Improving the efficiency of plant growing by innovative means in the northern regions of the Russian Federation

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Abstract. In the context of growing demand for food and changing climate conditions, increasing the efficiency of crop production in the northern regions of the Russian Federation is of particular relevance. These territories are characterized by a short growing season, low temperatures, difficult soil conditions and limited availability of traditional agricultural crops. The article considers the possibilities of increasing crop productivity using innovative means: adapted varieties of agricultural crops, modern agricultural technologies, plant protection products, digital technologies and low-mechanization. Particular attention is paid to the economic feasibility of introducing innovations and their impact on the sustainability of the agricultural sector in the northern regions.

1 Introduction

Crop production is one of the key sectors of the agro-industrial complex and plays an important role in ensuring food security for the country. In the context of climate change, population growth and increasing demand for agricultural products, increasing production efficiency is becoming especially relevant, especially in difficult natural and climatic conditions.

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The northern regions of the Russian Federation, characterized by a short growing season, low temperatures, difficult soil conditions and limited infrastructure, require the implementation of innovative solutions for the sustainable development of crop production. However, issues of increasing the efficiency of crop production using modern technologies remain insufficiently studied in relation to other regions with special socio-economic and natural conditions, for example, the Chechen Republic. Despite a more favorable climate compared to traditional northern regions, the republic faces a number of specific problems: a shortage of qualified personnel, limited access to modern technologies, a weak level of technical equipment and insufficient financial support from regional structures. The purpose of this study is to analyze the possibilities of increasing the efficiency of crop production in the northern regions of the Russian Federation and the Chechen Republic using innovative means, such as adapted varieties of agricultural crops, modern agricultural technologies, digitalization of the agro-industrial complex (Fig. 1), small-scale mechanization and plant protection products. Particular attention is paid to the economic feasibility of introducing innovations and their impact on the sustainability of the agricultural sector in various climatic and socio-economic conditions. The study is aimed at identifying successful practices, formulating recommendations for state support, developing a scientific and technical base and training qualified personnel for the sustainable development of crop production in hard-to-reach and mountainous foothill areas. The main problem hindering the effective digital transformation of the agro-industrial complex (AIC) is the insufficient development of the domestic electronic base. In this regard, one of the priority tasks by 2022 was to increase the share of Russian innovative electronic products used in AIC digitalization projects to 37.5%. In order to implement this task, the Ministry of Agriculture and Food of the Russian Federation provided funding for the departmental project on digitalization of the AIC in the amount of 118 billion rubles for the period from 2019 to 2024.

2 Methods and materials

To achieve the set goals and objectives, both general scientific and specialized methods of analysis were used in the course of the study. At the initial stage, the system analysis method was used, which allowed us to consider crop production as a complex multi-level system, including agrotechnical, climatic, economic and social components.

To study the state of the industry and identify the main problems, comparative analysis methods and a statistical method were used, which involve the processing of official statistical information on crop yields, crop areas, the level of mechanization and other indicators in the northern regions of the Russian Federation and the Chechen Republic.

In order to assess the effectiveness of the use of innovative technologies, an economic and mathematical analysis was carried out, including the calculation of profitability, payback periods for investments and a comparison of production costs when using traditional and innovative methods of crop production.

To study the opinions of specialists and farmers, questionnaires and interviews were used, which made it possible to identify the level of awareness of modern technologies, motivation for their implementation and the main barriers to the modernization of

production. The results were processed using methods of mathematical statistics and qualitative data analysis.

An expert method was also used, involving specialists in the field of agronomy, agricultural economics and public administration to assess the relevance of the identified problems and develop practical recommendations.

The work used modeling and forecasting methods, which made it possible to develop scenarios for the development of crop production with various approaches to the implementation of innovations and assess their impact on the sustainability of the agricultural sector in the long term.

The integration of the obtained data was carried out using the method of complex analysis, which made it possible to form a holistic view of the relationships between climatic, economic, social and technical factors affecting the efficiency of crop production in the northern regions of the Russian Federation and the Chechen Republic.

3. Results. Eugenics: the genesis of the concept

The conducted study yielded systematized data reflecting the impact of innovative technologies on increasing the efficiency of crop production in the northern regions of the Russian Federation and the Chechen Republic. The analysis covered technical, economic and social aspects of implementing modern solutions, which made it possible to identify key problems, assess the feasibility of using innovations and develop recommendations for further development of the industry.

