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Ecological and economic evaluation of using arable land in the Republic of Bashkortostan

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Abstract. In our country, with the transition to a market-oriented economy, the scientifically based farming systems with their rational crop rotations were violated, which intensified the process of soil fertility depletion. Accordingly, the cumulative damage from non-recoverable soil humus losses is rapidly growing and becomes quite comparable with the cost of crop production received from this land. The article substantiates the necessity of conducting an ecological and economic evaluation of the use of land in agriculture at the regional level. The proposed methodical approach to solving the problem of optimal allocation of crops and cattle-breeding industries is determined by the criterion of the most effective use of the basic means of agricultural production. The analysis of the use of arable land and the structure of cereal crops in all categories farms of the Republic of Bashkortostan was carried out. The results of the economic and environmental damage evaluation caused by the agricultural production of the region were presented. The results of the economic and environmental damage evaluation caused by the agricultural production of the region were presented. The calculation of ecological and economic efficiency of land use in agriculture of the Republic of Bashkortostan is presented in the paper.

1. Introduction

In the pre-reform period, the actual agriculture of our country and its territorial distribution was the result of system state regulation and directive planning, which determined a rather high efficiency of the functioning of agricultural organizations. The agricultural production formed by that time was generally subordinated to a single global goal and criterion maximization of satisfaction of society's social needs. At the same time, this criterion could not be formalized practically and quantified in practical terms; therefore, government authorities applied appropriate control measures and a certain system of indicators by which agricultural producers could maintain a sustainable expanded reproduction.

Due to the renunciation of the methods of state regulation of the economic sphere and directive planning, the main types of agricultural products of domestic production, including those in the Republic of Bashkortostan (and designed to meet domestic needs of the country), were uncompetitive, especially after the Russian Federation joined the World Trade Organization and became one of the subjects of the global food market.

In this regard, domestic producers had to adapt the structure of production of agricultural products, and, accordingly, cultivated area structures to their commercial interests, regardless of the



recommendations based on the theory and practice point of view [1, 2]. This led to the violation of the existing agricultural system with its rational crop rotation and intensification of the soil fertility exhaustion processes, which ultimately requires the carrying out a scientific research and develop practical measures that would ensure all agro-formations highly profitable functioning in the conditions of fiercest competition, as well as the possibility of reproduction of soil fertility.

2. Results and Discussion

Scientific research and practice show that today, knowledge of information technologies and even the basic models of their application are not enough for an effective activity of a specialist. It requires new competencies, including critical and creative thinking, initiative and responsibility, adaptability, innovation and entrepreneurial approach, emotional intelligence, independence, ingenuity and organized nature.

Thus, educational trajectories are significantly changing today under the influence of the digital environment, taking into account the requirements for new professions and the people's values change; moreover, the orientation toward the applied science and practice is prevailing.

3. Research Questions

The agricultural production of the Republic of Bashkortostan is run in difficult climatic conditions and dispersed on the territory of more than 15 million hectares. As part of the land mass, a significant area is occupied by low-productive soils, 1/3 of all arable lands has high acidity and needs liming. More than 60% of the arable land areas suffers various types of erosion and is located on slopes with different steepness.

Existing in the "pre-reform" years, the trend of reducing soil fertility due to the constant negative balance of nutrients and humus in soils continue to develop rapidly. This reduction is primarily due to a significant decrease in the use of organic fertilizers by rural producers (almost 5 times in 2016, if compared to 1990) and mineral fertilizers (8.4 times for the comparable period).

In 1990, 295 thousand tons of mineral fertilizers were imported all over the republic (in terms of 100 % of nutrients), and one could mention already 35-40 thousand tons in 2013-2016 that compensated less than 10% of nutrient losses in the soil.

All this led to the degradation of huge areas of agricultural land. Namely, more than 1.2 million hectares of such land in the Republic of Bashkortostan were identified in the period of 1996-2004. This is 26% of the arable land area from 1990. Later, after these land areas were practically no longer cultivated, they were transferred to the category of forage lands [1]. This fact can explain that the share of arable land in farmland at the regional level in 2016 compared to 1990 decreased from 67.3 % to 51.5 %. And even after such a significant reduction, a certain share of arable land is not in demand among agricultural producers.

Large areas of arable land that are simply not processed, as required by modern technology, are listed as complete fallows. So in 2016 the area of "complete fallows" amounted to 607 thousand hectares (16.7% of the arable land, which annually "walks") and exceeded the scientifically based norm by 6-7 percentage points. (Table 1).

