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Stovba E.V.[1] *, Gabdulkhakov R.B.[2], Stovba A.V.[3], Meshkova N.G.[4], Kolonskikh N.E.[5]
[1] ORCID: 0000–0002–9041–6194;
[3] ORCID: 0000–0003–0946–4816;

[1, 3, 5] Birsk Branch of Bashkir State University, Birsk, Russia;
[2, 4] Ufa State Petroleum Technological University, Ufa, Russia

* Correspodning author (stovba2005[at]rambler.ru)

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THE NATURAL RESOURCE POTENTIAL DEVELOPMEN IN RURAL AREAS IN THE CONTEXT OF THE FORMATION OF THE DIGITAL ECONOMY

Research article

Abstract

The article updates the role and the importance of natural resource potential as the factor of ensuring regional food security in modern conditions of digital economy development. It is indicated that the development of "smart" agriculture aims to form productive agri-food systems characterized by high adaptability to the ongoing climate change, which leads to an increase in the level of food security at the national level. Detailed characteristics of the climatic conditions of the Republic of Bashkortostan at the zonal level is presented. The actual agricultural specialization and combination of crop and livestock sectors of agro-organizations is established taking into account the differentiation of natural resource and soil-climatic conditions and is caused by regional differences. The volume of ecological and economic damage from the loss of soil fertility as a result of agricultural production is calculated on a regional scale. It is summarized that the continued accelerated soil fertility "deterioration" can lead to a significant decrease in the volume of agri-food production in the Republic of Bashkortostan.

Keywords: natural and resource capacity, agriculture, rural areas, food security, digital technologies, digital economy.

Стовба Е.В.[1] *, Габдулхаков Р.Б.[2], Стовба А.В.[3], Мешкова Н.Г.[4], Колонских Н.Е.[5]
[1] ORCID: 0000–0002–9041–6194;
[3] ORCID: 0000–0003–0946–4816;

[1, 3, 5] Бирский филиал Башкирского государственного университета, Бирск, Россия
[2, 4] Уфимский государственный нефтяной технический университет, Уфа, Россия

* Корреспондирующий автор (stovba2005[at]rambler.ru)

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РАЗВИТИЕ ПРИРОДНО-РЕСУРСНОГО ПОТЕНЦИАЛА СЕЛЬСКИХ ТЕРРИТОРИЙ В УСЛОВИЯХ ФОРМИРОВАНИЯ ЦИФРОВОЙ ЭКОНОМИКИ

Научная статья

Аннотация

В статье актуализируется роль и значение природно-ресурсного потенциала как фактора обеспечения региональной продовольственной безопасности в современных условиях развития цифровой экономики. Показано, что развитие «умного» сельского хозяйства направлено на формирование продуктивных агропродовольственных систем, характеризующихся высокой адаптацией к происходящим изменениям климата, что ведет к повышению уровня продовольственной безопасности на национальном уровне. Представлены подробные характеристики климатических условий Республики Башкортостан на зональном уровне. Фактическая сельскохозяйственная специализация и объединение отраслей растениеводства и животноводства агроорганизаций устанавливается с учетом дифференциации природных ресурсов и почвенно-климатических условий и вызвана региональными различиями. Объем экологического и экономического ущерба от потери плодородия почв в результате сельскохозяйственного производства рассчитывается в региональном масштабе. Резюмируется, что продолжающееся ускоренное

«ухудшение» плодородия почв может привести к значительному снижению объёмов агропродовольственного производства в Республике Башкортостан.

Ключевые слова: природно-ресурсный потенциал, сельское хозяйство, сельские территории, продовольственная безопасность, цифровые технологии, цифровая экономика.

1. Introduction

At present, the peculiarities of the geographical location, climatic and soil conditions, the historically established specifics of sitting agricultural production and socio-cultural objects, the current demographic situation, the actually achieved level of the economy and social sphere, the mentality of residents have a resultant impact on the functioning of rural entities in different districts of the Russian Federation.