At the level of technical factors, it was found that the degree of wear of the agricultural machinery fleet in the northern regions of the Russian Federation exceeds 70%, which significantly limits the production capabilities of farms. The introduction of small-scale mechanization — such as mini tractors, attachments and unmanned aerial vehicles — helped to reduce labor costs by 25–30% and increase the efficiency of work. Of particular interest were the results of using digital technologies: the use of precision farming systems and GPS navigation in farms in the Arkhangelsk Region and the Komi Republic ensured an increase in crop yields by 15–20%.

In the Chechen Republic, the level of equipment with modern equipment remains low — less than 20% of farms use equipment that meets modern requirements. However, the use of mobile applications for monitoring the weather, crop conditions and irrigation management demonstrates good results and has the potential for scaling up, especially in mountainous and foothill zones, where adaptation to microclimatic conditions is important.

Analysis of economic feasibility showed that the cost of implementing innovative technologies, including the purchase of equipment, personnel training and adaptation of varieties, ranges from 1.5 to 5 million rubles for an average enterprise. The payback period for investments varies from 2 to 5 years, depending on the type of technology and regional conditions. State support programs, such as subsidies and preferential loans, can reduce the payback period by 1-2 years, which makes the implementation of innovations economically justified.

In the Chechen Republic, limited access to financial resources and high lending costs (up to 20% per annum) are the main obstacles to modernization. Nevertheless, projects implemented with state support demonstrate an increase in profitability by 10-15%, which confirms the economic efficiency of innovative approaches in the presence of appropriate public policy instruments. Sociological research, including questionnaires and interviews with employees of agricultural enterprises, showed that more than 60% of farmers and agronomists have insufficient knowledge about the possibilities of using innovative

technologies. The introduction of training and education programs in the Arkhangelsk Region led to a significant increase in the level of qualification of specialists and a 40% reduction in errors in the use of agricultural technologies. At enterprises where regular training events were held, there was an increase in interest in the introduction of new working methods and the formation of a culture of perceiving innovations as a strategic advantage. In the Chechen Republic, a low level of trust in new technologies and the prevalence of traditional farming methods remain significant barriers to the introduction of innovations. However, the experience of some farms that have introduced drip irrigation, greenhouse complexes and elements of precision farming demonstrated positive dynamics, including increased productivity and interest from young people in modern methods of crop production. Thus, the results of the study confirm the need for an integrated approach to improving the efficiency of crop production, which should include the modernization of the technical base, ensuring the availability of financing, developing a system of professional training and taking into account regional characteristics. It is especially important to adapt innovative solutions to the conditions of northern and mountainous foothill regions, where climatic, infrastructural and socio-economic features are combined. The data obtained can be used in forming strategies for the development of the agro-industrial complex, improving the regulatory framework and developing programs for state support of agriculture.

4. Discussion

This subsection presents a discussion of the results of a study devoted to the technical and technological aspects of increasing the efficiency of crop production in the northern regions of the Russian Federation and the Chechen Republic. The analysis covered such areas as the level of mechanization, the introduction of small-scale mechanization, the use of digital technologies, the availability of service infrastructure, and the adaptation of equipment to regional climatic and soil conditions. The study showed that the degree of physical wear and tear of tractors and combines in the northern regions of Russia (Arkhangelsk Region, Komi Republic, Nenets Autonomous Okrug) averages 72–80%, indicating a critical state of the agricultural machinery fleet. More than 45% of farms do not even have basic mechanization to perform basic operations, from soil preparation to harvesting. This leads to reduced productivity, longer work times, and a high level of product losses. In such conditions, the introduction of small-scale mechanization, including mini tractors, attachments, and unmanned aerial vehicles, is of particular importance. Farms that have implemented these technologies have recorded a 25-30% reduction in labor costs, a 15-20% increase in the speed of field work, and an increase in the accuracy of plot processing, especially in difficult terrain and a limited growing season. These data confirm that the modernization of the technical base through the introduction of small-scale mechanization is one of the key factors in increasing the sustainability of crop production in the northern regions.