In our opinion, it is possible to "return" up to 450-500 thousand hectares of arable land to the high-marginal branches of crop production. The first way is due to the maximum full use of natural forage resources and proportional reduction of areas of forage crops cultivated on arable land, where, there are, according to our calculations, up to 200-250 thousand hectares of arable land were unreasonably "withdrawn." Second, it is necessary to replace the complete fallow areas with seed fallows (legumes) and sidual fallows (green fertilizers), while reducing the area of the actual steam fields by about 250 thousand hectares.

The area of all crops decreased by 30 %, grain crops decreased by the same amount, and the area of forage crops decreased by almost half. The last one is primarily due to a sharp reduction in the number

of cattle almost twice at a significant increase in the area of natural forage. As can be seen from Table 1, sunflower seeds turned out to be the only crop that shows relatively large growth, both in absolute and relative terms, which, in our opinion, is not entirely justified and leads to a sharp soil fertility depletion.

The area of sugar beet crops, which was decreased to 45 thousand hectares in 2012, was stabilized at the level of 50-52 thousand hectares in 2014-2016, but with a significant increase in the yield of this crop (up to an average of 250 kg/ha). Due to this, the obtained volumes of beet raw materials almost completely provide the capacity of sugar refineries operating in the republic. It should be noted that in all regions and climatic zones (including regions of the republic), grain farming remains and will be the main branch of agriculture in the future. Therefore, the species structure of cereal crops is of interest.

Table 1. Structure of arable land use in all categories farms of the Republic of Bashkortostan in 1990-2016, % [3].

Crops and agricultural lands	Time period					
	1990	1995	2000	2005	2010	2016
Cultivated area, total	90.5	87.8	84.9	82.8	85.2	83.3
Cereals and grains	53.5	50.3	45.6	43.2	48.0	49.9
Sunflower oilseeds	1.4	1.2	2.3	3.1	4.1	5.9
Potatoes and ground vegetables	2.5	2.7	3.0	3.1	3.0	2.8
Sugar beet	1.6	1.5	1.6	1.6	1.9	1.4
Forage crops	31.5	32.1	32.4	31.8	28.2	23.3
Complete fallows	9.5	12.2	15.1	17.2	14.8	16.7
Arable land	100	100	100	100	100	100

* Unused arable land is also included.

The grain market situation in recent years shows a significant increase in demand for food grain in the export market. In this regard, it is possible to predict with high probability the growth of demand for grain in the domestic regional market. At the same time, the changes in the structure of grain crops, which are estimated on the basis of these positions, are not positive (Table 2).

Table 2. Structure of grain crops in general in the Republic of Bashkortostan in 1990-2016.

Grain Crops	1990		2012-2016	
	Thous. ha	%	Thous. ha	%
All cereals and grain legumes	2597	100	1752	100
Winter rye	732	28.2	296	16.9
Spring wheat	861	33.2	713	40.7
Oat	254	9.8	159	9.1
Barley	386	14.9	392	22.4
Buckwheat	96	3.7	91	5.2
Millet	26	1.0	7	0.4
Pea	239	9.2	65	3.7
Other cereal crops	-	-	29	1.6

If the structure proposed by the agricultural economists of the region is considered as a certain norm, then, according to the presented statistics, it can be concluded that the producers themselves almost completely rejected it [3, p. 34]. This statement is evidenced by the significant increase of the specific weight of spring wheat crops, which is the only source of income for the agro formed region.

Accordingly, the specific weight of winter rye (the best predecessor in crop rotations and important insurance crop) unreasonably reduced, as well as the specific weight of peas did.

The sharp decrease in acreage of peas is also an ill-considered decision of the agricultural producers, because the pea is virtually the only culture in the republic which can reduce feed wastage due to the increase of balanced animal feeding rations for protein. It should be noted, that pea is also a good preceding crop as a seed fallow for other crops (enriches the soil with nitrogen). This is important with due regard to the unavailability of mineral fertilizers due to their high cost. Taking into account this fact, it is impossible to explain why agricultural producers do not use the “free supplier” of nitrogen and prefer to use mineral fertilizers. And it is not clear at all why the share of chemical fertilizers reaches 97-99 % in the total volume of purchase of mineral fertilizers by agricultural organizations.