Rural territories are unique multifunctional communities with considerable natural resource potential and historic cultural significance. Present-day rural territories are integrated into the rural-urban environment, performing diverse tasks in certain sectors of socio-economic activity and public life. It is the rural territories, in addition to solving the strategic task of providing the population with food, that carry the civilizational mission of reproducing national identity and clearly demonstrate the distribution of productive forces. The strategic goal in developing rural municipalities based on the diverse agricultural production, the versatile and multifunctional rural economy is to improve the quality and standard of living of rural residents while improving all the basic elements of the social sphere and infrastructure. Taking into account the fact that rural territories represent an elaborate socio-economic system, the development of their strategies is determined not only by the agro-industrial production.

The direction and pace of sustainable development of rural areas are determined by the potential and, in particular, their natural and resource component. The natural resource potential is an important characteristic of rural development, reflecting the location of natural resources, the availability of agricultural sectors to them, their influence on the formation of economic specialization and the spatial organization in rural areas [1], [2].

We should point out that the natural and climatic conditions directly determine the development of rural areas, the resource availability in the agricultural sector economy, the village population living. The natural factors are an important reserve of saving material, technical and labor costs, an effective increasing means for the volume of agricultural products production.

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. 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. 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. Large areas of arable land that are simply not processed, as required by modern technology, are listed as complete fallows.

Recent years have shown negative trends in the rural life: the decline of the rural population, degradation and lack of the necessary social, engineering and institutional infrastructure, making the countryside an unattractive and unsafe living place for people. Official statistics show an increase outflow, migration and “departure” of rural residents to urban areas, currently there is an increase in the number of unemployed and villagers below the poverty line [3]. All this directly leads to the extinction of the rural territories and settlements.

The ongoing "re-wildness" of rural territories and labor and life "decivilization" make the village less attractive for living. Other obstacles in the sustainable rural development are the spatial dispersion of agro-industrial production, associated with farming specifics and administrative barriers hindering the positive functioning of the agricultural sector of the economy.

Deconcentration of population and agricultural production due to the specific management characterizes the current state of rural territories. Besides, each rural territory has its specific features formed under the influence of local conditions and factors [4]. The current trends of the agrarian economy identify the priority of new methodological approaches and provisions that will be aimed at higher competitiveness and efficiency of rural economic entities.

2. Methods

It should be especially noted that the problem under study is directly related to the achievement of conditions for food security and self-sufficiency of the population of rural areas with agri-food products. The formation of strategic goals for sustainable development in rural areas requires an assessment of the possibility for achieving them through optimizing of all available resources.

The conducted research was based on methodological recommendations and developments of leading research institutes. The information base of the study was compiled by statistical data of the Russian State Statistics Service Rosstat, materials of the Agricultural Ministry of the Bashkortostan Republic for recent years [4].

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. The existing zonal specialization of agriculture, in general, corresponds to the peculiarities of the natural and climatic conditions. At the same time, the production of food products in our country, including the Republic of Bashkortostan, relatively more stringent natural conditions, primarily because of territorial peculiarities in heat and moisture supply, as well as their distribution over periods of plants vegetation. As a result, the bioclimatic potential of our lands is significantly lower (approximately 2,3–3 times) than in the USA and France, the FRG, England.

According to the natural and agricultural zoning, the Republic of Bashkortostan refers to the temperate zone. The actual agricultural specialization and combination of crop and livestock sectors in agro-formations of the region is established according to differentiation of natural resource and soil-climatic conditions and is caused by zonal differences.

The natural-resource and soil-climatic conditions in the Republic of Bashkortostan are very diverse, they are not always favorable for the agricultural production and are distinguished by pronounced horizontal and vertical zoning. The expediency of territorial zoning was caused by the need to use the entire natural and resource potential of the region most effectively. In accordance with soil characteristics, the territory of the Republic of Bashkortostan (similar to the territory of the Russian Federation) is subdivided into the Non-humus and Humus zones. The Non-humus zone of the republic in comparison with the Humus zone is characterized by more unfavorable natural and climatic conditions and comparatively worse indicators of a qualitative assessment of arable land has higher indicators reflecting the supply of precipitation during the vegetation period.

According to the system of agricultural management adopted in the Republic of Bashkortostan, three natural climatic (agricultural) subzones with predominance of soils of the non-humus type are included in the non-humus zone [5]:

- The Northern forest-steppe subzone (fourteen municipalities);
- The North-Eastern forest-steppe subzone (five municipalities);
- The Mountain forest subzone (three municipalities).

