministry of Agriculture, it is necessary to take measures for the forcible withdrawal of land and transfer to the balance sheet of dedicated research institutes since the agriculture forms the basis of country’s food security, which in turn is an element of national security of the state.

Declarations

• The authors have no relevant financial or non-financial interests to disclose.

• The authors have no conflicts of interest to declare that are relevant to the content of this article.

• All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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Azat Tleubayev[1], Gabelashvili Kakhaberi[6], Bazarkhan Rustembayev[2], Faya Shulenbayeva[1], Michal Lošťák[3]- carried out an official identification of the plant material used in your study, Adil Rakhimov[4], Ruslan Kassym[5], Akmaral Tlenshiyeva[5*] conducted a study.

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Figures

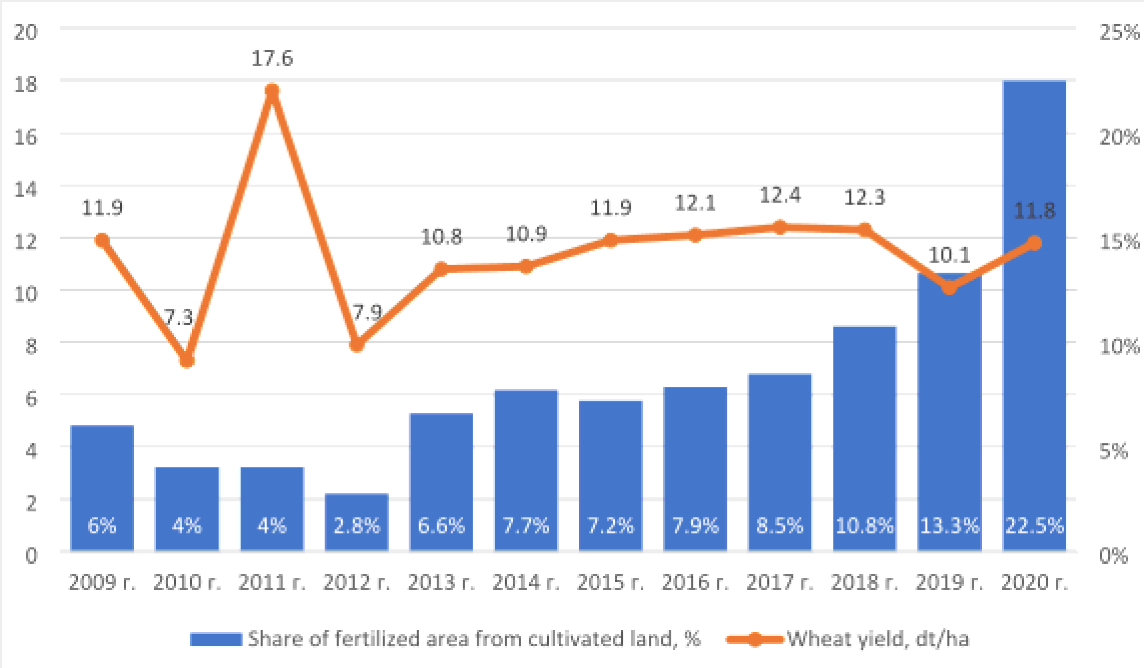

Figure 1

Interrelation between the wheat yield and share of fertilized area from cultivated land in 2010-2020s

Note: Statistics on the use of mineral fertilizers on the official statistics website of Kazakhstan has been maintained since 2009.