Thus, throughout the Republic of Bashkortostan (as well as in the whole of the Russian Federation), scientifically-based farming systems with their placement, specialization of all agriculture and rational crop rotations were violated. This led to an acceleration in the rates of destruction of the most important indicator of soil fertility (humus and its irreversible losses), according to our calculations, up to 500-600 kg per hectare of arable land annually, including more than 2.0 million tons generally throughout the republic.

If the loss data are transferred to soil nutrients (NPK = 80 kg per 1 ha of arable land in 2016), it is equivalent to the loss of one harvest annually, i.e. approximately the same amount of NPK soil is removed annually during harvest. In our calculation of the loss of humus, we used the structure of arable land (taken as a unit) for the period of time for which the assessment was carried out (for all categories of farms), since the latter is the determining factor of the level of mineralization of humus [4]. In this case, the total losses of soil and humus nutrients (the total contribution of all crops to the loss of the first one), cultivated on the territory under consideration (in the economy, municipal district, region) will be obtained in the final line of the table.

Determination of NPK losses due to carry-over with the crop (the second type of loss) is calculated in a similar manner. The NPK removal rates for each crop [4, 5] are multiplied by the yields and specific gravities of the crops in the plowland, in the summary line of the table these indicators are also summarized.

The damage from lost fertility of the soil is calculated on the basis of determining all the costs that are necessary to restore lost fertility with the help of chemical fertilizers, i.e. to purchase, transport, and apply 1 kg of NPK to the soil (Table 3).

Table 3. Determination of economic and environmental damage from agricultural production in the Republic of Bashkortostan in 1990-2016.

Parameters	Time period						2016 to 2010 (%)
	1990	1995	2000	2005	2010	2016	
NPK fertilizer treatment was applied, thousand tons	295	179	60	37	49	33	67
Expenses on fertilizers, mln. rub.	115	160	318	768	966	2059	213
Total non-recoverable losses of NPK, kg/ha	0.4	0.9	5.3	22.0	20.3	61.6	303
Economical environmental damage, rub./ha	40	80	126	153	129	148	115
Total non-recoverable losses of NPK, kg/ha	15	70	670	3365	2620	9120	348

* The “price” of NPK compensation is calculated on the basis of the consolidated annual reports of agricultural organizations of the Republic of Bashkortostan for the relevant years.

According to the calculations, the specific ecological and economic damage from the soil fertility loss due to agricultural production (excluding compensation) amounted to 9120 rubles per hectare in 2016 on the average in the republic. With this in mind, in terms of the total area of arable land of the Republic of Bashkortostan, the amount of damage will make 33.2 billion:

$$D_A = 61,6 \text{ rub/kg} * (80 + 80 - 12) \text{ kg / ha} * 3641 \text{ thous. ha} = 33.2 \text{ billion rubles.}$$

Some researchers consider it necessary to establish the loss of humus and soil nutrients by determining the changes in the previous and subsequent soil analysis [6, p. 71], that will require, firstly, very large material and financial expenses; secondly, it can last for a rather long period. In this regard, we consider it possible and legitimate to use the standards developed by agricultural scientists based on field experiments [2, 4].

All this reflects the inefficiency of use and preservation the main wealth of the country – the land. The Republic of Bashkortostan is not an exception in this respect. For the region under consideration, the ecological and economic effect, which is the difference between the production results and its costs, adjusted for the amount of environmental damage, decreases every year. The main reason of this negative phenomenon is determined by the money's worth of environmental damage namely NPK soil loss, which is significantly increased. As a result, the costs required to eliminate or prevent the soil fertility depletion associated with agricultural land use are quite comparable to the cost of crop production, and in some unfavorable for agricultural production years they exceed the amount of net income that comes from the crop sector or from the actual land use (Table 4).

Table 4. Ecological and economic efficiency of land use in agriculture of the Republic of Bashkortostan in 1990-2016, per 1 hectare of arable land, rub.

Parameters	Time period						2016 to 2010 (%)
	1990	1995	2000	2005	2010	2016	
Gross crop production	285	380	2070	6615	8715	21170	243
Expenses for the crop production	240	330	1530	2850	4330	8870	205
Conditional net profit	45	50	540	3765	4385	12300	281
Conditional net profit less environmental damage	30	- 20	- 130	400	1765	3180	180

Such a level of management cannot be justified by the ecological and economic point of view. At the same time, according to the Decree signed in 1996 by the first President of the Russian Federation, B.N. Yeltsin, it is necessary in our country to curtail agricultural production, since this legislative document literally prescribes that “no economic activity can be justified if the benefit from it does not exceed the damage caused” [8].