The dedicated subzones are territorially limited natural complexes, delimited by relief, climatic and hydrological conditions, and soil cover. In the composition of agricultural subzones, according to the principle of uniformity of the soil cover and uniformity of natural climatic conditions, nine agro-soil regions are distinguished. For the subzones under consideration, the heterogeneity of the soil cover and the complex state of the soil types are characteristic, which, in turn, determines the different possibilities of rural commodity producers in the production of agro-food products.

3. Results

The natural and climatic conditions of the non-humus zone are suitable for cultivating individual crops. According to the availability of precipitation, especially during the growing season, the northern and mountainous regions in the non-humus zone belong to the territory of sufficient moisture. The meteorological factors are generally favorable for obtaining stable harvests of crops of agro formations of the non-humus zone. The detailed characteristic of the climatic conditions in the non-humus zone in the Republic of Bashkortostan is presented in Table 1.

Table 1 – Characteristics of the climatic conditions of the non-humus zone of the Republic of Bashkortostan [5], [6]

Indicators	Non-humus zone		
	The Northern forest-steppe subzone	The Northeastern forest-steppe subzone	The Mountain-forest subzone
Number of municipalities	14	5	3
The sum of precipitation, mm: - in a year - for vegetation period	 556 350	 513 370	 570 350
Average annual temperature, ^{0}C	2,1	1,7	1,2
Sum of positive temperatures, ^{0}C	2350	2170	2150
The sum of temperatures, ^{0}C: - for a period above 5 ^{0}C - for a period above 10 ^{0}C	 2150 2000	 2050 1800	 2100 1700
Hydrothermal Coefficient	1,20	1,33	1,40
Humidity factor	0,73	0,74	0,80
Duration, days: - frost-free period - with snow cover	 115 163	 96 110	 95 170
Average height of the snow cover, cm	55	50	70
Probability of drought, %	10–20	10–20	–
Number of dry days	31	21	27
Qualitative assessment, points: - arable land - hayfields - pasture - agricultural land	 81 30 17 65	 91 33 27 72	 79 34 16 46

However, in spite of the sufficient amount of precipitation in the Northern forest-steppe and in the Northeastern forest-steppe subarea, in some periods crops may suffer from a lack of moisture. At the same time, a negative sign that adversely affects the development of thermophilic crops, and in particular spring crops, is the emergence of early autumn and late spring frosts in various regions of the non-humus zone.

Essential factors contributing to the decline in soil fertility of the non-humus zone are: non-observance of scientifically based agro technologies, in particular, crop rotations, increased erosion processes, and a reduction in nutrients and phosphorus in soils. In the Northern forest-steppe subzone at the existing level of technology intensity, the economic efficiency of wheat grain production will be low. The research shows that the agro-organizations of the Northern forest-steppe subzone need to

focus primarily on the development of livestock and fodder grain production in order to achieve complete self-sufficiency in the livestock sector with high-quality fodder.

At the same time, the grain industry should be the basis of agricultural production and its support and financing by the state will allow forming positive prerequisites for the development of meat and dairy cattle breeding and pig production. However, in the Northeastern forest-steppe subzone and in the Mountain-forest subzone, the vegetation of plants occurs largely at a low sum of positive temperatures, which limits the formation of high-quality grain.

For the subzones under consideration, the heterogeneity of the soil cover and the complex state of the soil types are characteristic, which, in turn, determines the different possibilities of rural commodity producers in the production of agro-food products. In the composition of agricultural subzones, according to the principle of uniformity of the soil cover and uniformity of natural climatic conditions, nine agro-soil regions are distinguished [7]. An important component of the natural resource potential of rural areas is land resources. A qualitative assessment of arable land of the non-humus zone is on average 83 points, hayfields – 31, pastures – 19. In the Northern forest-steppe and Northeastern forest-steppe subzones, the plowing of agricultural land is higher (more than 70%) than in the Mountain-forest subzone (35–40%). However, the mountain-forest subzone, unlike the other subzones under consideration, is better provided with hayfields (35%) and pastures (25%).