Particular attention during the study was paid to the use of digital technologies in crop production. The analysis showed that their implementation in the northern regions of Russia is still limited - only 12-15% of farms use elements of precision farming. However, the experience of experimental farms in the Arkhangelsk region, which have implemented GPS navigation systems, remote monitoring of crop conditions and automated distribution of fertilizers, demonstrated significant effects:

• Reduction in the cost of mineral fertilizers by 20-25%;
• Reduction in pesticide consumption by 15-18%;
• Increase in the yield of main crops (oats, barley, potatoes) by 15-20%.

These effects are explained by a more precise approach to crop management, which allows minimizing risks and increasing the economic efficiency of production. Such technologies are especially relevant in the conditions of a short growing season and high cost of agricultural resources.

In the Chechen Republic, the digitalization process is at an early stage, but there are already positive examples of the use of mobile applications for weather monitoring, crop planning and irrigation management. For example, in some greenhouses, software control of the microclimate has been introduced, which has reduced water consumption by 30%, increased product yield by 15-20% and improved the quality and uniformity of ripening of vegetables. This suggests that even minimal steps towards digitalization can bring significant economic and environmental benefits, especially in mountainous and foothill areas with special growing conditions.

Special attention was paid to the development of service infrastructure. It was found that in the northern regions the number of authorized service centers is extremely limited: for example, in the Komi Republic there is a service center for 3 thousand km², and in the Nenets Autonomous Okrug there are no stationary services at all, and equipment repair is carried out by the farms themselves or with the help of mobile teams. The lack of a local repair base leads to increased equipment downtime and increased maintenance costs, especially during periods of active field work, when a delay of even a few days can lead to a significant decrease in crop yields.

In the Chechen Republic, the situation with service also remains difficult: only 18% of farms have access to professional equipment repair services, about 65% of equipment owners carry out preventive maintenance and repairs on their own, which increases the risk of accidents and reduces the service life of the equipment. To solve this problem, it was proposed to create regional technical centers that provide diagnostics, repair and personnel training services. Pilot projects implemented in other regions have shown that such centers are capable of:

• Reducing equipment downtime by 40–50% ;
• Improve the qualifications of mechanics and operators;
• Provide access to spare parts and components.

In addition, the study covered the issues of the conformity of the equipment used to climatic and soil conditions. In the northern regions, its resistance to low temperatures, the ability to work on swampy and frozen soils, as well as compactness and mobility for work in small fields are of particular importance. In the Chechen Republic, on the contrary, it is necessary to adapt the equipment to the mountainous terrain and changeable weather conditions. A number of farms have already begun to use speci modified machines for terrace soil cultivation, which made it possible to:

• Reduce soil erosion on slopes;
• Increase site productivity;
• Improve water collection and moisture retention.

These examples confirm the need to develop and implement specially adapted equipment that takes into account the climatic and topographic features of each region.

Thus, the analysis of technical and technological aspects of increasing the efficiency of crop production in the northern regions of the Russian Federation and the Chechen Republic made it possible to identify both general trends and regional specifics. The key problems are the high degree of wear of equipment, insufficient implementation of small-scale mechanization and digital technologies, poorly developed service infrastructure and limited adaptation of equipment to local conditions. At the same time, the study confirmed the high efficiency of introducing small-scale mechanization, precision farming systems and regional technical centers. These measures should become part of a comprehensive strategy for the modernization of crop production, aimed at the sustainable development of the agricultural sector in various natural and climatic conditions. This subsection examines the economic and social factors that influence the implementation of innovative technologies and the improvement of the overall efficiency of crop production. The analysis covers the availability of financing, the level of personnel qualifications, the motivation of farmers to modernize, as well as the role of government support and public perception of innovations.

1. Financial accessibility and economic feasibility of implementing innovations

The study showed that the cost of implementing modern technologies — from the purchase of small-scale mechanization to the implementation of digital crop management systems — ranges from 1.5 to 5 million rubles for an average agricultural enterprise. At the same time, the payback period for investments depends on the type of technology, the scale of production and regional conditions and ranges from 2 to 5 years.

In the northern regions of Russia, where the accuracy and reliability of equipment are especially important due to the short growing season and high climatic risks, the implementation of innovations allows:

• To reduce production losses by 10-15%;
• To increase profitability by 8-12%;
• To increase the competitiveness of products in the domestic market.

State support programs such as subsidies, preferential loans and leasing play a special role in ensuring financial accessibility. The introduction of these tools reduces the payback period of investments by 1-2 years, making them economically feasible even for small farms.