Then a reasonable question may arise: who can compensate for the soil fertility losses caused the production of agricultural products? The administrative staff responsible for resolving this issue quite logically believe that land users themselves should do this, compensating for the damage from their incomes. However, even in the most favorable years for the development of agricultural production, the tendencies in the soil fertility reduction continued steadily, although the order of the State Agroindustrial Committee of the USSR from August 25, 1988 was in force, stating that “.. in the case of soil fertility reduction and damage to leased natural resources caused by the renter, one is obliged to reimburse the cost of remediation” [9, c. 62].

Scientists who believe that in the future only “keeping” crop yields at the achieved level [10, p. 3-8; 11, p. 8-11] requires more and more finances, which is absolutely right. This will cause a sharp rise in prices for production, a decrease in the efficiency of production, and, accordingly, make the

agrarian business completely unprofitable in view of the need to compensate the losses of the natural potential of the soil due to large investments of chemical fertilizers.

It is quite obvious, that achieving a full balance between the supply and removal of soil organic matter only through optimal crop rotations is a difficult task, especially considering the significant reduction in livestock number, leading to the reduction in the volume of manure added to soil. But, as our calculations have shown, in most of the arable lands of the Republic of Bashkortostan, it is quite achievable. Also, the imbalance can be minimized in some areas.

4. Conclusions

Thus, insufficient reproduction of soil fertility is not fully apparent and obvious; therefore, particularly dangerous is the process of soil “deterioration” as the main means of production and its fertility. In its turn, this negative trend is not an objective natural law and shows the desire to obtain immediate benefits from irrational use of soil without appropriate calculation of negative consequences.

The definition of ecological and economic efficiency allows us to determine how natural and economic resources of agriculture are used as a single natural and economic complex, to make an objective evaluation of the results of production activities of agricultural formations that are located in different natural and climatic conditions.

The conducted research allows to draw a conclusion that the actual processes of incomplete reproduction of soil fertility during their agricultural use undoubtedly determine the appearance of a negative effect economically and environmentally, resulting in the fact that maintaining the actually achieved crop yield level becomes more expensive.

It is important to emphasize that the ongoing accelerated soil fertility “deterioration” is continuing at present and can lead to a significant decrease of the production of agricultural food products and, consequently, to the termination of agricultural activities in a significant part of the territory of the Republic of Bashkortostan and other entities of the Russian Federation. Hence, the main priority of strategic planning at the industrial level should be ensuring the “sustainable” land use.

References

- [1] Rosstat Bashkortostan 2017 *State (national) report on the consistence and use of land in the Republic of Bashkortostan in 2017* (Ufa, Russia) p 244
- [2] 1991 *The system of agricultural production in the areas of the Bashkir SSR* (Ufa, Russia) p 518
- [3] 2017 *Agriculture, hunting and forestry of the Republic of Bashkortostan: statistical collection* (Ufa, Bashkortostan) p 201
- [4] Kiraev R S 2003 *Rational use of arable lands of the southern Urals* (Ufa, Russia: BSAU) p 260
- [5] Volkov S N 2001 *Land Management, Economic and Mathematical Methods and Models* **4** (Moscow, Russia: Kolos) p 696
- [6] Sharipov S A *et al* 2004 *Economic mechanism of land relations in agriculture* (Kazan, Russia) p 274
- [7] Shafronov A 2002 Evaluation and factors of land use efficiency *Economist* **12** pp 83-88
- [8] Presidential Executive Office 1996 Presidential decree "Concerning the concept of transition of the Russian Federation to sustainable development" *Meeting of the legislation of the Russian Federation* **15**
- [9] Quoted after 1988 Recommendations on the organization of rental relations in agricultural production *Economy of Agricultural and Processing Enterprises* **11** pp 58-62
- [10] Mirkin B M and Khaziev F H 1999 Agroecology in the Republic of Bashkortostan: consistence, tasks, prospects *Bashkir ecological Bulletin* **3** pp 3-8
- [11] Shishov L L, Karmanov I I and Durmanov D N 1987 *Criteria and models of soil fertility* (Moscow, Russia: Agropromizdat) p 184