Source: Own calculations based on data of the ASPR of the of the RK of BNS

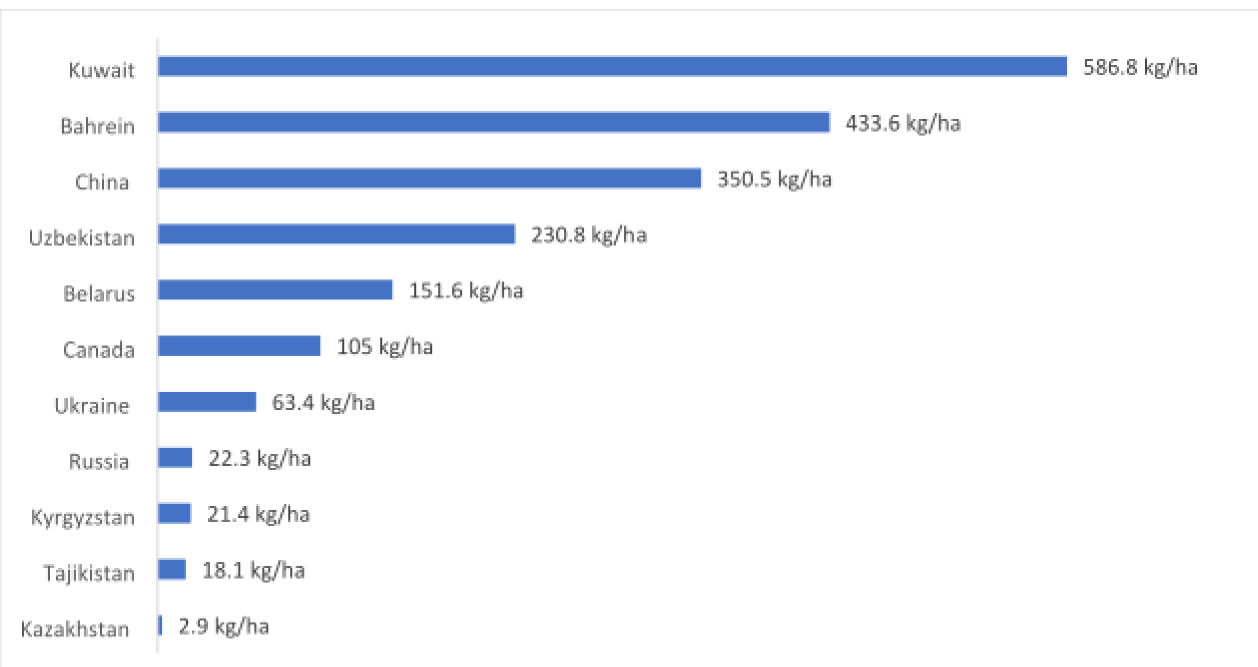

Figure 2

Use of mineral fertilizers per total area of croplands, 2019

Source: Own calculations based on data of FAO

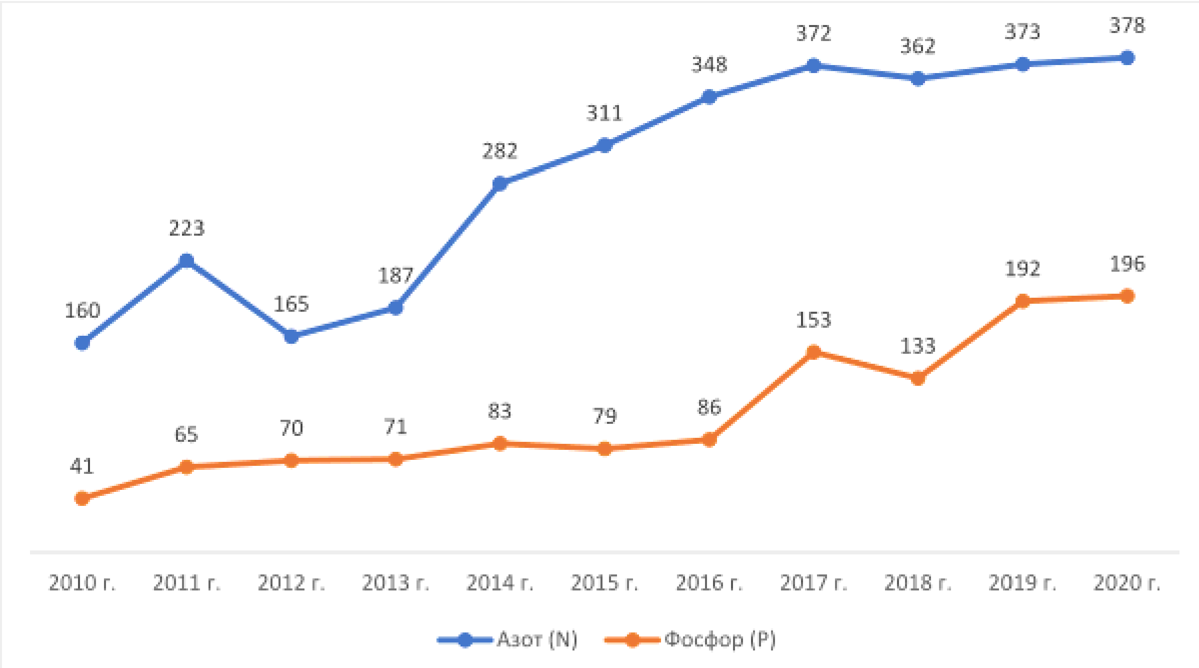

Figure 3

Production of nitrogen (N) and phosphate (P) fertilizers (mineral or chemical), ths. tons

Note: ASPR of the of the RK of BNS