The distribution of crops according to the zonal characteristic, basically, corresponds to their soil-climatic conditions. The total sown area of agricultural crops used by agro formations of the non-humus zone in 2020 amounted to 618 thousand hectares (Table 2).

Table 2 – The dynamics of land in all types of Non-humus of the Republic of Bashkortostan in 2000-2020 [5]

Land Plots	Years								
	2000	2005	2010	2015	2016	2017	2018	2019	2020
Agricultural grounds, thousand hectares	2174	2157	2161	2159	2159	2155	2155	2155	2155
Arable land, thousand hectares	1323	1015	1017	1011	1012	1013	1004	1004	1001
Crop area agricultural crops, thousand hectares, total	1091	789	822	746	743	708	678	639	618
– incl. cereals, thousand hectares	558,7	367,9	448,1	386,1	385,1	379,0	357,0	338,4	335,3
– sunflower, thousand hectares	4,8	1,7	6,5	4,8	2,9	2,6	1,8	1,3	0,9
– white beet, thousand hectares	0,8	0,1	0,2	–	–	–	–	–	–
– potatoes, thousand hectares	32,0	30,5	30,0	30,3	29,6	16,1	15,5	14,6	13,8
– vegetables, thousand hectares	4,6	4,4	3,9	4,3	3,9	2,4	2,4	2,4	2,4
– fodder crops, thousand hectares	485,4	378,7	330,4	311,0	306,2	291,9	279,4	259,2	250,2

Thus, throughout the Republic of Bashkortostan, 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 2019–2020), it is equivalent to the loss of one harvest annually, i.e., approximately the same amount of NPK soil is removed annually during harvest.

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. 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 2019-2020 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:

$$DA = 61{,}6 \text{ rub/kg} * (80 + 80 - 12) \text{ kg / ha} * 3641 \text{ thous. ha} = 33{,}2 \text{ billion rubles.} \quad (1)$$

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.

World experience clearly shows that optimal soil-agrotechnical and organizational-territorial conditions are formed to develop agricultural organizations with the effective use of modern digital technologies. They are also used to activate factors directly aimed at increasing workers' productivity, reducing producers' costs for electricity and protecting crops [8].

Of course, the digitalization of agriculture has its characteristic features, which are due to climatic risks and biological processes in agriculture and the seasonal nature of the activities of agricultural organizations in the area under consideration [9]. Not all agricultural organizations of the Republic of Bashkortostan can introduce digital technologies directly related to the personal interest and motives of enterprise owners in digitalizing agricultural production as additional costs when installing

expensive innovative equipment. In the region, the digital divide, as unequal access to information technologies, undoubtedly affects the population's quality of life, is an obstacle to developing individual agro-formations and rural areas.

Thus, digital technologies contribute to more efficient management of farmland, rational use of resources and, in turn, the development of digitalization in agriculture will give a powerful impetus to the Food-net market and the adoption of IT decisions in the agricultural sector [10]. The conducted research has identified the following perspective areas for the development of digital agriculture in the Republic of Bashkortostan, presented in Figure 1.