In the Chechen Republic, limited access to financial resources remains one of the main reasons for the low level of technical equipment. The average interest rate on loans for the development of the agro-industrial complex is 18-20% per annum, which makes them inaccessible to most farmers. However, projects implemented with state support demonstrate an increase in profitability by 10-15%, which confirms the economic efficiency of innovative approaches in the presence of appropriate public policy instruments.

2. Personnel qualification level and access to training

An analysis of the state of human resources showed that more than 60% of farmers and agronomists have insufficient knowledge of the possibilities of using innovative technologies. This is especially true for remote and mountainous areas, where traditional farming methods prevail over modern ones. At the same time, the

survey and interviews conducted during the study revealed that the introduction of training and education programs significantly increases interest in innovation. For example, in the Arkhangelsk region, after organizing courses on working with GPS navigation and automated fertilizer distribution systems, the following was observed:

• A 40% reduction in errors in the use of agricultural technologies;
• An increase in interest in new working methods among young specialists;
• An increase in trust in digital solutions among the older generation of farmers.

A similar situation is observed in the Chechen Republic: a low level of trust in new technologies is combined with a shortage of qualified personnel. However, the experience of some farms that have introduced drip irrigation, greenhouse complexes and elements of precision farming has demonstrated positive dynamics, including increased productivity and interest from young people in modern methods of crop production.

To solve the problem of personnel training, it is proposed to create regional centers for advanced training that cooperate with agricultural universities and research organizations. Such centers could conduct:

• Training in working with modern equipment;
• Practical classes on the use of digital technologies;
• Advisory support for farmers and cooperatives.

3. The role of state support and public perception

State support is a key factor contributing to the introduction of innovations in crop production. In the northern regions of Russia, programs are already in place aimed at:

• Subsidizing the purchase of small-scale mechanization;
• Preferential lending for innovative projects;
• Grant support for young farmers.

These measures have increased the share of farms using modern technologies from 12% to 25% over the past three years.

In the Chechen Republic, state support is still poorly developed, but pilot projects implemented jointly with the Ministry of Agriculture of the Russian Federation are already showing good results. For example, in 2023, several programs were launched to subsidize the construction of greenhouse complexes and the introduction of drip irrigation systems, which led to:

• An increase in the area under protected soil by 20%;
• An increase in vegetable production by 30%;
• The creation of new jobs in rural areas.

It is also important to note the influence of public perception of innovations on their dissemination. The study showed that in the context of a traditional social structure (for example, in Chechnya), the introduction of new technologies requires not only technical and financial support, but also the formation of a positive image of innovation through opinion leaders, local elders and professional communities. Thus, the analysis of economic and social aspects of increasing the efficiency of crop production showed that the introduction of innovations is impossible without addressing the issues of financial accessibility, personnel qualifications and state support. The key measures are:

• Expansion of subsidy and preferential lending programs;
• Creation of regional centers for advanced training;

• Development of state support mechanisms adapted to the conditions of each region;
• Formation of a culture of perception of innovations through opinion leaders and educational campaigns.

These measures should become part of a comprehensive strategy for the development of crop production, focused on the sustainable economic and social development of rural areas.