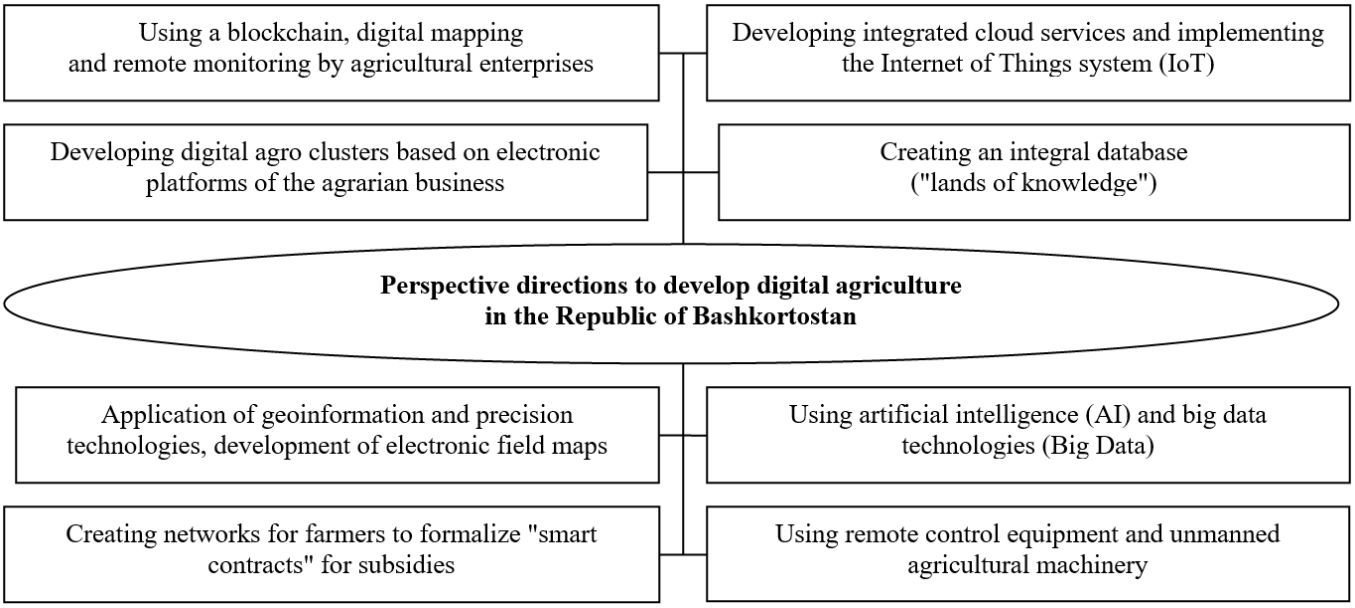

Fig. 1 – Perspective areas to develop digital agriculture

The introduction of digital and innovative technologies radically changes the traditional socio-economic paradigm of rural territorial entities and opens new opportunities and prospects in the economic activities of agricultural producers. The issues associated with the implementation of digital innovations in the agri-food sector include administrative barriers, the deterioration of the main production assets of agro-formations, the inefficient structure of demand for innovative products [11]. Currently, it is necessary to search for drivers to develop economic entities operating in the agricultural food market, determining the opportunities for economic growth, both in individual sectors of agriculture and the regional economy as a whole.

In our opinion, the objective is to adapt agricultural organizations to the new digital realities; that is, management structures should effectively introduce innovations directly into production processes [12], [13]. Large-scale digitalization of agriculture should be carried out based on the active use of artificial intelligence and big data technologies (Big Data), the development of integrated cloud services, and the implementation of technologies in the IoT's agro-organizations (IoT).

The most critical components that determine the scale of modern digital modifications in the agricultural sector of the economy can be represented:

- support for a typical digital culture of entrepreneurship and the introduction of digital innovations in the agri-food sector;
- development of programs and activities to support digitalization;
- financial affordability and practical skills in working with digital technologies.

The large-scale introduction of information and digital technologies determines the optimization of production and economic processes, decreased management costs, and increased competitive advantages in the agri-food market. Furthermore, the practical application of digital technologies will help preserve the natural fertility of agricultural land and solve urgent environmental problems directly related to sustainable farming.

The digitalization of the activities of agricultural producers determines a significant breakthrough both in the production of certain types of agricultural products and in the promotion of food products to end consumers. Furthermore, the use of modern digital technologies in their practical activities by agricultural producers will help to increase labour productivity, make effective management decisions while increasing the level of sustainability and competitiveness of agribusiness.

4. Conclusion

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. 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.

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 should be emphasized that smart agriculture will ensure high efficiency of agricultural production and improve the ability to adapt to climate change,

thereby increasing the level of food security and resilience of the crop and livestock sectors. In turn, precise land use is an intelligent system for collecting, analyzing, and updating information on the study area's state of soil and land resources.

Digital technologies help create a favorable market environment that helps to increase the rate of exchange of innovative ideas directly between producers and consumers of agri-food products. It expands their potential for making adjustments and improving the ongoing management processes of agricultural production. The practical application of digital technologies will help preserve the natural fertility of agricultural land and solve urgent environmental problems directly related to sustainable farming.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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