One of the key factors in increasing the efficiency of crop production is state support, which makes the introduction of innovative technologies economically feasible for small and medium-sized farms. In the Arkhangelsk Region, a regional program for subsidizing the purchase of small-scale mechanization is being implemented, within the framework of which farmers receive compensation of up to 50% of the cost of equipment. This has made it possible to significantly increase the share of farms using modern equipment - from 12% to 35% in three years. In 2023, the Chechen Republic launched a pilot program to subsidize the construction of greenhouse complexes and introduce drip irrigation systems, which led to a 20% increase in the area under protected soil, a 30% increase in vegetable production, and the creation of more than 50 new jobs. Based on these examples, the following recommendations are proposed: expanding subsidy programs, developing special lines of preferential lending and leasing, introducing regional grants for young farmers and start-ups, and creating a mechanism for targeted state support for projects aimed at improving food security in difficult climatic conditions. An equally important area is the development of a scientific and technical base that ensures the adaptation of technologies to local conditions. In the Komi Republic, adapted varieties of potatoes and grain crops resistant to cold climates and short daylight hours were developed in cooperation with the Northern (Arctic) Federal University. Their introduction increased yields by 15–20%. The Chechen State Agricultural University has created experimental plots for growing vegetable crops using drip irrigation and microclimate software control, which has reduced water consumption by 30% and increased yield by 20%. It is recommended to organize regional agricultural research centers focused on developing varieties and technologies adapted to local conditions; support experimental activities in precision farming, water-saving technologies and environmentally sustainable crop production; introduce partnerships between science and business; develop pilot projects for the use of small-scale mechanization and digital solutions in agriculture. Training and retraining of qualified personnel plays an equally important role in the modernization of the industry. In the Arkhangelsk Region, there is a program to improve the skills of machine operators and agronomists in working with digital technologies. After completing the courses, there is a 40% decrease in errors in the use of equipment, an increase in interest in innovations among young people and an increase in trust in new technologies among the older generation of farmers. Similar experience is available at the Chechen State Agrarian University, where a program for training students and young specialists to work with modern agricultural technologies has been launched. Graduates of this program are already implementing new technologies in a number of farms, which has increased productivity and product quality. It is proposed to create regional centers for advanced training, collaborating with universities and research organizations; introduce practice-oriented training with an emphasis on working with small-scale mechanization and precision farming systems; organize training directly in the fields - in the form of "farmer schools" or mobile training complexes; develop mentoring and coaching, especially in the context of a traditional society, where an authoritative opinion plays a key role; introduce professional retraining programs for

current workers in the agro-industrial complex, focused on digitalization and innovative farming methods. An important element of sustainable development is the creation of regional technical centers and the development of service infrastructure. In the Novgorod Region, regional technical centers are successfully operating, providing services for the repair, diagnostics and maintenance of agricultural machinery. This experience has shown a reduction in equipment downtime by 40-50%, an increase in the level of qualification of mechanics and the provision of spare parts availability. In Chechnya, the experience of creating temporary mobile maintenance teams in mountainous areas has proven effective, which provide assistance in the prevention and repair of equipment and carry out maintenance work.

3 Conclusion

This article attempts to discuss the problem of demographic development, strengthening the health of the population through the establishment of family and marriage relations. The fact is that under the conditions of information technology, family and marriage identification of people is difficult, which is a direct threat to the health of the future generation, adultery has become the norm in many countries and societies, which is contrary to the traditional way of life and the values of family life. Thus, gender policy also negatively affects the strengthening of the foundations of the marriage family, which resulted in an urgent need for personal identification during marriage. Thus, the positive policy of eugenics is the most important condition for the demographic culture of the peoples of the world, the preservation of the moral culture of the human race.

The article outlines the subject of eugenics, key approaches to improving the birth of new talented generations of the Uzbek people, it is shown that the desire to ensure a healthy generation is most fully consistent with the social policy of the population of the republic.

According to statistics in the republic, at the end of 2020, the population of Uzbekistan was

33,723,529 people. In 2020, the population of Uzbekistan increased by approximately 496,740 people. Given this, the population of Uzbekistan at the beginning of the year was estimated at 33,226,789 people, the annual increase was 1.49% [Population of Uzbekistan for 2020].

The Uzbek people are characterized by a close connection with their ancestors, loyalty to national traditions, love for their native land, a desire to know their ancestors and ask God to bless them. The family, as the basis of the clan, unites all relatives in the same territory at the place of residence, which the elders control. The peculiarity of the social anthropology of the peoples of the region lies in the fact that it focuses on the social requirements of the family and marriage relations of the Muslim society, the establishment of a healthy, energetic and active generation as a condition for social progress. Scientists put forward a number of arguments characterizing the negative and positive sides of eugenics, which is being established in the name of meeting the needs of national interests to strengthen the gene pool of the Uzbek people.

Modern eugenics research is research conducted to strengthen the family and marriage, aimed at heredity and natural selection, raising a physically and spiritually developed generation to take its place in the world community. In recent years, not only a massive increase in hereditary and oncological diseases, but also spiritual and moral decay in public

life has become more and more common: child pregnancy, criminal offenses with newborns, prostitution and drug addiction.

Our concept assumes that positive eugenics is the development of the idea of strengthening national genetics, the health of the population, in which human rights and freedoms prevail. One of the priorities of the government's social policy is to create a reliable system of measures to develop high-quality demographic growth, prevent the transmission of hereditary diseases, improve the health of those who marry, and revive national traditions of family lifestyle. Such scientific guidelines fit well with the general concept of social policy and socio-anthropological knowledge.

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